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XXXXVII Academic Council

Department of Mechanical Engineering

31st BOS meeting minutes

Minutes of the 31st BOS meeting-Mechanical Department held on 04-08-2026 in Hybrid mode in room no.M118(HOD Chamber) from 2:00 pm onwards.

Following is the link for the meeting

https://meet.google.com/yqw-xqho-ttf

The following members were present

1. Dr.K.V.Durga Rajesh, Associate Professor, I/C HOD-ME & Chairman BOS
2. Dr.T.Vijaya Kumar, Associate Professor, HOD-ME
3. Dr.K.Rama Krishna, Professor, Dean IQAC
4. Dr. G.Murali, Professor, Group Head-Energy & CFD
5. Dr.S.N.Padhi, Professor, Group Head-Design & Manufacturing
6. Dr.S.S.Rao, Professor, Group Head-Smart Manufacturing
7. Dr. D.V.A. Rama Sastry, Associate professor
8. Dr.G.Yedukondalu, Associate Professor, associate Dean Skill Development & Progression
9. Dr. Priyaranjan Samal, Assistant Professor, Prof I/C Exams & OBE
10. Dr.K.Sai Sarath,Assistant Professor, Prof I/C Counselling & Faculty affairs
11. Dr .T. Kanthimathi, Assistant Professor, Professor I/C Academics
12. Dr.A.Venu Gopal, Professor & Dean Academics, NIT Warangal
13. Dr. P. Srinivasa Rao, Global Training Head, Cyient Technologies, Hyderabad
14. Dr. K.Ravi Teja, Senior Manager, R&D, Hyundai R&D Division, Hyderabad

BOS Chairman welcomed the members and presented the Agenda items for the meeting

Agenda-1: To present the significant events of the department from December 2025 to till date

Chairman BOS presented the following significant events of the department from December 2025 to till date.

Honours Received by Students:

- Mr. N.Sai Ananth (2300070011), was awarded gold medal at State Skills Competition-2025 in the skill categoryAdditive Manufacturing held at VVIT on 19th December 2025 as part of India Skill Competitions.

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- Ms. K.Eesha (2300079018), was awarded silver medals at State Skills Competition-2025 in the skill category Additive Manufacturing held at VVIT on 19th December 2025 as part of India Skill Competitions.
- .Mr. B. Harshith Singh (2200070006) was awarded as winner in State level competition in Additive manufacturing held from 19th to 20th December 2025, Hyderabad given by Department of Employment & Training, Government of Telangana.
- Mr.Ayush Avuri (2200070012), Emerged as winner and secured first position in PRAGNA of LAKSHYA held on 03-01-2026 at Lakireddy Bali Reddy College of Engineering, Mylavaram, A.P, India.
- Mr. B. Harshith Singh (2200070006), Awarded with the Medallion for Excellence in Additive Manufacturing at India Skills 2025–26 Regional Competition – Southern Region from Feb 21-25, 2026 held at Kanha Shanti Vanam, Hyderabad, conducted by National Skill Development Corporation (NSDC) under the Ministry of Skill Development & Entrepreneurship, Government of India.







Placement Details:

- Mr.Velagapudi Sathvik Prasad (2200079037-IV year B.Tech Student), is palced in NEXPERT industrial Company, Saudi Arabia with a pay package of 81 LPA.
- Mr.Chandu Naidu (2200079007-IV year B.Tech Student), is placed in Porite Corporation (Japanese Company) with a Pay Package of 28 LPA.
- Mr.D.Nanda Kishore (2200079026- IV year B.Tech Student), is placed in Tiger Machines Co. Ltd (Japanese Company) with a Pay Package of 27.08 LPA.

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- Mr.K.V.Sai Siva Kushmit (2300070031-III Year B.Tech Student) is placed in AUTOPIA (Japanese Company) with a CTC of 20 LPA.

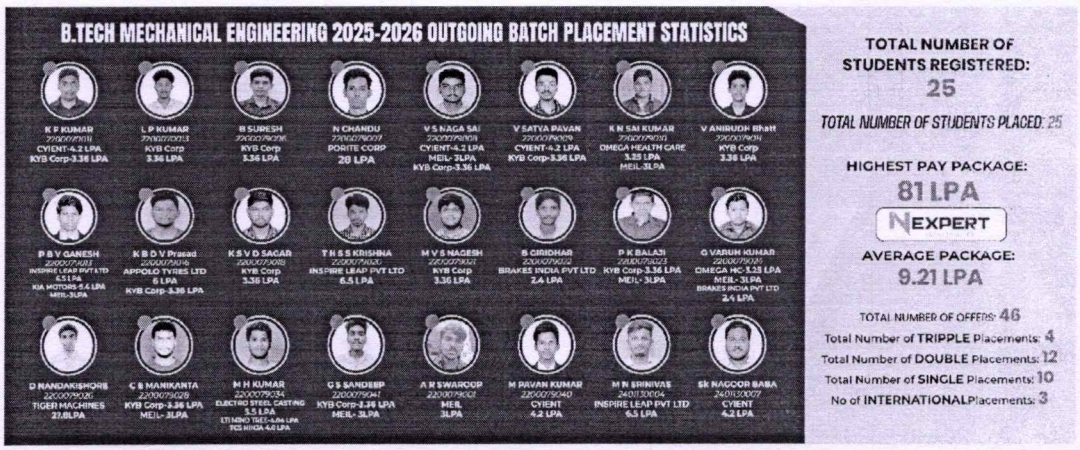
- Mr.S.Akhil (2300070006-III Year B.tech Student) placed in AUTOBACS (Japanese Company) with a CTC of 20 LPA.

- Mr.Abhiram Chowdary (2300070010 III year student) & D.Joseph Jakwes (2300070015 III year student), Placed in Keisei Jidousha Seibi Company limited (Japanese Company) with apa package of 20 LPA.

- Mr.Ambati Ram Swaroop (2200079001-IV year student), placed in Arcelor Mittal Nippon Steel India with a pay package of 6 LPA.

- Mr.K.Bala Durga Vara Prasad (2200079016-IV year Student) placed in Apollo tyres with a a pay package of 6 LPA.

- Mr.P.Bala Venkata Ganesh Prasad (2200079013 IV year student) placed in KIA motors with a pay package of 5.8 LPA



Ph.D Awarded:

S. No.	Dept.	Name of the Faculty/Scholar	Name of the Supervisor	Month and Year
1	ME	Ms.Varalakshmi Penugonda	Dr.G.Murali	January-2026
2	ME	Mr. Pureti Siva Naga Masthan Vali	Dr.G.Murali	January-2026
3	ME	Mr.Surase Ravindra Sahebrao	Dr.K.RamaKrishna	April-2026
4	ME	Mr. Alla V R Surya Prasad	Dr.M.Nageswara Rao	June-2026

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	NSS Activities conducted through Virtual Mode

S. No.	Dept.	Details of NSS Activities	Conducted On
1	ME	NSS Unit-7, Department of Mechanical Engineering organized a NSS Event on "Awareness on Conservation of Water" at Tummapudi Village, Near Tenali, Andhra Pradesh on 04th April 2026 (Saturday)	04-04-2026



Resolution: BOS members appreciated the achievements of the department

Agenda item:2

Agenda: To approve the DAC resolutions conducted on 11-07-2026.

Chairman BOS presented the following deliberations on Stakeholders feedback at the DAC meeting, which was held on 11-07-2026.

- Dr.K.Ramakrishna, recommended the following revisions in Thermodynamics and Heat transfer courses and also suggested to include course of air conditioning and battery management for Y25 and Y26 admitted batches.

  i. Include Gas Power and Vapour power cycles in Thermodynamics course to make students understand the applications of thermodynamic concepts.

  It is resolved to approve the recommendation and rename Thermodynamics course as **Thermodynamics and Energy Conversion Systems** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students

  ii. Include the topics on Electronic/Component cooling and heat sink

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design in heat transfer course so that students will be learning the concept of designing in thermal systems.

It is resolved to approve the recommendation and rename Heat Transfer course as **Heat Transfer and System Design** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students.

iii. Include a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centers/EV's etc.,

It is resolved to approve the recommendation and include a new course **HVAC and Battery Thermal Management Systems** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students.

- Dr.B.Nageswar Rao-Professor, suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.

  It is resolved to approve the recommendation and to offer a new course titled **Mathematics for Mechanical Engineers** to Y25 & Y26 (Regular & Trimester) admitted B.Tech Students.

- Dr.S.V.S.Narayana Murthy, Industry person, suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.

  It is resolved to offer new course **Digital manufacturing** in place of Advanced manufacturing by including the suggested concepts to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.Satish Ben, academic peer, suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.

  It is resolved to offer **Computer Aided Engineering and Simulation** course in place of Finite Element Analysis and Analysis of Energy Systems to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

Detailed stake holders feedback and action taken report is given in **Annexure-1**.

The DAC meeting minutes are given in **Annexure-2**.

Resolution: It is resolved to approve the DAC resolutions and recommend the same to the academic council for further approval.

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Agenda item:3

Agenda: To approve the modifications proposed for the curriculum of Y25 B.Tech Mechanical Engineering admitted batch students

Chairman BOS presented the following modifications proposed to the curriculum of Y25 B.Tech admitted batch students

- Dr.A.Srinath, recommended to modify the syllabus of Robotics and Mechatronics (Flexi core) course by including Robot programming using Python as Robo programming increases the opportunities in placement drives.

  It is resolved to modify the syllabus of Robotics and Mechatronics by including Robo programming using Python and rename the course as **Robotics and Mechatronics** and offer it as Professional Core course to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.A.Srinath, Dr. S.N.Padhi and members of Design group suggested the following modifications to Design related courses

  i. Concepts of thermal stresses and power transmission are added to Mechanics of solids course by removing the concept of truss, since this topic is covered in Mechanics course. The course title is changed from Mechanics of Solids to **Mechanics of Deformable Solids to** Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

  ii. Kinematics and Dynamics of machines course is suggested to offer as two courses **Kinematics of Machines** and **Machine Dynamics and Vibrations**, so that students will be well equipped with the concepts of vibration required in many engineering applications to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

  iii. Concepts on product development, integrated product design with cost accounting and simulation based assembling with AI related design reviews were suggested to include in Machine Design course and rename it a **Machine Design and Product Development** to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.S.S.Rao and the members of Manufacturing group suggested the following modifications to Manufacturing cohort related courses

  i. In **Material Science and Metallurgy** course, concepts like Characterization of materials (XRD, SEM analysis), additive manufacturing, Stress strain behavior of materials and advanced materials are included and also the modules were reshuffled to make students understand the concepts sequentially. These modifications are proposed to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

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ii. It was proposed to add topics on welding, production planning, materials, quality testing in Manufacturing processes and technology course by removing topics on Geometric Dimensioning & Tolerancing and rename it as **Manufacturing and Production Systems**. It is also recommended to offer a new course on **Geometric Dimensioning and Tolerancing**, since most of the core placement companies are suggesting to include this course. These modifications are proposed to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.Murali and the members of Energy & CFD group suggested to reframe the syllabus of **Fluid Mechanics and Hydraulic Machines** by including simulation related experiments in the lab component to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Dr. Jeswin JayaSingh, Industry person, suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the inductries.

  It is resolved to offer a new course **IOT for Smart Manufacturing** as per the recommendation to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Dr.D.V.A.Rama Sastry, suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field.

  It is resolved to offer **Generative AI for Engineering Design** course as per the recommendation to Y25 and Y26 (Regular & Trimester)admitted batch B.Tech Students.
- Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems.

  It is resolved to offer new courses **Fundamentals of IOT and Sensors, Full Stack Web Development** and **Embedded System Design & IOT** as per the recommendations to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Based on the recommendations of the group heads and their respective group members it is proposed to offer **Smart Manufacturing and Digital Engineering** specialization to Y25 & Y26 (Regular & Trimester) admitted batch B.Tech Students by including Green and Sustainable development. Following are the proposed courses under this specialization.

  i. Green and Sustainable Manufacturing technologies
  ii. Autonomous Robotic Systems
  iii. Integrated Energy Systems for Smart Industries

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iv. Mechanics of Advanced Materials

v. Digital Twin Engineering and Manufacturing Analytics

It is resolved to propose the new specialization and courses in place of Engineering Design, Smart Manufacturing and Automotive Energy Engineering specializations to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.P.Srinivas Rao, suggested that the courses Digital manufacturing, IOT for smart manufacturing and Embedded System Design & IOT are related to Industry 5.0. he enquired that any core course is removed to offer these courses. Chairman BOS replied that all these courses are offered without sacrificing any core course.
- Dr.A.Venu Gopal appreciated the inclusion of AI concepts into the regular curriculum. He also suggested that by the time Y25 & Y26 students are graduated they will be well equipped with the much needed AI tools.
- Dr. P. Srinivasa Rao, recommended to include the concepts of Machine vision and inspection concepts into the course Geometric Dimensioning and Tolerancing, Chairman BOS assured that the decision will be taken after discussion with the concerned group members.
- Dr.K.Ravi Teja, enquired about the syllabus of Generative AI for Engineering Design and he suggested that before this course is offered students must be aware of FEA and simulation concepts. Chairman BOS presented the course structure of Y25 regulation and informed to the member that simulation and FEA concepts are covered before offering Generative AI course.
- Dr.P.Srinivas Rao, requested to present the syllabus of open elective course Precision Agriculture & Data Driven Farm Management and recommended to go ahead with the syllabus, as it is in line with the present day agricultural technology.
- Dr. Ravi Teja, suggested to integrate the software tools like MAT lab, ANSYS and solidworks in the course modules of the course **Computer Aided Engineering and Simulation** instead of a separate module so that students will understand the simulation process. Chairman BOS informed the member that from Y25 regulation the lab and skill concepts are integrated with the regular modules so that the practical concepts are clearly understood by the students.

Courses Introduced for Y25 B.Tech admitted batch

S.No.	Course Code	Course Title	Category	Remarks
1	25MT2020	MATHEMATICS FOR MECHANICAL SYSTEMS	BSC	Suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.
2	25EC1203	FUNDAMENTALS OF IOT AND SENSORS	ESC	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems

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3	25SC2008	FULL STACK WEB DEVELOPMENT	ESC	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
4	25EC2206	EMBEDDED SYSTEM DESIGN AND IOT	ESC	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
5	25ME3111	IOT FOR SMART MANUFACTURING	PCC	Suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the inductries
6	25ME3112	COMPUTER AIDED ENGINEERING AND SIMULATION	PCC	Suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.
7	25ME3113	DIGITAL MANUFACTURING	PCC	Suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.
8	25ME3115	MACHINE DYNAMICS AND VIBRATIONS	PCC	Based on the feedback from faculty the course is offered with the concepts of Dynamics of machines and vibrations which is the requirement in many design related industries
9	25ME3217	GENERATIVE AI FOR ENGINEERING DESIGN	PCC	Suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field
10	25ME4119	HVAC & BATTERY THERMAL MANAGEMENT SYSTEMS	PCC	As per the suggestion of faculty, a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centres/EV's etc.,
11	25SMD3111	GREEN AND SUSTAINABLE MANUFACTURING TECHNOLOGIES	PE-1	Based on the recommendations of the group heads and their respective group members it is proposed to offer Smart Manufacturing and Digital Engineering specialization by including Green and Sustainable development
12	25SMD3221	AUTONOMOUS ROBOTIC SYSTEMS	PE-2	
13	25SMD3231	INTEGRATED ENERGY SYSTEMS FOR SMART INDUSTRIES	PE-3	
14	25SMD3341	MECHANICS OF ADVANCED MATERIALS	PE-4	
15	25SMD3351	DIGITAL TWIN ENGINEERING & MANUFACTURINGANALYTICS	PE-5	

Proposed revisions in the courses offered to Y25 admitted batch students

S.No.	Course Code	Course Title	Category	% of Revision	Remarks
1	25ME2120	SCIENCE ELECTIVE - 2 (MATERIAL SCIENCE AND METALLURGY)	BSC	25%	As per the feedback received, suggested topics were added so that students will be exposed to latest technological advancements in the field of material science
2	25ME2105	MECHANICS OF DEFORMABLE SOLIDS	PCC	25%	As per the feedback received, suggested topics were added to the syllabus to educate the students on various theories of failure
3	25ME2106	THERMODYNAMICS AND ENERGY CONVERSION SYSTEMS	PCC	25%	As per the feedback received, concepts were rearranged and few topics were added so that all advance concepts are included in the course

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4	25ME2207	FLUID MECHANICS AND HYDRAULIC MACHINES	PCC	25%	As per the discussions in Energy group meeting the proposed topics are incorporated into the syllabus as per the requirements of CFD concepts by thermal related companies
5	25ME2208	MANUFACTURING AND PRODUCTION SYSTEMS	PCC	50%	As per the feedback of stakeholders the proposed topics are added to the course as these are the topics which are not covered in any course and are needed for GATE
6	25ME2209	ROBOTICS AND MECHATRONIC SYSTEMS	PCC	25%	As per the feedback of faculty it is necessary to include Robo programming in Robotic and Mechatronic Systems to increase the opportunities in placement drives
7	25ME2210	KINEMATICS OF MACHINES	PCC	25%	Based on the feedback of Engineering Design group head the course Kinematics and Dynamics of machines course is split into two courses and the topics are rearranged by removing certain topics and adding few concepts
8	25ME3114	HEAT TRANSFER AND SYSTEM DESIGN	PCC	30%	Based on the feedback given by faculty members new concept on new transient intuition, combined-convection-radiation and thermal systems design which includes electronics cooling and design is added as these are identified as the need of thermal based industries
9	25ME3216	MACHINE DESIGN AND PRODUCT DEVELOPMENT	PCC	70%	Based on the feedback of faculty product Development concepts are added also topics on failure theories, material selection are included so that the student is made well equipped with all the concepts related to machine design
10	25ME3218	GEOMETRIC DIMENSIONING AND TOLERANCING	PCC	50%	Based on the feedback of faculty, Material Conditions and Metrology and Inspection concepts are included in the course to cover all the topics related to dimensioning

The detailed Course Structure of B.Tech Y25 regulation is give in **Annexure-3**.

The syllabus for the new courses introduced for Y25 B.Tech regulation is given in **Annexure**-4.

The detailed revisions proposed in the syllabus of Y25 BTech regulations is given in **Annexure-5**.

Resolution: It is resolved to approve the modifications proposed to the curriculum of Y25 admitted batch students and recommend the same to the academic council for further approval.

Agenda item:4

Agenda: To approve the course structure and curriculum of Y26 (both Semester and Trimester modes) B.Tech admitted batch students.

- Chairman BOS informed the members that for Y26 B.Tech admitted batch students from II year onwards the curriculum will be same as that of Y25 regulation.
- Chairman BOS informed the members that B.Tech Mechanical programme will be offered in Trimester and semester modes from Y26 admitted batch onwards.

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- Chairman BOS elaborated the credit distribution of Trimester mode of operation for Y26 admitted batch students, He explained that in Trimester mode L-1.5 is 1 credit, T-1.5 is 1 credit, P-3 is 1 credit and S-6 is 1 credit. Ex: for a course with L-T-P-S:3-3-3-6 the total credits will be 6.
- Based on the discussions in the Engineering Design group meeting it is recommended to revise the syllabi of the following course for Y26 Trimester and Regular semester programs
    i. Engineering Graphics syllabus is modified by including the topics of assembly drawing and digital manufacturing designs.

    It is resolved to include the suggested topics in the Graphics course and rename it as **Computer-Aided Design and Drafting** for Y26 (Trimester and Regular) B,Tech admitted batch students.

    ii. Engineering Mechanics syllabus is modified by including the topics on friction to wedges, screw jacks, belts, rectilinear and curvilinear motion.

    It is resolved to include the recommended topics in the Engineering Mechanics course for Y26 (Trimester and Regular) B,Tech admitted batch students.

    iii. It is recommended to change the title of the course Workshop practices for Engineers course as **Mechanical Engineering Workshop** for Y26 (Trimester and Regular) B,Tech admitted batch students.

- Based on the thrust areas identified for the present industries following courses are recommended for Y26 admitted batch B.Tech students
    i. Computational foundations for AI (Trimester and Regular)
    ii. Machine Learning for Mechanical Applications (Trimester and Regular)
    iii. Mathematics for AI and Engineering Application (Trimester and Regular)
    iv. Robotic Perception, Computer Vision & Sensor Fusion (Trimester)
    v. Robotic Motion Planning, Navigation & Control Systems (Trimester)

    It is resolved to offer the above courses for Y26 (Trimester and Regular) admitted B.Tech admitted batch students.

The detailed course structure for Y26 Semester mode of operation is given in **Annexure**-6.
The detailed course structure for Y26 Trimester mode of operation is given in **Annexure-7**.
The syllabus for the new courses in Y26 (Semester and Trimester mode) regulation is given in **Annexure-8**.

Resolution: It is resolved to approve the course structure and curriculum of Y26 (both Semester and Trimester modes) B.Tech admitted batch students and to recommend the same in the upcoming academic council for further approval.

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Agenda item: 5

Agenda: To approve the course structure and curriculum of Y26 (Trimester) M.Tech-Machine Design program.

- Chairman BOS informed to members that M.Tech-Machine Design program is offered in Trimester mode from Y26 regulation onwards.
- As per the feedback received from the alumni Mr.Manikanta(23001130005) M.Tech-MD and based on the discussion in the engineering design cohort, Dr S.N.Padhi Cohort professor I/C suggested the following revisions to Y26 M.Tech-MD curriculum by incorporating AI based designing and PLM concepts.
    1. New Courses Proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S: 3-1-3-0, Cr:3.5
        i. Digital Engineering and PLM for Product Design
        ii. Smart Materials and Structures
        iii. Reliability analysis and predictive maintenance
        iv. Composite Structures and Engineering Materials
        v. Non linear Finite element methods and Multiphysics
    2. Revisions proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S of 3-1-3-0, Cr:3.5
        i. Mechanical Behavoir of Materials course is revised and renamed as **Continuum Mechanics of Deformable Solids.**
        ii. Advanced Strength of materials course is revised and renamed as **Advanced Strength of materials and Design Optimization.**
        iii. Computational Techniques in Engineering Optimization is revised and renamed as **AI based Engineering design Optimization.**
        iv. Robotics manipulator design and analysis course is revised and renamed as **Robot Modelling and Design Analysis.**
        v. Tribological systems design course offered as professional elective is now offered as professional core and renamed as **Tribology.**
        vi. Design of Pressure vessels and Plates course is revised and renamed as **Design of pressure Vessels and Piping.**
        vii. Mechanical Vibrations course outcomes are revised and offered with the same title.
    3. Two streams of professional electives are recommended for Y26 M.Tech-MD admitted batch. Following are the streams and courses in each stream

        Stream-A: Vehicle and Mobility Design

        i. Automotive Vehicle Design

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ii. Powertrain Engineering for EV's and Hybrid's
iii. Vehicle Dynamics and suspension systems
iv. Drone and UAV Mechanical Design

Stream-B: Manufacturing and Industrial Engineering

i. Additive manufacturing and Design for AM
ii. Mechatronics, IOT and Smart Systems
iii. Generative Design and Topology Optimization
iv. Precision Engineering and Metrology

4. Audit course-Professional Communication Skills for Engineers is replaced with **Communication Skills and Technical Writing**. Essentials of Research Design Course is replaced with **Research Methodology and Intellectual Property Rights**.

The detailed course structure for Y26 M.Tech-MD programme is given in **Annexure-9.**

The syllabus for new courses and revised courses of Y26 M.Tech-MD programme is given in **Annexure-10**.

Resolution: It is resolved to approve the course structure and curriculum of Y26 M.Tech-Machine Design (Trimester) Program and to recommend the same to the academic council for further approval.

Agenda item: 6

Agenda: To approve any other point with the permission of chair

- Chairman BoS presented the domains of Value added/Global Certification courses to be offered to Y25 & Y26 admitted B.Tech Mechanical students. Following are the domains to be offered.

  i. CAD
  ii. Computational Thinking
  iii. AI Coding and Design Tools
  iv. Smart Manufacturing
  v. Mechatronics
  vi. Thermal & Energy
  vii. AI for Engineering
  viii. Simulation/CAE

  The detailed list of courses to be offered under these domains is given in **Annexure-11**.

- Chairman BOS presented the open elective streams to be offered to Y25 & Y26 B.Tech admitted batch students. Following is the list of streams to be offered.

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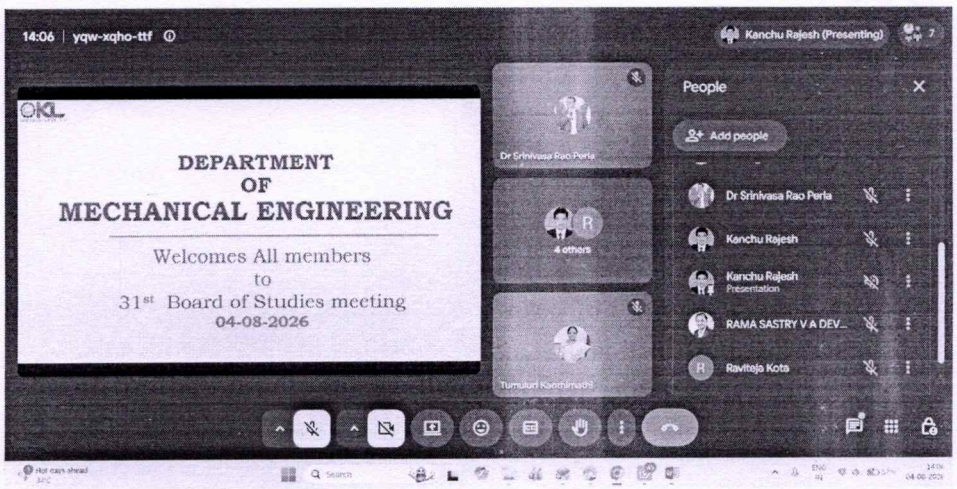
i. AI Business Models, Pricing Strategy & Monetization
ii. Computational Arts & Digital Creative Media
iii. Digital Economics & Platform Market Intelligence
iv. Digital Health & Healthcare Informatics
v. Fintech & Digital Financial Services
vi. Precision Agriculture & AgriTech
vii. Supply Chain Logistics Intelligence

The detailed list of courses offered under each stream is given in **Annexure-12.**

- Chairman BOS informed the members that a new course OEME0007-Fundamentals of Automobiles is offered to Y23 & Y24 admitted batch B.Tech students as open elective in place of Operations Research as the concepts of Operations research are covered to these regulations in Mathematical Optimization course. It is resolved to approve the new open elective for Y23 & Y24 regulations. The syllabus for this course is given in **Annexure-13**.
- Chairman BOS presented the OBE analysis of Y22 regulation and informed that outcome attainment of all courses has reached the threshold value.

Resolution: It is resolved approve the new domains of value added courses and new streams of Open electives for Y25 & Y26 admitted B.Tech students and to recommend the same to the academic council for further approval.

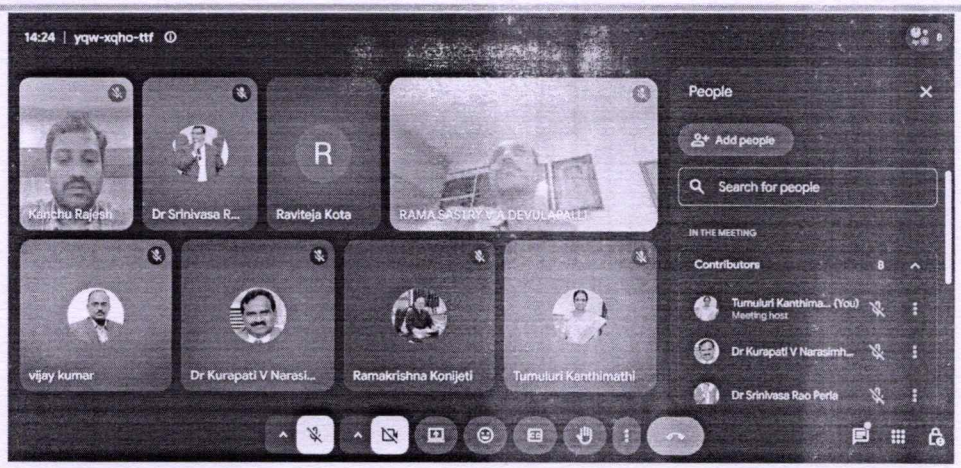
Meeting Photos:

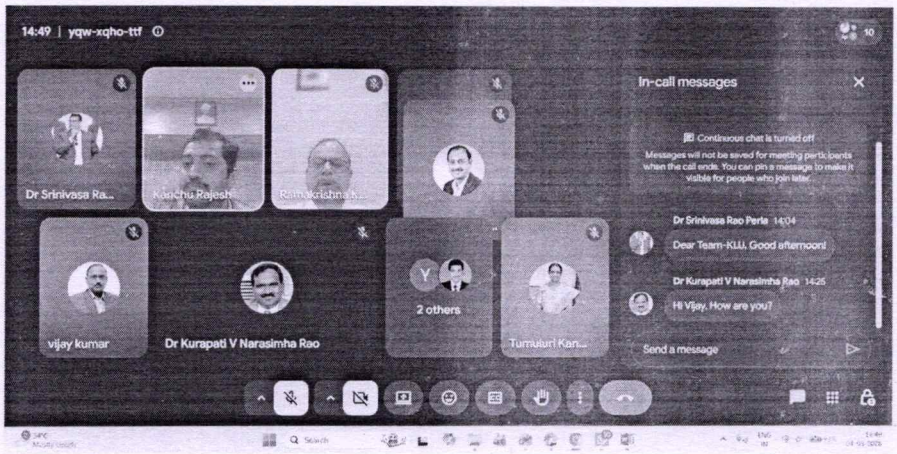


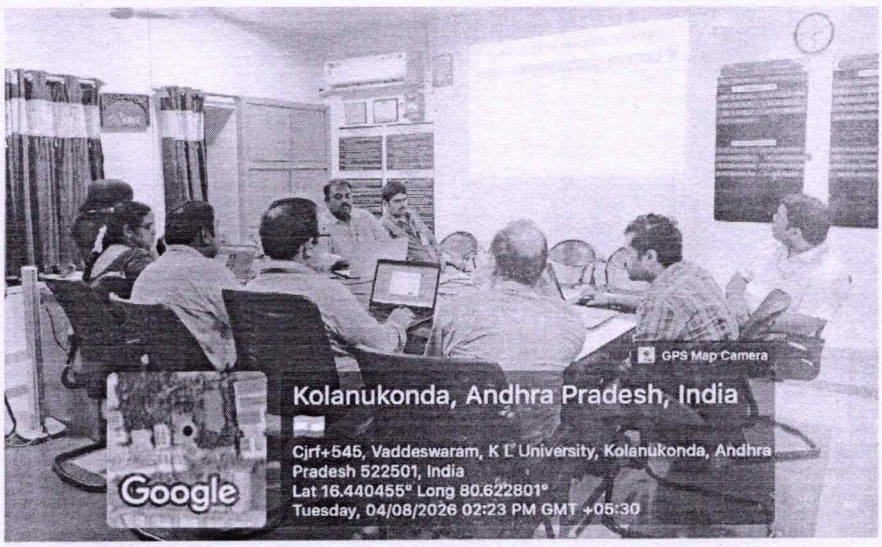
4/8/26

Head, Department of Mechanical Engineering
K L (Deemed to be University)
Vaddeswaram-522502

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Phone No. +91 8645 - 350 200; www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2576129







04/08/2026
Professor I/C Academics

4/8/26
Chairman-BOS
I/C HOD-ME

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DEPARTMENT OF MECHANICAL ENGINEEEINRG

Stake Holder Feedback Analysis and Action Taken Report

Academic Year: 2026-27 Odd Sem

S.No	Stake Holders	Count
1	Academic Peers	5
2	Alumni	4
3	Faculty	13
4	Industry personnel	10
5	Parents	2
6	Students	92
	Total	**126**

Acedemic Peer

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	B.Tech	Dr.Satish Ben, Professor, NIT Warangal	Suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.	As per the present market demand it is important that every mechanical graduate learn about a handful of simulation tools in the relevant fields	It is resolved to offer **Computer Aided Engineering and Simulation** course in place of Finite Element Analysis and Analysis of Energy Systems to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students	30	4	11-07-2026	31	5	04-08-2026
2	ME	B.Tech	Dr G Rudra Narsimha rao, Director, The Energy and Resources Institute (TERI), India	Based on the thrust areas, concepts related computational AI, machine learning, Mathematics for AI, Robotic motion planning, Computer vision are recommended to be included in the curriculum	These are the present industry requirements as the technology is taking anew shape with AI	It is resolved to approve the recommendations and offer the following new courses to Y26 Admitted batch Students i. Computational foundations for AI (Trimester and Regular) ii. Machine Learning for Mechanical Applications (Trimester and Regular) iii. Mathematics for AI and Engineering Application (Trimester and Regular) iv. Robotic Perception, Computer Vision & Sensor Fusion (Trimester) v. Robotic Motion Planning, Navigation & Control Systems (Trimester)	30	6	11-07-2026	31	11	04-08-2026

Alumni

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	M.Tech-MD	**Mr.Manikanta (23001130005), Dr.S.N.Padhi, Professor**	Suggested to revise the curriculum of M.Tech-MD. Following are the recommendations made 1. New Courses Proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S: 3-1-3-0, Cr:3.5 i. Digital Engineering and PLM for Product Design ii. Smart Materials and Structures iii. Reliability analysis and predictive maintenance iv. Composite Structures and Engineering Materials v. Non linear Finite element methods and Multiphysics	Based on the technologicial advancement in Engineering design these courses are recommneded	It is reolved to approve the recommended courses and offer to the Y26 admitted M.Tech-MD students	30	7	11-07-2026	31	12	04-08-2026

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2	ME	M.Tech-MD	Mr.Manikanta (23001130005), Dr.S.N.Padhi, Professor	Suggested to revise the curriculum of M.Tech-MD. Following are the recommendations made 2. Revisions proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S of 3-1-3-0, Cr:3.5 i. Mechanical Behavoir of Materials course is revised and renamed as Continuum Mechanics of Deformable Solids. ii. Advanced Strength of materials course is revised and renamed as Advanced Strength of materials and Design Optimization. iii. Computational Techniques in Engineering Optimization is revised and renamed as AI based Engineering design Optimization. iv. Robotics manipulator design and analysis course is revised and renamed as Robot Modelling and Design Analysis. v. Tribological systems design course offerd as professional is offered as professional core and renamed as Tribology. vi. Design of Pressure vessels and Plates course is revised and renamed as Design of pressure Vessels and Piping. vii. Mechanical Vibrations course outcomes are revised and offered with the same title.	Based on the technologicial advancement in Engineering design revissions are proposed to the existing courses	It is reolved to approve the recommended revisions in the courses and offer to the Y26 admitted M.Tech-MD students	30	7	11-07-2026	31	12	04-08-2026
3	ME	M.Tech-MD	Mr.Manikanta (23001130005), Dr.S.N.Padhi, Professor	Suggested to offer the following electives in two streams to Y26 M.Tech-MD admitted students Stream-A: Vehicle and Mobility Design i. Automotive Vehicle Design ii. Powertrain Engineering for EV's and Hybrid's iii. Vehicle Dynamics and suspension systems iv. Drone and UAV Mechanical Design Stream-B: Manufacturing and Industrial Engineering i. Additive manufacturing and Design for AM ii. Mechatronics, IOT and Smart Systems iii. Generative Design and Topology Optimization iv. Precision Engineering and Metrology	The courses recommended in the two streams are relevant for the present day industry	It is resolved to offer the recommended specialization for Y26 M.Tech-MD admitted batch student.	30	8	11-07-2026	31	12	04-08-2026

Faculty

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	B.Tech	Dr.K.RamaKrishna, Professor	Suggested to modify the syllabus of Thermodynamcis by including the topics on Gas power cycles and Vapour power cycles and recommended to change the name of the course as Thermodynamics and Energy conversion Systems. He also recommended to include electronic component cooling and heat sink design in heat transfer course and also suggested to include a new course on air conditioning and battery management.	Vapour power cycles and gas power cycles are continuition for Thermodynamcs course so the introduction of thes topics need to be included in this course. Electronics cooling using heat sinks is a major research area nad also the HVAC and battery management is the presetn industry demand in the energy industry.	It is resolved to approve the changes in Thermodynamics course and rename the course as **Thermodynamics and Energy Conversion Systems**. It is resolved to approve the changes prposed for heat transfer course and rename it as **Heat transfer and Sytem design**. The new course on It is resolved to offer Computer Aided Engineering and Simulation course in place of Finite Element Analysis and Analysis of Energy Systems to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students is approved to be offered. These modifications are approved for Y25 and Y26 (regular and trimester)B.Tech admitted batch students	30	3	11-07-2026	31	4, 5	04-08-2026
2	ME	B.Tech	Dr.B.Nageswar Rao, Professor	Suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.	The topics suggested will enhance the usgae of simulation tool capacity of the studetns for solving numericals	It is resolved to approve the recommendation and to offer a new course titled **Mathematics for Mechanical Engineers** to Y25 & Y26 (Regular & Trimester) admitted B.Tech Students.	30	3	11-07-2026	31	5	04-08-0206

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3	ME	B.Tech	Dr.A.Srinath, Professor	Recommended to modify the syllabus of Robotics and Mechatronics by including concepts of robo rogramming using python as Robot programming enables students to secure more placement oppurtunities	Robotics and Mechatronics concepts offer good palcemetnt oppurtunities to the students	It is resolved to modify the syllabus of Robotics and Mechatronics course by including concepts of Robot programming using python and rename the course as **Robotics and Mechatronics Systems** to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.	30	4	11-07-2026	31	6	04-08-2026
4	ME	B.Tech	Dr A.Srinath, Professor & Dr.S.N. Padhi, professor	Suggested to i. Include topics on concepts of Thermal stresses and power transmission to mechanics of solids course ii. Offer Kinematic and Duynamics of course as two courses by including vibrations concepts. Iii. Include concepts of product development in Machine Design course.	The topics are suggested to refame the syllabi of core courses by including advanced topics	It is resolved to approve and offer i. Mechanics of Solids course as **Mechanics of deformable solids** by including the suggested concepts. Ii. Kinematic and Dynamics of Machines course as two courses with titles **Kinematics of Machines** and **Machine Dynamics and Vibrations.** iii. Machine Design course as **Machine Design and Product Development** with the suggested modifications. These modifications are approved to the curriculum of Y26 and Y26 (Regualr and trimester0 admitted batch students.	30	4	11-07-2026	31	6	04-08-2026
5	ME	B.Tech	Dr.S.S.Rao, Professor	Suggested to i. To include concepts like Characterization of materials (XRD, SEM analysis), additive manufacturing, Stress strain behavior of materials and advanced materials in material Science and Metallurgy course. Ii.Suggested to add topics on welding, production planning, materials, quality testing in Manufacturing processes and technology course by removing topics on Geometric Dimensioning & Tolerancing and rename it as Manufacturing and Production Systems. It is also recommended to offer new course Geometric Dimensioning and Tolerancing	The suggestions were made keeping in view that students need to study all important core concepts without missing anything	It is resolved to offer material Science and Metallurgy course with the suggested modifications. It is also resolved to offer Manufacturing and production sytems course with the suggested modifications and also resolved to offer Geometric Dimensioning and Tolerancing and Core in place of Computer integrated manufacturing course to Y25 & Y26(Regular & trimester) admitted batch students.	30	4, 5	11-07-2026	31	6, 7	04-08-2026
6	ME	B.Tech	Dr.G.Murali, Professor	Suggested to reframe the syllabus of **Fluid Mechanics and Hydraulic Machines** by including simulation related experiments in the lab component	A huge demand is existing for CFD engineers in the present market	It is resolved to include simulation beased experiments in the Fluid Mechanics and Hydraulic Machines lab for Y25 & y26 admitted batch students	30	5	11-07-2026	31	7	04-08-2026
7	ME	B.Tech	Dr.D.V.A.Rama Sastry, Associate Professor	Suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field.	It is necessary to introduce AI related courses for the present day world	It is resolved to offer **Generative AI for Engineering Design** course as per the recommendation to Y25 and Y26 (Regular & Trimester)admitted batch B.Tech Students.	30	5	11-07-2026	31	7	04-08-2026
8	ME	B.Tech	Dr.S.N. Padhi, Professor & Dr.S.S.Rao, Professor	Based on the present day technology changes it is recommended to include courses related to Smart manufacturing, Digital Engineering, Green and Sustainable development	Present day industry needs to need to be incorporated in the curriculum of engineering students	It is resolved to offer only one new Specialization "Smart Manufacturing and Digital Engineering" in place of the previous specializations with the following courses 1. Green and Sustainable Manufacturing Technologies 2. Autonomous Robotic Systems 3. Integrated Energy Systems for Smart Industries 4. Mechanics of Advanced Materials 5. Digital Twin Engineering and Manufacturing Analysis	30	5	11-07-2026	31	7	04-08-2026

Industry Personnel

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	B.Tech	Dr.S.V.S.Narayana Murthy, Retd. Engineer at VSSC	Suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.	The topics recommended are the cutting edge technologies in the manufacturing sector	It is resolved to offer new course **Digital manufacturing** in place of Advanced manufacturing by including the suggested concepts to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.	30	3	11-07-2026	31	5	04-08-2026

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2	ME	B.Tech	Dr. Jeswin Jaya Singh	Suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the inductries.	IOT enabled manufacturing is the need of present day manufacturing industries	It is resolved to offer a new course **IOT for Smart Manufacturing** as per the recommendation to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students	30	5	11-07-2026	31	7	04-08-2026

Parent

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	B.Tech		-	-	-	-		-			

Student

Sl.No.	Department	Name of the Programme	Details of Stake Holder	Recommendations / Suggestion(s)	Analysis	Action Taken	DAC No.	Pg No.	Date	BOS NO.	Pg No.	Date
1	ME	B.Tech	Ms.B.Chaitanya Bala (2400040004) & mr. I. Venkata Sai Karthikeya (2400070012)	Requested to include assembly drawing and digital manufacturing design in Engineering Graphics course as these concepts are not covered in any course.	These concepts are required fro placement drives	It is resolved to include the suggested topics in the Graphics course and rename it as **Computer-Aided Design and Drafting** for Y26 (Trimester and Regular) B,Tech admitted batch students.	30	6	11-07-2026	31	10	04-08-2026

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I/C HOD-ME

Head, Department of Mechanical Engineering
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Vaddeswaram-522502

Outlook

Ravi teja sir Feedback

From k.v. durga rajesh <kanchurajesh@kluniversity.in>
Date Tue 2026-08-11 14:18
To T. KANTHIMATHI <kanthi2014@kluniversity.in>

From: LEELA RAVI TEJA KOTA PROJECT ENGINEER <RAVITEJA.KOTA@HMIE.CO.IN>
Sent: 11 August 2026 01:45 PM
To: k.v. durga rajesh <kanchurajesh@kluniversity.in>; venu@nitw.ac.in <venu@nitw.ac.in>; anjupsrao@gmail.com <anjupsrao@gmail.com>
Subject: RE: Invitation to 31st BOS meeting of Department of Mechanical Engineering on 04-08-2026 at 02:00 pm in Hybrid Mode

Dear Sir,

Apology for late response!!

I am glad to note that the B.Tech structure, as it currently stands, is well thought out and already well aligned with the latest trends in the field.

As an external member reviewing 25ME3112 (Computer Aided Engineering and Simulation), I would like to share a sample alternative structure for the Board's consideration. I want to be clear at the outset that the current syllabus is well-designed and entirely sound as it stands — this is offered simply as an additional option for discussion, not as a correction.

The thought behind this sample:

Given the course's credit structure, I explored what a more application-forward version could look like — one where each session pairs a short concept briefing with an immediate hands-on exercise, and where MATLAB-based scripting and AI/ML exposure are woven into every module rather than treated as separate topics. I'm sharing it purely as one possible direction; the Board may well decide the existing structure serves the course better as is.

Sample structure highlights

1. Class + Application pairing per session. Each 2-hour weekly session carries a short (20–30 min) concept briefing followed by a guided software/MATLAB application.

2. A running MATLAB thread through every module, alongside the CAE software (ANSYS/SolidWorks Simulation). Not a separate module — a recurring 15–20 minute segment in each session where students implement a small, bounded piece themselves (e.g., assembling a hand-solvable truss stiffness matrix, coding a quadrature check, scripting a mesh-convergence plot, writing a simple eigenvalue check for a modal problem).

3. AI/ML touchpoints threaded through every module, not isolated to one lecture:
- Early modules: brief framing of where AI sits in the CAE pipeline (surrogate models, not a replacement for understanding).
- Middle modules: a simple ML regression exercise (e.g., fitting stress vs. mesh/load parameters) so students see a data-driven surrogate emerge from their own FEA runs,

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contrasted with the FEA result.
- Later modules: brief exposure to AI-assisted meshing or parameter-sweep automation available in the CAE package, framed as faster iteration, not a replacement for verification.
- A recurring, explicit message that AI predictions carry no intrinsic convergence or error guarantees, and that verification/validation remains a human task — repeated more than once across the semester so it lands as a working principle.

4. Assessment realignment (if this direction were adopted). Weekly lab checkpoints plus a single running project component carried across the structural/thermal/CFD modules, consolidated into a final CAE report and presentation with a mandatory verification/validation section.

I'd welcome the Board's thoughts on whether any elements of it are worth incorporating, alongside the current structure, at the next syllabus review.

Best Regards,

Leela Ravi Teja Kota
Project Engineer – Comfort&Dura | VDH

Hyundai Motors India Engineering Private Limited,
Office: +91-04-66574773 | Mobile: +91-9959142273
Email : raviteja.kota@hmie.co.in
Web : www.hmie.in

From: k.v. durga rajesh <kanchurajesh@kluniversity.in>
Sent: 31 July 2026 01:09 PM
To: venu@nitw.ac.in; LEELA RAVI TEJA KOTA PROJECT ENGINEER <RAVITEJA.KOTA@HMIE.CO.IN>; anjupsrao@gmail.com
Subject: Invitation to 31st BOS meeting of Department of Mechanical Engineering on 04-08-2026 at 02:00 pm in Hybrid Mode

Respected Sir,
You are invited to attend the **31st BOS meeting of Department of Mechanical Engineering scheduled on 04-08-2026 at 02:00 pm in Hybrid Mode** through the link given below. Your valuable inputs help us to shape our curriculum for Y25 & Y26 B.Tech and M.Tech-MD admitted batch students. The course structures and the syllabi of the programs are attached for your reference. Kindly make it convenient to attend the meeting.

Link for the meeting
https://meet.google.com/yqw-xqho-ttf

With Regards
Dr. K.V. Durga Rajesh,
Associate Professor,
Department of Mechanical Engineering,
Koneru Lakshmaiah Education Foundation.
Mobile: 9908266894

4/8/26

Head, Department of Mechanical Engineering
K L (Deemed to be University)
Vaddeswaram-522502

Outlook

Re: Invitation to 31st BOS meeting of Department of Mechanical Engineering on 04-08-2026 at 02:00 pm in Hybrid Mode

From Dr. A. Venu Gopal <venu@nitw.ac.in>
Date Thu 06-08-2026 05:11 PM
To k.v. durga rajesh <kanchurajesh@kluniversity.in>
Cc raviteja.kota@hmie.co.in <raviteja.kota@hmie.co.in>; anjupsrao@gmail.com <anjupsrao@gmail.com>

You don't often get email from venu@nitw.ac.in. Learn why this is important

Dear Prof.Rajesh,

I have fine through the B.Tech structure and it is well developed addressing the latest trends like AIML, Robotics, Mechatronics, etc. I have no further suggestions regarding the structure.

I hereby aprrove it.

Thanks, and regards
Prof. A. Venu Gopal / आचार्य ए. वेणु गोपाल
Dept. of Mechanical Engineering / यांत्रिक अभियांत्रिकी विभाग
former Dean, Academic / पूर्व डीन, अकादमिक
National Institute of Technology Warangal / राष्ट्रीय प्रौद्योगिकी संस्थान वारंगल
Warangal - 506004 (Telangana) INDIA / वारंगल - 506004 (तेलंगाना), भारत

Email: venu@nitw.ac.in; venu.1098@gmail.com
Mobile: +91 949 331 8537 **Office:** +91 870 246 2338
url: https://erp.nitw.ac.in/ext/profile/me-venu
Google Scholar: https://scholar.google.com/citations?user=aFkV2GcAAAAJ&hl=en&oi=ao
Scopus ID: https://www.scopus.com/authid/detail.uri?authorId=6506673490

ORCID id: 0000-0002-3698-6356

On Fri, 31 Jul 2026 at 1:08 PM, k.v. durga rajesh <kanchurajesh@kluniversity.in> wrote:

> Respected Sir,
> You are invited to attend the **31st BOS meeting of Department of Mechanical Engineering scheduled on 04-08-2026 at 02:00 pm in Hybrid Mode** through the link given below. Your valuable inputs help us to shape our curriculum for Y25 & Y26 B.Tech and M.Tech-MD admitted batch students. The course structures and the syllabi of the programs are attached for your reference. Kindly make it convenient to attend the meeting.
>
> Link for the meeting
> https://meet.google.com/yqw-xqho-ttf
>
> With Regards
> Dr. K.V. Durga Rajesh,
> Associate Professor,
> Department of Mechanical Engineering,
> Koneru Lakshmaiah Education Foundation.

k.v.d 7/8/26

Head, Department of Mechanical Engineering
K L (Deemed to be University)
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DAC (Department Academic Committee) meeting on 11-07-2026 in Hybrid mode at 2:00 PM

T. KANTHIMATHI

Reply Reply all Forward

To: KLU ME Faculty

Fri 2026-07-10 14:34

Bcc: Dean Skill & Students Progression; Dr. K Rama Krishna, Dean(Quality)

Respected Sir,

As per the instructions, the Department Academic Committee (DAC) meeting is scheduled to be held on **11 July 2026 (Saturday) at 2:00 PM** in **hybrid mode** (Venue: **Room No. M118 / HOD's Cabin**).

Below is the link to join the meeting

https://meet.google.com/meg-rqfj-ktu

The meeting is being convened to discuss and finalize the following agenda items for recommendation to the upcoming Board of Studies (BoS):

Agenda:

1. To discuss and propose the curriculum for the **Y26 B.Tech Mechanical Engineering** programme (Trimester and Regular schemes).
2. To discuss and propose the modifications made to the **Y25 B.Tech Mechanical Engineering** curriculum.
3. To discuss and propose the curriculum for the **Y26 M.Tech – Machine Design** programme.
4. Any other matter with the permission of the Chair.

Kindly make it convenient to attend the meeting.

Thanking You

Dr. T. Kanthimathi

Assistant Professor

11/7/26

Head, Department of Mechanical Engineering
K L (Deemed to be University)
Vaddeswaram-522502

K L E F

DEPARTMENT OF MECHANICAL ENGINEERING

MINUTES OF DEPARTMENT ACADEMIC COMMITTEE (DAC)

Date: 11-07-2026

The 30th Department Academic Committee (DAC) Meeting was conducted at 2:00 P.M. I Hybrid mode on 11/07/2026.`

Offline Venue:M118 (HOD Cabin)

Link for the online: https://meet.google.com/meg-rqfj-ktu

Agenda:

1. To discuss on the feedback given by the stakeholders
2. To discuss and approve the modifications made to the **Y25 B.Tech Mechanical Engineering** curriculum and to put forth the same in the upcoming BOS.
3. To discuss and approve the curriculum for the **Y26 B.Tech Mechanical Engineering** programme (Trimester and Regular schemes) and to put forth the same in the upcoming BOS.
4. To discuss and approve the curriculum for the **Y26 M.Tech – Machine Design** programme and to put forth the same in the upcoming BOS
5. Any other matter with the permission of the Chair.

The following members were present:

1. Dr.K.V.Durga Rajesh, Chairman, Dept.I/C HOD
2. Dr. K.Rama Krishna, Faculty Representative/Professor/Dean IQAC
3. Dr.S.N.Padhi, Faculty Representative/Cohort Professor I/C (Engineering Design)
4. Dr.G.Murali, Faculty Representatice/Cohort professor I/C(Energy & CFD)
5. Dr.S.S.Rao, Faculty Representative/Cohort Professor I/C(Smart Manufacturing)
6. Dr.D.V.A.Rama Sastry, Faculty Representative/Dept. Student activities In Charge
7. Dr.G.Diwakar, Faculty Representative/PG coordinator & placement In charge
8. Dr.P.Raj Kumar, Faculty Representative/ERP & Timetable Incharge/Year Coordinator
9. Dr.T.Kanthimathi, Academics Professor I/C & UG Programme Coordiantor
10. Ms.M. Eshitha Reddy- B.Tech-IV year, Student Representative (2300070003)
11. Mr.G.Ramalinga-B.Tech-IV Year, Student Representative (2300079013)
12. Ms. B. Chaitanya Bala-B.Tech-III Year, Student Representative (2400070004)
13. Mr.I. Venkata Sai Karthikeya-III Year, Student Representative (2400070012)

DAC Chairman welcomed all the members and delivered the agenda points to the members. Following are the deliberations in the meeting

11/7/26

Head, Department of Mechanical Engineering
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Agenda-1: To discuss on the feedback given by stake holders

- Dr.K.Ramakrishna, recommended the following revisions in Thermodynamics and Heat transfer courses and also suggested to include course of air conditioning and battery management for Y25 and Y26 admitted batches.

  i. Include Gas Power and Vapour power cycles in Thermodynamics course to make students understand the applications of thermodynamic concepts.

  It is resolved to approve the recommendation and rename Thermodynamics course as **Thermodynamics and Energy Conversion Systems** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students

  ii. Include the topics on Electronic/Component cooling and heat sink design in heat transfer course so that students will be learning the concept of designing in thermal systems.

  It is resolved to approve the recommendation and rename Heat Transfer course as **Heat Transfer and System Design** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students.

  iii. Include a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centers/EV's etc.,

  It is resolved to approve the recommendation and include a new course **HVAC and Battery Thermal Management Systems** for Y25 & Y26(Regular & Trimester) admitted B.Tech Students.

- Dr.B.Nageswar Rao-Professor, suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.

  It is resolved to approve the recommendation and to offer a new course titled **Mathematics for Mechanical Engineers** to Y25 & Y26 (Regular & Trimester) admitted B.Tech Students.

- Dr.S.V.S.Narayana Murthy, Industry person, suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.

  It is resolved to offer new course **Digital manufacturing** in place of Advanced manufacturing by including the suggested concepts to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.Satish Ben, academic peer, suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with

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the latest simulation tools.

It is resolved to offer **Computer Aided Engineering and Simulation** course in place of Finite Element Analysis and Analysis of Energy Systems to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

Resolution: It is resolved to approve the feedback given by stake holders and to put forth the same in the coming BOS.

Agenda-2: To discuss on the modifications proposed to Y25 B.Tech Curriculum

- Dr.A.Srinath, recommended to modify the syllabus of Robotics and Mechatronics (Flexi core) course by including Robo programming using Python as Robo programming increases the opportunities in placement drives.

  It is resolved to modify the syllabus of Robotics and Mechatronics by including Robo programming using Python and rename the course as **Robotics and Mechatronics** and offer it as Professional Core course to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.A.Srinath, Dr. S.N.Padhi and members of Design group suggested the following modifications to Design related courses

  i. Concepts of thermal stresses and power transmission are added to Mechanics of solids course by removing the concept of truss, since this topic is covered in Mechanics course. The course title is changed from Mechanics of Solids to **Mechanics of Deformable Solids to** Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

  ii. Kinematics and Dynamics of machines course is suggested to offer as two courses **Kinematics of Machines** and **Machine Dynamics and Vibrations**, so that students will be well equipped with the concepts of vibration required in many engineering applications to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

  iii. Concepts on product development, integrated product design with cost accounting and simulation based assembling with AI related design reviews were suggested to include in Machine Design course and rename it a **Machine Design and Product Development** to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.S.S.Rao and the members of Manufacturing group suggested the following modifications to Manufacturing cohort related courses

  i. In **Material Science and Metallurgy** course, concepts like Characterization of materials (XRD, SEM analysis), additive manufacturing, Stress strain behavior of materials and advanced materials are included and also the modules were reshuffled to make students understand the concepts sequentially. These modifications are proposed to Y25 and Y26 (Regular & Trimester) admitted batch

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B.Tech Students.

ii. It was proposed to add topics on welding, production planning, materials, quality testing in Manufacturing processes and technology course by removing topics on Geometric Dimensioning & Tolerancing and rename it as **Manufacturing and Production Systems**. It is also recommended to offer a new course on **Geometric Dimensioning and Tolerancing**, since most of the core placement companies are suggesting to include this course. These modifications are proposed to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

- Dr.Murali and the members of Energy & CFD group suggested to reframe the syllabus of **Fluid Mechanics and Hydraulic Machines** by including simulation related experiments in the lab component to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Dr. Jeswin JayaSingh, Industry person, suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the inductries.

  It is resolved to offer a new course **IOT for Smart Manufacturing** as per the recommendation to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Dr.D.V.A.Rama Sastry, suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field.

  It is resolved to offer **Generative AI for Engineering Design** course as per the recommendation to Y25 and Y26 (Regular & Trimester)admitted batch B.Tech Students.
- Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems.

  It is resolved to offer new courses **Fundamentals of IOT and Sensors, Full Stack Web Development** and **Embedded System Design & IOT** as per the recommendations to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.
- Based on the recommendations of the group heads and their respective group members it is proposed to offer Smart Manufacturing and Digital Engineering specialization to Y25 & Y26 (Regular & Trimester) admitted batch B.Tech Students by including Green and Sustainable development. Following are the proposed courses under this specialization.

  i. Green and Sustainable Manufacturing technologies
  ii. Autonomous Robotic Systems
  iii. Integrated Energy Systems for Smart Industries
  iv. Mechanics of Advanced Materials
  v. Digital Twin Engineering and Manufacturing Analytics

It is resolved to propose the new specialization and courses in place of Engineering Design, Smart Manufacturing and Automotive Energy Engineering specializations to Y25 and Y26 (Regular & Trimester) admitted batch B.Tech Students.

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Resolution: It is resolved to approve the modifications made to Y25 B.Tech Curriculum and to put forth the same in the coming BOS.

Agenda-3: To discuss on the proposed Structure and curriculum of Y26 (Trimester and Regular) admitted batch B.Tech students

- Chairman DAC informed the members that B.Tech Mechanical programme will be offered in Trimester and regular modes from Y26 admitted batch onwards.
- Based on the discussions in the Engineering Design group meeting it is recommended to revise the syllabi of the following course for Y26 Trimester and Regular semester programs
    i. Engineering Graphics syllabus is modified by including the topics of assembly drawing and digital manufacturing designs.

    It is resolved to include the suggested topics in the Graphics course and rename it as **Computer-Aided Design and Drafting** for Y26 (Trimester and Regular) B,Tech admitted batch students.

    ii. Engineering Mechanics syllabus is modified by including the topics on friction to wedges, screw jacks, belts, rectilinear and curvilinear motion.

    It is resolved to include the recommended topics in the Engineering Mechanics course for Y26 (Trimester and Regular) B,Tech admitted batch students.

    iii. It is recommended to change the title of the course Workshop practices for Engineers course as **Mechanical Engineering Workshop** for Y26 (Trimester and Regular) B,Tech admitted batch students.
- Based on the thrust areas identified for the present industries following courses are recommended for Y26 admitted batch B.Tech students
    i. Computational foundations for AI (Trimester and Regular)
    ii. Machine Learning for Mechanical Applications (Trimester and Regular)
    iii. Mathematics for AI and Engineering Application (Trimester and Regular)
    iv. Robotic Perception, Computer Vision & Sensor Fusion (Trimester)
    v. Robotic Motion Planning, Navigation & Control Systems (Trimester)

    It is resolved to offer the above courses for Y26 (Trimester and Regular) admitted B.Tech admitted batch students.

Resolution: It is resolved to approve the modifications made to Y26 (Trimester & Regular) B.Tech Curriculum and to put forth the same in the coming BOS.

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Agenda-4: To discuss and approve the curriculum for the Y26 M.Tech – Machine Design (MD) programme.

- Chairman DAC informed the members that M.Tech-MD programme will be offered in trimester mode from Y26 admitted batch onwards.
- As per the feedback received from the alumni Mr.Manikanta(23001130005) M.Tech-MD and based on the discussion in the engineering design cohort, Dr S.N.Padhi Cohort professor I/C suggested the following revisions to Y26 M.Tech-MD curriculum by incorporating AI based designing and PLM concepts.

1. New Courses Proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S: 3-1-3-0, Cr:3.5
   i. Digital Engineering and PLM for Product Design
   ii. Smart Materials and Structures
   iii. Reliability analysis and predictive maintenance
   iv. Composite Structures and Engineering Materials
   v. Non linear Finite element methods and Multiphysics
2. Revisions proposed for Y26 M.Tech-MD programme under Professional Core category with an L-T-P-S of 3-1-3-0, Cr:3.5
   i. Mechanical Behavoir of Materials course is revised and renamed as **Continuum Mechanics of Deformable Solids.**
   ii. Advanced Strength of materials course is revised and renamed as **Advanced Strength of materials and Design Optimization.**
   iii. Computational Techniques in Engineering Optimization is revised and renamed as **AI based Engineering design Optimization.**
   iv. Robotics manipulator design and analysis course is revised and renamed as **Robot Modelling and Design Analysis.**
   v. Tribological systems design course offerd as professional is offered as professional core and renamed as **Tribology.**
   vi. Design of Pressure vessels and Plates course is revised and renamed as **Design of pressure Vessels and Piping.**
   vii. Mechanical Vibrations course outcomes are revised and offered with the same title.
3. Two streams of professional electives are recommended for Y26 M.Tech-MD admitted batch. Following are the streams and courses in each stream

   Stream-A: Vehicle and Mobility Design
   i. Automotive Vehicle Design
   ii. Powertrain Engineering for EV's and Hybrid's
   iii. Vehicle Dynamics and suspension systems

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iv. Drone and UAV Mechanical Design

Stream-B: Manufacturing and Industrial Engineering

i. Additive manufacturing and Design for AM
ii. Mechatronics, IOT and Smart Systems
iii. Generative Design and Topology Optimization
iv. Precision Engineering and Metrology

4. Audit course-Professional Communication Skills for Engineers is replaced with **Communication Skills and Technical Writing**. Essentials of Research Design Course is replaced with **Research Methodology and Intellectual Property Rights**.

Resolution: It is resolved to approve the modifications made to Y26 (Trimester & Regular) M.Tech-MD Curriculum and to put forth the same in the coming BOS.

Agenda-5: Any other point with the permission of the chair

- A new course OEME0007-Fundamentals of Automobiles is offered as open elective from Y23 regulation onwards for B.Tech Students.

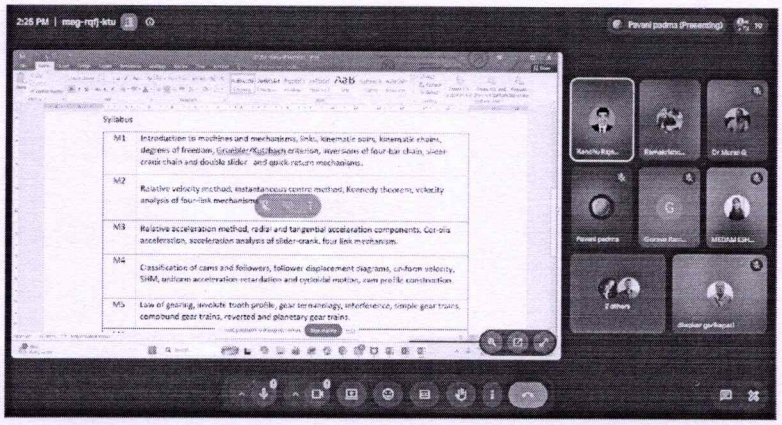
Resolution: It is resolved to approve the new open elective offered from Y23 regulation onwards for B.Tech students and the same is put forth in the upcoming BOS.

Meeting Photos:



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11/7/2026
Professor I/C Academics

(Dr.T.Kanthimathi)

11/7/26
I/C HOD-ME

(Dr.K.V.Durga Rajesh)

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KLEF
DEPARTMENT OF MECHANICAL ENGINEERING
Y25 B.Tech ME - REGULAR LIST OF COURSES

Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	New/Retained/Revised	Revision %	Revision Proposed by	Justification
1	S01	ESC	25SC1101	PROBLEM SOLVING THROUGH C	PSTC	3	0	2	4	5	9	NIL		Employability	Retained			
2	S01	HSS	25UC1203	DESIGN THINKING FOR INNOVATION	DTFI	0	0	4	0	2	4	NIL		Entrepreneurship	Retained			
3	S01	HSS	25UC1102	LANGUAGE SKILLS FOR ENGINEERS	LSFE	0	0	4	0	2	4	NIL			Retained			
4	S01	BSC	25MT1001	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	LACE	2	2	0	0	4	4	NIL			Retained			
5	S01	ESC	25ME1002	ENGINEERING GRAPHICS	ENGP	0	0	4	0	2	4	NIL		Skill Development	Retained			
6	S01	ESC	25ME1001	ENGINEERING MECHANICS	ENMC	3	0	0	0	3	3	NIL		Employability	Retained			
7	S01	BSC	25CY1001	ENGINEERING CHEMISTRY	ENCH	3	0	2	0	4	5	NIL		Employability	Retained			
8	S01	AUC	25UC0017	INDIAN ANCIENT KNOWLEDGE SYSTEMS - VEDIC MATHEMATICS	IKGS	2	0	0	0	0	2	NIL			Retained			
9	S02	ESC	25EC1101	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	BEEC	3	0	2	0	4	5	NIL		Employability	Retained			
10	S02	ESC	25SC1203	DATA STRUCTURES	DAST	3	0	2	4	5	9	PSTC		Skill Development	Retained			
11	S02	ESC	25SC2007	PYTHON PROGRAMMING	PYPG	2	0	2	0	3	4	NIL		Skill Development	Retained			
12	S02	HSS	25UC1204	COMMUNICATION SKILLS FOR ENGINEERS	CSFE	0	0	4	0	2	4	LSFE			Retained			
13	S02	BSC	25MT2019	PROBABILITY AND STATISTICS	PBAS	2	2	0	0	4	4	NIL			Retained			
14	S02	ESC	25ME1004	WORKSHOP PRACTICES FOR ENGINEERS	WPFE	0	0	4	0	2	4	NIL		Skill Development	Retained			
15	S02	ESC	25ME1103	DESIGN TOOLS WORKSHOP	DTWP	0	0	4	0	2	4	NIL		Skill Development	Retained			
16	S03	BSC	25MT2020	MATHEMATICS FOR MECHANICAL SYSTEMS	MFMS	2	2	0	0	4	4	NIL			New	100%	Faculty	Suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.
17	S03	ESC	25EC1203	FUNDAMENTALS OF IOT AND SENSORS	FOIS	2	0	2	0	3	4	NIL		Employability	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
18	S03	ESC	25SC2008	FULL STACK WEB DEVELOPMENT	FSWD	0	0	2	4	2	6	DAST		Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
19	S03	BSC	25ME2120	SCIENCE ELECTIVE - 2 (MATERIAL SCIENCE AND METALLURGY)	SCE2	3	0	2	0	4	5	NIL		Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added so that students will be exposed to latest technological advancements in the field of material scisence
20	S03	PCC	25ME2105	MECHANICS OF DEFORMABLE SOLIDS	MODS	3	0	2	0	4	5	ENMC	CAPS	Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added to the syllabus to educate the students on various theories of failure
21	S03	PCC	25ME2106	THERMODYNAMICS AND ENERGY CONVERSION SYSTEMS	TECS	3	1	0	0	4	4	NIL		Employability	Revised	25%	Faculty	As per the feedback received, concepts were rearranged and few topics were added so that all advance concepts are included in the course
22	S04	PCC	25ME2207	FLUID MECHANICS AND HYDRAULIC MACHINES	FMHM	3	0	2	0	4	5	NIL	CASE	Skill Development	Revised	25%	Faculty	As per the discussions in Energy group meeting the proposed topics are incorporated into the syllabus as per the requirements of CFD concepts by thermal related companies

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Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	New/Retained/Revised	Revision %	Revision Proposed by	Justification
23	S04	PCC	25ME2208	MANUFACTURING AND PRODUCTION SYSTEMS	MAPS	3	0	2	0	4	5	NIL	CAPS	Skill Development	Revised	50%	Faculty	As per the feedback of stakeholders the poposed topics are added to the course as these are the topics which are not covered in any course and are needed for GATE
24	S04	PCC	25ME2209	ROBOTICS AND MECHATRONIC SYSTEMS	RAMS	2	0	2	0	3	4	FOIS	CASE	Skill Development	Revised	25%	Faculty	As per the feedback of faculty it is necessary to include Robo programming in Robotic and Mechatronic Systems to increase the opportunities in placement drives
25	S04	ESC	25AD2102	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	AIML	3	0	2	0	4	5	PYPG		Skill Development	Retained			
26	S04	PCC	25ME2210	KINEMATICS OF MACHINES	KOMS	2	1	0	4	4	7	ENMC	CAPS	Skill Development	Revised	25%	Faculty	Based on the feedback of Engineering Design group head the course Kinematics and Dynamics of machines course is split into two courses and the topics are rearranged by removing certain topics and adding few concepts
27	S04	ESC	25EC2206	EMBEDDED SYSTEM DESIGN AND IOT	EBSD	2	0	0	4	3	6	FOIS	FULL	Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
28	S05	PCC	25ME3111	IOT FOR SMART MANUFACTURING	IFSM	2	0	2	0	3	4	FOIS	FULL	Skill Development	New	100%	Industry person	Suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the inductries
29	S05	PCC	25ME3112	COMPUTER AIDED ENGINEERING AND SIMULATION	CAES	0	0	2	4	2	6	MODS	CAPS	Skill Development	New	100%	Academic Peers	Suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.
30	S05	PCC	25ME3113	DIGITAL MANUFACTURING	DGMF	2	0	2	0	3	4	MAPS	CASE	Employability	New	100%	Industry person	Suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.
31	S05	PCC	25ME3114	HEAT TRANSFER AND SYSTEM DESIGN	HTSD	3	0	2	0	4	5	TECS	CASE	Skill Development	Revised	30%	Faculty	Based on the feedback given by faculty members new concept on new transient intuition, combined-convection-radiation and thermal systems design which includes electronics cooling and design is added as these are identified as the need of thermal based industries
32	S05	PCC	25ME3115	MACHINE DYNAMICS AND VIBRATIONS	MDAV	3	0	2	0	4	5	ENMC	CASE	Skill Development	New	100%	Faculty	Based on the feedback from facutly ane w course is offered with the concepts of Dynamics of machines and vibrations which is the requirement in many design related industries
33	S05	PEC	PE-1	PROFESSIONAL ELECTIVE – 1	PEC1	2	0	0	4	3	6	NIL						
34	S06	PCC	25ME3216	MACHINE DESIGN AND PRODUCT DEVELOPMENT	MDPD	3	0	0	4	4	7	MODS	CAPS	Skill Development	Revised	70%	Faculty	Based on the feedback of faculty product Development concepts are added also topics on failure theories, material selection are included so that the student is made well equipped with all the concepts related to machine design
35	S06	HSS	FL	FOREIGN LANGUAGE	FRLG	3	0	0	0	3	3	NIL		Employability	Retained			
36	S06	PCC	25ME3218	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	2	0	2	0	3	4	ENGP		Skill Development	Revised	50%	Faculty	Based on the feedback of faculty, Material Conditions and Metrology and Inspection concepts are included in the course to cover all the topics related to dimensioning
37	S06	PRI	25IE4101	TERM PAPER	TMPR	0	0	6	0	3	6	NIL		Skill Development	Retained			
38	S06	PEC	PE-2	PROFESSIONAL ELECTIVE - 2	PEC2	2	0	0	4	3	6	PE-1						
39	S06	PEC	PE-3	PROFESSIONAL ELECTIVE - 3	PEC3	2	0	0	4	3	6	PE-1						
40	S07	PCC	25ME3217	GENERATIVE AI FOR ENGINEERING DESIGN	GAED	2	0	2	0	3	4	CAES	CASE	Skill Development	New	100%	Faculty	Suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field
41	S07	AUC	25UC0008	INDIAN CONSTITUTION	INCT	2	0	0	0	0	2	NIL		Entrepreneurship	Retained			
42	S07	OEC	OE-1	OPEN ELECTIVE - 1	OEC1	4	0	0	0	4	4	NIL						

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Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	New/Retained/Revised	Revision %	Revision Proposed by	Justification
43	S07	PCC	25ME4119	HVAC & BATTERY THERMAL MANAGEMENT SYSTEMS	HBMS	3	0	2	0	4	5	TECS	CASE	Skill Development	New	100%	Faculty	As per the suggestion of faculty, a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centers/EV's etc.,
44	S07	PEC	PE-4	PROFESSIONAL ELECTIVE - 4	PEC4	2	0	0	4	3	6	PE-1						
45	S07	PRI	25IE4053	CAPSTONE PROJECT - 1	CAP1	0	0	8	8	6	16	TMPR		Skill Development	Retained			
46	S08	HSS	25UC0026	HUMAN VALUES, ETHICS AND GENDER INCLUSION FOR TECHNOLOGY	HVEG	2	0	0	0	2	2	NIL		Entrepreneurship	Retained			
47	S08	OEC	OE-2	OPEN ELECTIVE - 2	OEC2	4	0	0	0	4	4	NIL						
48	S08	HSS	ME	MANAGEMENT ELECTIVE	MGEL	4	0	0	0	4	4	NIL		Entrepreneurship				
49	S08	PEC	PE-4	PROFESSIONAL ELECTIVE - 5	PEC5	2	0	0	4	3	6	PE-1						
50	S08	PRI	25IE4054	CAPSTONE PROJECT - 2	CAP2	0	0	8	8	6	16	CAP1			Retained			
51	1S	PRI	25IE2040	SOCIAL INTERNSHIP	SOIP	0	0	0	4	0	4	NIL		Skill Development	Retained			
52	1S	AUC	25UC0032	INSIGHTS TO SUSTAINABLE DEVELOPMENT GOALS	ISDG	2	0	0	0	0	2	NIL		Entrepreneurship	Retained			
53	2S	PRI	25IE3041	TECHNICAL INTERNSHIP	TEIP	0	0	0	4	0	4	NIL		Skill Development	Retained			
54	2S	AUC	25UC0009	ECOLOGY AND ENVIRONMENT	ECEN	2	0	0	0	0	2	NIL			Retained			
55	S03	VAC	VAC-1	VALUE ADDED COURSE 1 - SPORTS	VAC1	0	0	0	2	0	2	NIL		Skill Development	Retained			
56	S04	VAC	VAC-2	VALUE ADDED COURSE 2 - TECHNICAL GLOBAL CERTIFICATION 1	VAC2	0	0	0	2	0	2	NIL		Skill Development	Retained			
57	S05	VAC	VAC-3	VALUE ADDED COURSE 3 - TECHNICAL GLOBAL CERTIFICATION 2	VAC3	0	0	0	2	0	2	NIL		Skill Development	Retained			
58	S06	VAC	VAC-4	VALUE ADDED COURSE 4 - TECHNICAL GLOBAL CERTIFICATION 3	VAC4	0	0	0	2	0	2	NIL		Skill Development	Retained			
TOTAL										164	280							

LIST OF PROFESSIONAL ELECTIVE COURSES TO BE OFFERED TO Y25 B.TECH MECHANICAL STUDENTS

S.No.	Semester	Category	Course Code	Course Title	Acronm	L	T	P	S	Cr	CH	Pre-req	PBL	Entrepreneurship/ Employability/ Skill Development	New/Retained/Revised	Revision %	Revision Proposed by	Justification
SMD1	S05	PE-1	25SMD3111	GREEN AND SUSTAINABLE MANUFACTURING TECHNOLOGIES	GSMT	2	0	0	4	3	6	NIL	–	Skill Development	New	100%	Group Heads (Faculty)	Based on the recommendations of the group heads and their respective group members it is proposed to offer Smart Manufacturing and Digital Engineering specialization by including Green and Sustainable development
SMD2	S06	PE-2	25SMD3221	AUTONOMOUS ROBOTIC SYSTEMS	AMRS	2	0	0	4	3	6	SMD1	–	Skill Development	New	100%		
SMD3	S06	PE-3	25SMD3231	INTEGRATED ENERGY SYSTEMS FOR SMART INDUSTRIES	IESI	2	0	0	4	3	6	SMD1	–	Skill Development	New	100%		
SMD4	S07	PE-4	25SMD3341	MECHANICS OF ADVANCED MATERIALS	MOAM	2	0	0	4	3	6	SMD2or SMD3	–	Skill Development	New	100%		
SMD5	S08	PE-5	25SMD3351	DIGITAL TWIN ENGINEERING & MANUFACTURINGANALYTICS	DTMA	2	0	0	4	3	6	SMD3or SMD4	–	Skill Development	New	100%		

No.of New Courses	15
No.of revised courses	10
Total No. of courses	58
% of syllabus revision	43.103
% of courses focussing on Entrepreneurship	8.6207
% of courses focussing on Employaility	13.793
% of courses focussing on skill development	60.345

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LIST OF PROFESSIONAL ELECTIVE COURSES TO BE OFFERED TO Y25 B.TECH MECHANICAL STUDENTS

S.No.	Course Code	Course Title	PBLCode	L-T-P-S	CR	CH	Pre-req
SMD1	25SMD3111	Green and Sustainable ManufacturingTechnologies	–	2-0-0-4	3	6	NIL
SMD2	25SMD3221	Autonomous Robotic Systems	–	2-0-0-4	3	6	SMD1
SMD3	25SMD3231	Integrated Energy Systems for Smart Industries	–	2-0-0-4	3	6	SMD1
SMD4	25SMD3341	Mechanics of Advanced Materials	–	2-0-0-4	3	6	SMD2orSMD3
SMD5	25SMD3351	Digital Twin Engineering & ManufacturingAnalytics	–	2-0-0-4	3	6	SMD3orSMD4

LIST OF PROFESSIONAL ELECTIVE COURSES TO BE OFFERED TO Y26 (Regialr) B.TECH MECHANICAL STUDENTS

S.No.	Course Code	Course Title	PBLCode	L-T-P-S	CR	CH	Pre-req
SMD1	26SMD3111	Green and Sustainable ManufacturingTechnologies	–	2-0-0-4	3	6	NIL
SMD2	26SMD3221	Autonomous Robotic Systems	–	3-0-0-0	3	3	SMD1
SMD3	26SMD3231	Integrated Energy Systems for Smart Industries	–	2-0-0-4	3	6	SMD1
SMD4	26SMD3341	Mechanics of Advanced Materials	–	3-0-0-0	3	3	SMD2orSMD3
SMD5	26SMD3351	Digital Twin Engineering & ManufacturingAnalytics	–	3-0-0-0	3	3	SMD3orSMD4

LIST OF PROFESSIONAL ELECTIVE COURSES TO BE OFFERED TO Y26 (Trimester) B.TECH MECHANICAL STUDENTS

S.No.	Course Code	Course Title	PBLCode	L-T-P-S	CR	CH	Pre-req
SMD1	26SMD3111E	Green and Sustainable ManufacturingTechnologies	–	3-0-0-6	3	9	NIL
SMD2	26SMD3221E	Autonomous Robotic Systems	–	3-0-0-6	3	9	SMD1
SMD3	26SMD3231E	Integrated Energy Systems for Smart Industries	–	3-0-0-6	3	9	SMD1
SMD4	26SMD3341E	Mechanics of Advanced Materials	–	3-0-0-6	3	9	SMD2orSMD3
SMD5	26SMD3351E	Digital Twin Engineering & ManufacturingAnalytics	–	3-0-0-6	3	9	SMD3orSMD4

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Mathematics For Mechanical Systems

25MT2020

L-T-P-S	2-2-0-0	Credits	4	Contact Hrs/Wk	4
Semester	S03	Mode	Regular	Category	BSC
Pre-requisite	None				

Course Outcomes (COs)

	Statement	BTL
CO1	Apply vector calculus — gradient, divergence, curl, line and surface integrals, Stokes' and Divergence theorems — to fluid-flow and heat-flux analysis.	BTL3 · Apply
CO2	Apply complex variables — analytic functions, Cauchy-Riemann equations, contour integration at intuition, conformal mapping for 2D potential flow.	BTL3 · Apply
CO3	Apply Laplace transforms — solving ODEs with discontinuous forcing, control-system transfer functions, mechanical impedance — to mechanical-system analysis.	BTL3 · Apply
CO4	Apply Fourier series and Fourier transforms — periodic-signal decomposition, vibration analysis, FFT for engineering-data spectrum analysis.	BTL3 · Apply
CO5	Apply partial differential equations – separation of variables for heat-conduction, wave equation, vibration of strings/membranes; the canonical mechanical-engineering boundary-value problems.	BTL3 · Apply
CO6	Analyze numerical methods for mechanical engineering — finite-difference for PDEs, finite-element method at intuition, modern simulation tools (ANSYS, Abaqus at intuition; OpenFOAM at intuition; AI-assisted solvers).	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1
CO1	H	H	–	–	H
CO2	H	H	–	–	H
CO3	H	H	H	–	H
CO4	H	H	H	–	H
CO5	H	H	H	–	H
CO6	H	–	H	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Vector Calculus** Vector fields — scalar field and vector field; the canonical mechanical-engineering examples (temperature field, velocity field).; Gradient — direction of steepest ascent; the connection to heat flux (Fourier law $q = -k\nabla T$).; Divergence — sources and sinks; the connection to mass conservation in fluid mechanics.; Curl — rotation; the connection to vorticity in fluid flow.; Line integrals — work done by a force along a path; the canonical engineering applications.; Surface integrals and flux — heat flux through a surface, mass flux in fluid systems.; Stokes' theorem and the Divergence theorem — the canonical relationships and their applications.; A first lab: compute heat flux through a surface for a given temperature field in Python (sympy + scipy.integrate); verify by analytical computation for simple geometries.	CO1

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	Title & Topics	CO
M2	**Complex Variables** Complex numbers recap — algebraic and polar forms; Euler's formula.; Functions of a complex variable; analytic functions; the Cauchy-Riemann equations.; Contour integration at intuition — Cauchy's integral theorem; residue theorem.; Conformal mapping at intuition — preserving angles; the canonical use in 2D fluid flow.; Joukowski transformation at intuition — mapping a circle to an airfoil; the canonical aerodynamics application.; A lab: visualize a 2D potential flow around a cylinder (and around a Joukowski airfoil) using Python; observe streamlines.	CO2
M3	**Laplace Transforms** Laplace transform definition — the canonical integral; the complex frequency domain.; Important transform pairs — exponential, sin/cos, ramp, step, delta; the canonical reference table.; Properties — linearity, time-shift, frequency-shift, derivative, integral.; Inverse Laplace transform — partial fractions for rational expressions.; Solving ODEs via Laplace — the canonical first-and-second-order mechanical systems (mass-spring-damper, RLC analog).; Transfer function — output/input ratio in s-domain; the canonical control-system foundation.; Mechanical impedance — force/velocity in s-domain; the bridge to vibration analysis.; A lab: solve mass-spring-damper response to step input via Laplace transform method; verify against scipy.signal.lti simulation.	CO3
M4	**Fourier Series and Transforms** Fourier series — periodic-signal decomposition; the canonical square-wave example.; Fourier transform — extension to aperiodic signals; the continuous-frequency representation.; Properties — linearity, time-shift, frequency-shift, scaling, convolution-multiplication duality.; Discrete Fourier transform (DFT) and Fast Fourier Transform (FFT) — the canonical computational tools.; Vibration analysis applications — modal analysis, sinusoidal response, frequency-response functions.; Engineering spectrum analysis — observing vibration spectra of rotating machinery; the canonical condition-monitoring application.; A lab: in NumPy, compute FFT of a real machine-vibration signal (downloaded from open repositories); identify dominant frequencies; interpret as machine-shaft and bearing harmonics.	CO4
M5	**Partial Differential Equations** PDE fundamentals — order, linearity, homogeneity; the canonical second-order classifications (parabolic, hyperbolic, elliptic).; Heat conduction equation (parabolic) — derivation from energy conservation + Fourier law.; Wave equation (hyperbolic) — derivation from Newton's second law + Hooke's law.; Laplace equation (elliptic) — steady-state heat conduction, potential flow.; Method of separation of variables — the canonical analytical-solution approach for simple geometries.; Boundary conditions — Dirichlet, Neumann, Robin; the engineering interpretation.; Eigenvalue problems for PDEs — the connection to vibration mode shapes and natural frequencies.; A lab: solve 1D transient heat-conduction in a rod by separation of variables; verify with finite-difference numerical solution in Python.	CO5
M6	**Numerical Methods and Modern Simulation** Finite-difference method (FDM) for PDEs — explicit vs implicit schemes; stability (CFL condition).; Finite-element method (FEM) at intuition — discretization, shape functions, assembly; the canonical commercial-package foundation.; Commercial FEA tools at intuition — ANSYS, Abaqus, COMSOL Multiphysics; the canonical industrial workflow (mesh, solve, post-process).; Open-source CFD — OpenFOAM as the canonical OSS solver; the canonical workflow.; AI-augmented simulation — physics-informed neural networks (PINNs); ML-based reduced-order models; the emerging frontier.; AI-assisted symbolic computation — Claude / ChatGPT for derivation assistance; sympy for verification.; India's simulation-software industry — Altair India, Ansys India, Siemens Industry Software India; the canonical placement corridor for CAE-strong students.; A final-week lab: solve 2D steady-state heat conduction in a square plate with mixed boundary conditions using FDM in Python; visualize with matplotlib; compare against analytical solution for verifiable cases.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Advanced Engineering Mathematics**	Erwin Kreyszig	Wiley	2022 (10th Ed.)

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#	Title	Authors	Publisher	Year
2	**Higher Engineering Mathematics**	B. S. Grewal	Khanna Publishers	2017 (44th Ed.)
3	**Numerical Methods for Engineers**	Steven C. Chapra & Raymond P. Canale	McGraw-Hill	2020 (8th Ed.)
4	**Mathematical Methods for Physicists — A Comprehensive Guide**	George B. Arfken, Hans J. Weber & Frank E. Harris	Academic Press	2012 (7th Ed.)
5	**Computational Methods for Engineers — Using MATLAB**	Joe D. Hoffman & Steven Frankel	CRC Press	2018 (3rd Ed.)
6	**Partial Differential Equations — Methods and Applications**	Robert C. McOwen	Pearson	2002 (2nd Ed.)
7	**A First Course in the Finite Element Method**	Daryl L. Logan	Cengage Learning	2016 (6th Ed.)

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Fundamentals of IOT and Sensors

25EC1203

L-T-P-S	2-0-2-0	Credits	3	Contact Hrs/Wk	4
Semester	S03	Mode	Regular	Category	ESC
Pre-requisite	Nil				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand the basic concepts of IoT and the role of Arduino-based hardware platforms in IoT systems.	2
CO2	Apply and demonstrate the interfacing of various sensors with Arduino to acquire and process real-time data.	3
CO3	Apply and demonstrate the interfacing of different actuators with appropriate driver circuits for IoT applications.	3
CO4	Analyze and develop IoT applications using ESP32 and display modules supported by various case studies.	4
CO5	Design, simulate, and implement IoT-based systems using Arduino and ESP32, integrating sensors, actuators, and displays to build functional prototypes.	4

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1
CO1	-	-	–	–	H
CO2	H	H	H	–	H
CO3	H	H	H	–	H
CO4	H	H	H	–	H
CO5	H	H	H	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Fundamentals of IoT**: Introduction, Characteristics, Architecture, Applications, Concept of transducers. Introduction to Arduino: Introduction, types, Microcontroller (ATMEGA328P), Features, Pin Description, IDE - Applications, Arduino GPIO Programming, Hardware Development.	CO1
M2	**Sensors and its Interfacing:** Introduction, Types, Classification, Temperature Sensors and its types, LM35 Interfacing, Light Dependent Resistor Interfacing, Infra-Red Sensor Interfacing, PIR Sensor Interfacing, Ultrasonic Sensor Interfacing, Gas Sensor Interfacing	CO2

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	Title & Topics	CO
M3	**Actuators and its interfacing:** Introduction, Types, Actuators: DC Motor, Servo Motor, Stepper Motor, Relay, Motor Driver circuit, Interfacing and implementation for various applications	CO3
M4	**Displays and its interfacing:** 7 Segment and its types, LCD pin description, commands. ESP32: Introduction, Features, Pin Description, Programming. IoT Case Studies: Home Automation, Smart Irrigation, Smart Health care, Smart Lighting, Intrusion Detection, Smoke Detectors, Smart Parking, Air Pollution.	CO4

Reference Books

#	Title	Authors	Publisher	Year
1	**CAD/CAM: Computer-Aided Design and Manufacturing**	Mikell P. Groover & Emory W. Zimmers	Pearson	1984
2	**Automation, Production Systems, and Computer-Integrated Manufacturing**	Mikell P. Groover	Pearson	2019 (5th Ed.)
3	**Additive Manufacturing Technologies**	Ian Gibson, David Rosen, Brent Stucker & Mahyar Khorasani	Springer	2021 (3rd Ed.)
4	**CNC Programming Handbook**	Peter Smid	Industrial Press	2007 (3rd Ed.)
5	**Digital Manufacturing and Assembly Systems in Industry 4.0**	Kaushik Kumar et al. (eds.)	CRC Press	2019

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Full Stack Web Development

25SC2008

L-T-P-S	0-0-2-4	Credits	2	Contact Hrs/Wk	6
Semester	S03	Mode	Regular	Category	ESC
Pre-requisite	DAST				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand the full-stack-web architecture – client-server model, HTTP request-response cycle, the canonical layers (browser → frontend framework → API → application server → database) – and trace one user action end-to-end.	BTL2 · Understand
CO2	Apply HTML/CSS/JavaScript foundations – semantic HTML5, modern CSS (Flexbox + Grid + responsive design), vanilla JavaScript (ES2020+), the DOM API, fetch – to build static and dynamic web pages.	BTL3 · Apply
CO3	Apply React fundamentals – functional components with hooks (useState, useEffect), props, conditional rendering, lists with keys, controlled forms – to build interactive single-page-application frontends.	BTL3 · Apply
CO4	Apply server-side Node.js + Express – routing, middleware, REST API design, request validation, error handling, environment configuration – to build production-grade backend services.	BTL3 · Apply
CO5	Apply data persistence – MongoDB via Mongoose (document-style), PostgreSQL via Prisma (relational with type safety), basic CRUD endpoints, schema design discipline – to build full-stack apps with real data.	BTL3 · Apply
CO6	Analyze authentication (JWT, sessions, OAuth at intuition), deployment (Vercel for frontend, Render/Railway for backend, MongoDB Atlas / Supabase for managed databases), the AI-augmented developer workflow (Copilot/Claude/Cursor) – and ship a complete full-stack application to production.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PO6	PO9	PSO1
CO1	H	H	–	–	–	–	H
CO2	H	–	H	–	–	–	H
CO3	H	–	H	–	–	–	H
CO4	H	–	H	–	–	–	H
CO5	H	–	H	H	–	–	H
CO6	H	–	H	H	M	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

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Module-wise Syllabus

	Title & Topics	CO
M1	**The Web Stack and HTML/CSS Foundations** The full-stack architecture: browser (HTML/CSS/JS) → HTTP/HTTPS → backend server → database → response back. The mental model that every full-stack engineer uses.; HTTP at the level a full-stack engineer needs: methods (GET/POST/PUT/DELETE), status codes (2xx/3xx/4xx/5xx), headers (Content-Type, Authorization, Cookie), request/response bodies.; Browser rendering revisited: HTML parsed into DOM, CSS into CSSOM, render tree, layout, paint; why CSS in <head> and JS at end-of-body.; Semantic HTML5: <header>/<nav>/<main>/<aside>/<footer> landmarks, <h1>-<h6> hierarchy, <form> with proper <label>/<input> association, accessibility implications of semantic markup.; Modern CSS layout: the box model, Flexbox (1D layout) with justify-content/align-items, CSS Grid (2D layout) with grid-template-columns/areas.; Responsive design: mobile-first methodology, media queries, fluid typography with clamp(), viewport-relative units (vw, vh, dvh).; CSS custom properties (variables): theming, design tokens, the modern alternative to Sass for most use cases.; A first lab: build a static 3-page responsive site (Home / About / Contact) using semantic HTML + Flexbox + Grid + CSS variables; verify Lighthouse 90+ on Accessibility.	CO1
M2	**JavaScript and the DOM** Modern JavaScript essentials (ES2020+): let/const, arrow functions, template literals, destructuring, spread/rest, modules (import/export), optional chaining, nullish coalescing.; Functions revisited: first-class functions, callbacks, higher-order functions (map/filter/reduce); the functional patterns that React relies on.; Promises and async/await: the modern asynchronous model; why callback hell ended; error handling via try/catch with async/await.; Fetch API: the modern HTTP client; GET / POST / PUT / DELETE patterns; the response.ok and response.json() flow.; DOM manipulation in vanilla JS: querySelector / querySelectorAll, element.classList, addEventListener, dataset.; Event handling: the event object, event delegation, removing listeners; the canonical patterns.; Local storage and session storage at intuition level: client-side persistence; the security and size limits.; A lab: build a small to-do app in vanilla JavaScript – fetch from a JSONPlaceholder API, render to DOM, add filter buttons, persist to localStorage; deploy to GitHub Pages.	CO2
M3	**React Component Basics** Why React: declarative ("describe what UI should look like") vs imperative DOM manipulation; render(state) → UI as the central abstraction.; JSX: syntactic sugar over React.createElement; what the bundler does before the browser sees it; the rules (one root element, className not class).; Functional components: function that returns JSX; modern default since hooks (2019); class components mentioned only as legacy.; Props: passing data into a component; props as the component's API; the read-only discipline.; useState hook: local component state; the setState updater pattern; the reducer-style updater function.; useEffect hook: side effects after render; the dependency array; common pitfalls (missing deps, infinite loops).; Conditional rendering and lists: ternaries vs && short-circuit, the .map() pattern, the importance of keys and the canonical bug from missing them.; Controlled forms in React: state owns the input value; onChange updates state; the discipline of controlled inputs.; Project setup with Vite: npm create vite@latest, the dev server with HMR, the production build; the modern alternative to Create React App.; A lab: rebuild the M2 to-do app as a React + Vite project; observe the productivity gain and the cost (no internals visibility); deploy to Vercel.	CO3

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	Title & Topics	CO
M4	**Server-Side Node and Express** Node.js as the JS runtime outside the browser: the event loop, npm as the package manager, package.json as the project descriptor.; Express.js as the canonical web framework: app.use middleware, app.get/post/put/delete routes, req/res objects.; Middleware deeply: the (req, res, next) signature; built-in (express.json), third-party (cors, morgan), custom (auth, logging).; REST API design: resource-oriented URLs (/users, /users/:id), HTTP methods mapped to CRUD operations, response status conventions.; Request validation: zod or joi as the modern schema-first approach; the discipline of validating inputs at the API boundary.; Error handling: the express-async-errors pattern, centralized error middleware, the discipline of returning structured error responses.; Environment configuration: dotenv for .env files, the dev/test/staging/prod separation, secrets management discipline.; tRPC at intuition level: when both frontend and backend are TypeScript, type-safe RPC eliminates an entire class of "the API broke the frontend" bugs; the modern alternative to REST in full-stack TypeScript projects.; A lab: build a Node + Express REST API with 5 endpoints (CRUD on a notes resource), zod validation, centralized error handling; test with curl and Thunder Client / Postman.	CO4
M5	**Data Persistence — MongoDB and Postgres** Why a database is the right answer: persistence across server restarts, query support, integrity guarantees, multi-process safety.; MongoDB at survey level: the document model (collections of JSON-like documents), the BSON storage format, the operators ($eq, $gt, $in).; Mongoose as the canonical Node ODM: schema definition, model creation, CRUD methods, populate for references; when to use it vs raw driver.; PostgreSQL at survey level: the relational model, schema with tables and constraints, SQL queries, JSON columns for flexibility (depth in DBMS).; Prisma as the modern Postgres ORM: schema-first, TypeScript-first, type-safe queries, migrations as code; the 2026-current contrast with classic Sequelize.; Schema design discipline: when to embed vs reference (Mongo), normalisation vs denormalisation (SQL); the patterns that survive scale.; CRUD endpoints in practice: the canonical "GET /resources, POST /resources, GET /resources/:id, PUT /resources/:id, DELETE /resources/:id" mapping with database operations.; A lab: extend the M4 notes API to persist to either MongoDB Atlas (Mongoose) or Supabase Postgres (Prisma); pick one stack per student preference; verify CRUD via Postman; demonstrate data survives server restart.	CO5
M6	**Authentication, Deployment, the AI-Augmented Workflow** Authentication fundamentals: identifying who the user is. The canonical schemes – session-based (cookie + server-side store) vs token-based (JWT in Authorization header).; Password handling discipline: NEVER store plaintext, ALWAYS use bcrypt/argon2, the salt-and-hash pattern; the canonical security failures.; JWT (JSON Web Tokens) at depth needed: the three-part structure (header.payload.signature), how the server verifies, the access-token + refresh-token pattern.; OAuth 2.0 at intuition level: "Sign in with Google/GitHub", the authorization-code flow; using libraries (Passport, Auth.js, Clerk) rather than rolling your own.; CORS: the same-origin policy, when CORS is needed, the Express CORS middleware; the canonical deployment-time gotcha.; Frontend deployment: Vercel as the canonical zero-config option for React apps; environment variables, preview deployments per PR.; Backend deployment: Render / Railway / Fly.io for Node + Express; the "git push to deploy" model; the contrast with classic VPS-with-PM2.; Database hosting: MongoDB Atlas free tier, Supabase free tier (Postgres + auth + storage), Neon for serverless Postgres; the managed-DB landscape.; AI coding assistants for full-stack: Copilot / Claude / Cursor for component scaffolding, Express route boilerplate, Prisma schema generation, test writing; the discipline of treating AI output as a first draft requiring review.; When AI assistants fail in full-stack work: subtle auth bugs (missed token validation), missing input sanitization (XSS / SQL injection holes), CORS misconfigs, exposed secrets in committed code; the security review eye that students must develop.; A lab: ship a complete full-stack mini-app – React frontend on Vercel, Node/Express backend on Render, MongoDB Atlas database, JWT auth, deployed to a real public URL; a 5-minute peer-review session before final submission.	CO6

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Reference Books

#	Title	Authors	Publisher	Year
1	**Eloquent JavaScript — A Modern Introduction to Programming**	Marijn Haverbeke	No Starch Press / Free PDF	2024 (4th Ed.)
2	**Learning React — Modern Patterns for Developing React Apps**	Alex Banks & Eve Porcello	O'Reilly	2020 (2nd Ed.)
3	**Node.js Design Patterns — Design and implement production-grade Node.js applications**	Mario Casciaro & Luciano Mammino	Packt	2020 (3rd Ed.)
4	**Express in Action — Writing, building, and testing Node.js applications**	Evan M. Hahn	Manning	2016
5	**MongoDB — The Definitive Guide — Powerful and Scalable Data Storage**	Shannon Bradshaw, Eoin Brazil & Kristina Chodorow	O'Reilly	2019 (3rd Ed.)
6	**Full Stack React — A Practical Guide to Building Real-World React Applications**	Anthony Accomazzo, Ari Lerner, Nate Murray, Clay Allsopp, David Guttman & Tyler McGinnis	Fullstack.io	2017
7	**Designing Web APIs — Building APIs That Developers Love**	Brenda Jin, Saurabh Sahni & Amir Shevat	O'Reilly	2018

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Embedded System Design And Iot

25EC2206

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S04	Mode	Regular	Category	ESC
Pre-requisite	FOIS				

Course Outcomes (COs)

	Statement	BTL
CO1	Apply ARM Cortex-M architectural concepts (core pipeline, memory model, NVIC, system tick) to characterise an STM32H7-class microcontroller and its programming model.	BTL3 · Apply
CO2	Apply STM32 peripheral subsystems — GPIO, ADC, timers, PWM, USART, SPI, I²C — through STM32 HAL to interface with sensors and actuators in small embedded programs.	BTL3 · Apply
CO3	Apply interrupt-driven and timer-driven programming patterns to build periodic and event-driven embedded behaviour without an RTOS.	BTL3 · Apply
CO4	Apply discrete-time PID controller design to a small position or velocity control loop, accounting for sampling rate and saturation at an introductory level.	BTL3 · Apply
CO5	Apply PWM-based motor drive concepts and current sensing to characterise a basic brushless or stepper motor drive scheme.	BTL3 · Apply
CO6	Apply CAN bus fundamentals – frame format, arbitration, transceivers – to design a simple node-to-node telemetry protocol on STM32H7 FDCAN.	BTL3 · Apply

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1
CO1	H	M	–	–	–
CO2	H	–	M	M	M
CO3	H	–	M	–	–
CO4	H	M	M	–	–
CO5	H	–	M	–	–
CO6	H	–	M	M	–

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**STM32 Microcontroller Architecture** Microcontroller vs microprocessor; on-chip integration of memory, peripherals, and connectivity.; ARM Cortex-M family overview and the Cortex-M7 in the STM32H7 series.; STM32H7 memory map: flash, ITCM, DTCM, AXI SRAM, peripheral region.; Clock tree at the user level: HSE, HSI, PLL, system clock, peripheral prescalers.; NVIC interrupt model: priority levels, the system tick, vector table.; Boot sequence: from power-on to main(); the role of the startup file.; STM32CubeMX as the configuration entry point; STM32CubeIDE as the development environment.; A first program: blink an LED on a Nucleo-H743ZI board.	CO1
M2	**GPIO, ADC, Timers, PWM** GPIO at the HAL level: input mode, output mode, alternate function, pull-up/pull-down.; Reading buttons and driving LEDs through the HAL.; STM32 timer subsystems: basic, general-purpose, advanced-control timers.; Timer modes: counting, capture, compare, PWM generation.; PWM configuration through STM32CubeMX: frequency, duty cycle, polarity.; STM32H7 ADC: SAR architecture, channels, resolution, sampling time.; Reading an analog sensor (potentiometer, temperature) at a fixed sample rate.; Common GPIO/ADC/PWM pitfalls and how to debug them.	CO2

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	Title & Topics	CO
M3	**Interrupts, Timers, and Periodic Tasks** Polling vs interrupts: when each is appropriate.; NVIC priority and pre-emption.; Writing interrupt service routines: do's and don'ts; keeping ISRs short.; Periodic tasks via timer interrupt: building a 1 kHz tick for a control loop.; External interrupts (EXTI): wiring a button or limit switch to a callback.; DMA fundamentals at the introductory level: offloading data movement from the CPU.; Bare-metal periodic-task pattern: state machine driven by a tick interrupt.; When you would want an RTOS — and why this course stays bare-metal (RTOS depth comes in ESDT).	CO3
M4	**Discrete-Time PID Control** Continuous PID at intuition level: P, I, D — what each term contributes.; Discrete-time PID — the implementable form on a microcontroller.; Sampling rate selection: rule of thumb relative to the closed-loop bandwidth.; Output saturation and anti-windup at introductory level.; Tuning by manual adjustment using step responses.; Implementing a PID loop on a 1 kHz timer tick.; Measuring the closed-loop response and verifying stability.; Cascaded control loops at preview level (position outside, velocity inside).	CO4
M5	**Motor Drive Basics** PWM-based motor drive: duty cycle as voltage proxy.; DC motor drive with an H-bridge; direction and speed control.; Brushless DC motor basics: three-phase windings, six-step commutation.; Stepper motor basics: full-step and half-step modes.; Motor driver ICs: integrated H-bridges and three-phase drivers.; Current sensing through a shunt resistor and op-amp.; Safe operating limits: current, temperature, dead-time.; Pairing the PID loop from M4 with a small motor drive.	CO5
M6	**CAN Bus Fundamentals** Why CAN: dominance in automotive and industrial automation; differential signalling and noise immunity.; CAN physical layer: CAN-H/CAN-L, twisted pair, 120 Ω termination, common bit rates.; CAN frame format: identifier, DLC, data field, CRC, ACK.; Priority by identifier and bus arbitration.; CAN transceivers as the interface between the MCU and the bus.; STM32H7 FDCAN peripheral at the HAL level: configuration, transmit, receive.; A simple node-to-node telemetry exchange: periodic state frames between two STM32 boards.; Higher-level protocols (CANopen, J1939) at awareness level — those are application-domain courses, not part of EBSD.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Mastering STM32**	Carmine Noviello	Leanpub	2023 (revised)
2	**Programming with STM32 — Getting Started with the Nucleo Board and C/C++**	Donald Norris	McGraw-Hill	2018
3	**The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors**	Joseph Yiu	Newnes	2014 (3rd Ed.)
4	**Embedded Systems — Real-Time Operating Systems for ARM Cortex-M Microcontrollers**	Jonathan Valvano	CreateSpace	2017
5	**Controller Area Network Prototyping with Arduino**	Wilfried Voss	Copperhill Technologies	2014
6	**Electric Motors and Drives — Fundamentals, Types and Applications**	Austin Hughes & Bill Drury	Newnes	2019 (5th Ed.)

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Iot For Smart Manufacturing

25ME3111

L-T-P-S	2-0-2-0	Credits	3	Contact Hrs/Wk	4
Semester	S05	Mode	Regular	Category	PCC
Pre-requisite	FOIS				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze the Industry-4.0 / smart-manufacturing paradigm and the IIoT architecture (edge-fog-cloud) that underpins a connected factory.	BTL4 · Analyze
CO2	Apply industrial sensing and edge data acquisition - vibration, temperature, current, acoustic sensors and edge gateways - to instrument a manufacturing asset.	BTL3 · Apply
CO3	Analyze industrial connectivity and interoperability - OPC UA, MQTT, the Asset Administration Shell - and OT/IT integration for the shop floor.	BTL4 · Analyze
CO4	Analyze condition monitoring and predictive maintenance - signal features, failure signatures and remaining-useful-life estimation - for rotating machinery.	BTL4 · Analyze
CO5	Apply the digital-thread and manufacturing-analytics layer (OEE, dashboards, MES integration) to turn shop-floor data into operational insight.	BTL3 · Apply
CO6	Apply an end-to-end smart-manufacturing use case - sensor to dashboard to maintenance action - with attention to OT security and the SAMARTH/Industry-4.0 context.	BTL3 · Apply

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PO6	PSO1
CO1	H	H	–	–	–	H
CO2	H	–	H	–	–	H
CO3	H	–	–	H	–	H
CO4	H	H	–	–	–	H
CO5	–	–	H	H	–	H
CO6	–	–	H	–	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Smart Manufacturing and the IIoT Architecture** The Industry-4.0 vision and India's SAMARTH Udyog Bharat 4.0 initiative.; The nine pillars of Industry 4.0 (overview).; The IIoT reference architecture: edge, fog, cloud.; The digital thread and digital twin (twin depth shared with DGMF/CAES).; Cyber-physical production systems.; Value of IIoT: OEE, quality, energy, maintenance.; The smart-factory maturity model.; Framing the course manufacturing asset to instrument.	CO1
M2	**Industrial Sensing and Edge Acquisition** Sensors for manufacturing: vibration (accelerometers), temperature, current, acoustic, pressure.; Sensor placement on machines and signal conditioning.; Sampling considerations for machine signals (Nyquist, aliasing).; Edge devices and gateways; edge vs cloud processing trade-off.; Data acquisition hardware and protocols at the edge.; Time synchronisation across sensors.; Data buffering and store-and-forward.; Instrumenting the project asset.	CO2

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	Title & Topics	CO
M3	**Industrial Connectivity and Interoperability** The protocol landscape: Modbus, PROFINET, EtherNet/IP (from a manufacturing view).; OPC UA as the interoperability backbone; information models.; MQTT and Sparkplug for IIoT messaging.; The RAMI 4.0 model and the Asset Administration Shell (concept).; OT/IT integration and the data pipeline.; Edge-to-cloud connectivity patterns.; Network reliability and determinism on the floor.; Connecting the instrumented asset to a broker/cloud.	CO3
M4	**Condition Monitoring and Predictive Maintenance** Maintenance strategies: reactive, preventive, predictive, prescriptive.; Vibration analysis: time and frequency domain, FFT, bearing/gear signatures.; Other techniques: thermography, oil analysis, motor-current signature analysis.; Feature extraction from machine signals.; Anomaly detection: threshold and ML-based methods (ML used as a tool from AIML).; Remaining-useful-life (RUL) estimation concepts.; Building a failure-mode catalogue for the asset.; A predictive-maintenance model for the project asset.	CO4
M5	**Digital Thread and Manufacturing Analytics** Overall Equipment Effectiveness (OEE): availability, performance, quality.; Manufacturing dashboards and KPI visualisation.; MES and ISA-95 (integration view).; Production traceability and the digital thread.; Energy monitoring and sustainability metrics.; Statistical process control on streaming data.; Closing the loop: data → insight → action.; Building the analytics dashboard for the project.	CO5
M6	**End-to-End Use Case, Security and Deployment** OT cybersecurity: IEC 62443, segmentation, the Purdue model.; Safety and reliability of connected manufacturing.; Edge AI for manufacturing (concept; deep edge AI elsewhere).; Scaling from a pilot to the plant.; Change management and workforce on the smart-factory journey.; Cost-benefit and ROI of IIoT projects.; Standards and the Indian manufacturing context.; Completing the sensor-to-action use case for the demo.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Industry 4.0: The Industrial Internet of Things**	Alasdair Gilchrist	Apress	2016
2	**Introduction to Industrial Internet of Things and Industry 4.0**	Sudip Misra et al.	CRC Press	2021
3	**Condition Monitoring and Fault Diagnosis**	Hong-Zhong Huang et al.	CRC Press	2020
4	**Machinery Vibration and Rotordynamics**	John Vance, Fouad Zeidan & Brian Murphy	Wiley	2010
5	**Smart Manufacturing: Concepts and Methods**	Masoud Soroush et al. (eds.)	Elsevier	2020

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Computer Aided Engineering And Simulation

25ME3112

L-T-P-S	0-0-2-4	Credits	2	Contact Hrs/Wk	6
Semester	S05	Mode	Regular	Category	PCC
Pre-requisite	MODS				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze CAE and finite element fundamentals.	BTL4 · Analyze
CO2	Apply 1D and 2D finite element formulations.	BTL3 · Apply
CO3	Apply structural FEA to mechanical component analysis.	BTL3 · Apply
CO4	Analyze thermal, modal and nonlinear simulations.	BTL4 · Analyze
CO5	Apply CFD fundamentals to basic flow problems.	BTL3 · Apply
CO6	Evaluate simulation quality through verification and validation.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PSO1
CO1	H	H	–	–	–	H
CO2	H	H	–	–	–	H
CO3	H	–	H	–	H	H
CO4	H	H	–	–	–	H
CO5	H	–	H	–	–	H
CO6	H	H	–	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	CAE and The Finite Element Method CAE in the product lifecycle; FEA, CFD, multibody dynamics; The finite element idea: discretise, approximate, assemble, solve Shape functions and interpolation; The element and global stiffness matrix; Boundary conditions and solving the system; Sources of error in FEA	CO1
M2	FEM Fundamentals Bars, Beams, 2D The 1 D bar element: stiffness, assembly, solution; Hand solving a small truss by FEM; The beam element: bending, the stiffness matrix; Plane stress vs plane strain. The constant strain triangle and quad elements; Isoparametric elements and numerical integration Gauss; Verifying FEM results against MODS analytical solutions.	CO2

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	Title & Topics	CO
M3	Structural FEA in Practice CAD import and geometry cleanup and defeaturing; Meshing: element types, mesh density, quality metrics; Material models and properties; Applying realistic loads and constraints Solving and reading stress, strain and deflection; Stress concentrations and singularities; Factor of safety and design checks; A structural analysis of the project component	CO3
M4	Thermal, Modal and Nonlinear Analysis Steady state and transient thermal FEA conduction; theory from TECS; Thermal stress and coupled thermal structural analysis; Modal analysis: natural frequencies and mode shapes Harmonic and random vibration analysis concept; Geometric and material nonlinearity; Contact analysis.	CO4
M5	Computational Fluid Dynamics The Navier Stokes equations and the CFD idea fluid theory from FMHE; Finite volume discretisation; Meshing for CFD; boundary layers and Boundary conditions: inlet, outlet, wall; Turbulence models: RANS k epsilon, k omega SST overview; Solving and post processing: pressure, velocity, drag; Conjugate heat transfer concept.	CO5
M6	Verification, Validation and Reporting Mesh convergence studies; Verification solving the equations right vs validation right equations; Comparing simulation to analytical and experimental data; Quantifying and communicating uncertainty Common simulation mistakes and how to catch them; Simulation driven design and optimisation the doorway to GAED; Documenting a CAE study for engineering decisions; Finalising and reporting the project simulation.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**A First Course in the Finite Element Method**	Daryl L. Logan	Cengage	2016 (6th Ed.)
2	**The Finite Element Method: Its Basis and Fundamentals**	O. C. Zienkiewicz, R. L. Taylor & J. Z. Zhu	Butterworth-Heinemann	2013 (7th Ed.)
3	**An Introduction to Computational Fluid Dynamics**	H. K. Versteeg & W. Malalasekera	Pearson	2007 (2nd Ed.)
4	**Concepts and Applications of Finite Element Analysis**	Robert D. Cook et al.	Wiley	2001 (4th Ed.)
5	**Finite Element Analysis: Theory and Application with ANSYS**	Saeed Moaveni	Pearson	2015 (4th Ed.)

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Digital Manufacturing

25ME3113

L-T-P-S	2-0-2-0	Credits	3	Contact Hrs/Wk	4
Semester	S05	Mode	Regular	Category	PCC
Pre-requisite	MAPS				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze the digital-manufacturing landscape and the CAD-CAM-CNC digital thread from product model to physical part.	BTL4 · Analyze
CO2	Apply parametric/feature-based CAD modelling and design-for-manufacturing principles to create manufacturable part models.	BTL3 · Apply
CO3	Apply CAM and CNC part programming - toolpaths, G/M-code, post-processing - to machine a part on a CNC mill/lathe.	BTL3 · Apply
CO4	Analyze additive-manufacturing processes (FDM, SLA, SLS, metal AM), Design-for-Additive-Manufacturing and their place alongside subtractive methods.	BTL4 · Analyze
CO5	Analyze the digital twin of manufacturing and computer-integrated manufacturing - process simulation, virtual commissioning and data integration.	BTL4 · Analyze
CO6	Apply an end-to-end digital-manufacturing workflow - CAD to CAM/AM to part to inspection - to produce and verify a real component.	BTL3 · Apply

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1
CO1	H	H	–	–	H
CO2	H	–	H	–	H
CO3	H	–	H	H	H
CO4	H	H	–	–	H
CO5	H	–	–	H	H
CO6	–	–	H	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**The Digital-Manufacturing Thread** From craft to digital: the evolution of manufacturing.; The digital thread: CAD → CAE → CAM → CNC/AM → inspection → PLM.; Subtractive vs additive vs formative processes.; Product Lifecycle Management (PLM) overview.; Digital manufacturing in Industry 4.0 (links to IFSM).; The Indian advanced-manufacturing context.; Cost and lead-time impact of going digital.; Framing the part to make in the project.	CO1
M2	**CAD and Design for Manufacturing** Parametric, feature-based solid modelling (building on ENGP CAD).; Assemblies and constraints.; Design for Manufacturing and Assembly (DFM/DFA) principles.; Tolerances and fits at design stage (GD&T depth owned by GDAT).; Sheet-metal and casting design considerations.; Model-based definition.; Exchange formats (STEP, STL).; Modelling the project part for manufacture.	CO2

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	Title & Topics	CO
M3	**CAM and CNC Programming** CNC machine fundamentals: axes, controllers, coordinate systems.; G-code and M-code basics.; CAM workflow: stock, toolpaths, strategies (roughing, finishing).; Tool selection, feeds and speeds.; Post-processing to machine-specific code.; Simulation and verification of toolpaths.; Multi-axis machining (concept).; Programming and (where possible) machining the project part.	CO3
M4	**Additive Manufacturing** AM process families: material extrusion (FDM), vat photopolymerisation (SLA/DLP), powder bed (SLS/SLM/DMLS), others.; Polymer vs metal AM.; The AM workflow: slicing, supports, orientation, parameters.; Design for Additive Manufacturing (DfAM): lattices, topology, consolidation.; Post-processing of AM parts.; Quality, defects and qualification in AM.; Choosing AM vs subtractive for a given part.; Printing a version of the project part and comparing.	CO4
M5	**Digital Twin and Computer-Integrated Manufacturing** The digital twin of a process/machine/plant.; Manufacturing process simulation and virtual commissioning.; Computer-Integrated Manufacturing (CIM) architecture.; CNC/robot integration and cellular manufacturing.; Data flow: CAD/CAM/MES/ERP integration.; In-process monitoring and adaptive control (links to IFSM).; Sustainability and material efficiency in digital manufacturing.; A digital-twin or virtual-commissioning element for the project cell.	CO5
M6	**End-to-End Workflow and Inspection** Metrology and inspection: CMM, 3-D scanning, in-process measurement.; Closing the loop: as-designed vs as-built.; First-article inspection and quality reporting.; Reverse engineering with 3-D scanning.; Documentation and traceability.; Cost analysis of the digital workflow.; Lessons from the make-and-measure cycle.; Completing and verifying the project part for the demo.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**CAD/CAM: Computer-Aided Design and Manufacturing**	Mikell P. Groover & Emory W. Zimmers	Pearson	1984
2	**Automation, Production Systems, and Computer-Integrated Manufacturing**	Mikell P. Groover	Pearson	2019 (5th Ed.)
3	**Additive Manufacturing Technologies**	Ian Gibson, David Rosen, Brent Stucker & Mahyar Khorasani	Springer	2021 (3rd Ed.)
4	**CNC Programming Handbook**	Peter Smid	Industrial Press	2007 (3rd Ed.)
5	**Digital Manufacturing and Assembly Systems in Industry 4.0**	Kaushik Kumar et al. (eds.)	CRC Press	2019

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Machine Dynamics And Vibrations

25ME3115

L-T-P-S	3-0-2-0	Credits	4	Contact Hrs/Wk	5
Semester	S05	Mode	Regular	Category	PCC
Pre-requisite	ENMC				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze dynamic forces in mechanisms and gyroscopes	BTL4 · Analyze
CO2	Analyze governors, flywheels	BTL4 · Analyze
CO3	Apply balancing methods for rotating and reciprocating masses.	BTL3 · Apply
CO4	Analyze free and forced vibrations of single-degree systems.	BTL4 · Analyze
CO5	Analyze vibration isolation and control of systems.	BTL4 · Analyze
CO6	Analyze vibration signals for measurement and condition monitoring.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PSO1
CO1	H	H	–	–	–	H
CO2	H	–	H	–	–	H
CO3	H	H	–	–	–	H
CO4	H	H	–	–	–	H
CO5	H	–	H	–	–	H
CO6	H	–	–	H	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	Force Analysis and Gyroscopic Effects Static force analysis, dynamic force analysis, inertia forces, D'Alembert principle, equivalent offset inertia force, dynamic analysis of slider-crank mechanisms. Gyroscopic couple, gyroscopic effects in vehicles and rotating systems	CO1
M2	Flywheels, Governors Turning moment diagrams, fluctuation of energy, flywheel concepts, centrifugal governors, stability, sensitivity,	CO2

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	Title & Topics	CO
M3	Balancing Static and dynamic balancing, balancing of rotating masses in single and multiple planes, balancing of reciprocating masses, primary and secondary forces, engine balancing	CO3
M4	Single Dof Vibration Free vibration of SDOF systems, natural frequency, damping, logarithmic decrement, forced vibration, resonance and transmissibility	CO4
M5	Vibration Control and Measurement Vibration isolation, transmissibility reduction, vibration absorbers, vibration measuring instruments, accelerometers.	CO5
M6	Experimental and Signal Based Vibration Analysis Machine condition monitoring, vibration signatures, rotating machinery faults, introduction to NVH, predictive maintenance concepts, Introduction to two DOF systems and modal analysis. ISO vibration severity standards; Measuring and interpreting the project system's vibration for the demo	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Theory of Machines**	S. S. Rattan	McGraw-Hill	2019 (5th Ed.)
2	**Mechanical Vibrations**	Singiresu S. Rao	Pearson	2017 (6th Ed.)
3	**Theory of Vibration with Applications**	William T. Thomson & Marie Dillon Dahleh	Pearson	1997 (5th Ed.)
4	**Theory of Machines and Mechanisms**	John J. Uicker, Gordon R. Pennock & Joseph E. Shigley	Oxford University Press	2016 (5th Ed.)
5	**Fundamentals of Mechanical Vibrations**	S. Graham Kelly	McGraw-Hill	2000 (2nd Ed.)

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Generative AI For Engineering Design

25ME3217

L-T-P-S	2-0-2-0	Credits	3	Contact Hrs/Wk	4
Semester	S07	Mode	Regular	Category	PCC
Pre-requisite	CAES				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze AI-driven transformation in engineering design.	BTL4 · Analyze
CO2	Apply design optimization to engineering problems.	BTL3 · Apply
CO3	Apply topology optimization and generative design methods.	BTL3 · Apply
CO4	Analyze surrogate models for engineering simulation.	BTL4 · Analyze
CO5	Analyze generative AI tools for engineering workflows.	BTL4 · Analyze
CO6	Evaluate AI-generated designs for validity and manufacturability.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO7	PO8	PO11	PSO1
CO1	H	H	–	–	–	–	–	H	H
CO2	H	–	H	–	–	–	–	–	H
CO3	H	–	H	–	–	H	–	–	H
CO4	H	H	–	–	H	–	–	–	H
CO5	–	–	H	–	H	–	–	H	H
CO6	H	–	–	H	–	–	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	AI in The Engineering Design Process Role of AI in modern engineering design; transition from parametric CAD to generative design; AI-driven optimisation, generative geometry, surrogate simulation and design copilots; use of simulation data in AI-assisted design; overview of contemporary tools such as Autodesk, Ansys SimAI and Altair; limitations, validation and responsible use of AI in engineering design.	CO1
M2	Design Optimisation Formulating a design optimisation problem: variables, objective, constraints; Gradient based optimisation; Gradient free methods: genetic algorithms, particle swarm, simulated annealing; Multi objective optimisation and the Pareto front Design of experiments and response surfaces; Optimisation coupled to simulation from CAES; Robust and reliability based design optimisation concept; Optimising a parameterised component for the project	CO2

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	Title & Topics	CO
M3	Topology and Generative Design Topology optimisation: the material distribution problem SIMP method intuition; Setting up loads, constraints and the design space; Interpreting and reconstructing topology optimised results; Generative design: many candidate solutions from goals and constraints Design for additive manufacturing synergy; Lattice and lightweight structures; Manufacturability constraints in generative design; Running a topology and generative study.	CO3
M4	AI Surrogate Models for Simulation Use of surrogate models to replace time-intensive FEA and CFD with fast predictive models; design-of-experiments for sampling the design space; response surface, Gaussian process and neural-network surrogate models; model training, validation, accuracy assessment and extrapolation risks; physics-informed machine learning concepts; overview of Ansys SimAI and Altair PhysicsAI; project workflow for building and validating a simulation surrogate model.	CO4
M5	Generative AI and LLM Tools in Engineering Role of large language models in engineering workflows; AI design copilots and retrieval-augmented generation over engineering documents; emerging text-to-CAD and AI-assisted CAD generation; use of AI for design documentation, calculations and code generation; limitations such as hallucination and the need for verification; tool integration and Model Context Protocol concepts; responsible use of generative AI in project design tasks.	CO5
M6	Evaluating and Trusting AI-Generated Designs Verification of AI-generated designs using engineering principles, simulations and calculations; manufacturability, practicality and safety checks; human-in-the-loop design review and engineer accountability; bias, data limitations and uncertainty in design AI; ethical, intellectual-property and liability considerations; transparent documentation of AI assistance; evaluation and finalisation of AI-assisted project designs for demonstration.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Engineering Design Optimization**	Joaquim R. R. A. Martins & Andrew Ning	Cambridge University Press	2021
2	**Topology Optimization: Theory, Methods, and Applications**	Martin P. Bendsoe & Ole Sigmund	Springer	2003 (2nd Ed.)
3	**Engineering Design: A Systematic Approach**	Gerhard Pahl, Wolfgang Beitz et al.	Springer	2007 (3rd Ed.)
4	**Machine Learning for Engineers**	Ryan G. McClarren	Springer	2021
5	**Data-Driven Science and Engineering**	Steven L. Brunton & J. Nathan Kutz	Cambridge University Press	2022 (2nd Ed.)

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HVAC & Battery Thermal Management Systems

25ME4119

L-T-P-S	3-0-2-0	**Credits**	4	**Contact Hrs/Wk**	5
Semester	S07	**Mode**	Regular	**Category**	PCC
Pre-requisite	TECS				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze the vapour-compression refrigeration cycle and its components, and evaluate performance (COP) for HVAC and cooling applications.	BTL4 · Analyze
CO2	Apply psychrometrics and the psychrometric chart to analyse air-conditioning processes and human-comfort conditions.	BTL3 · Apply
CO3	Analyze cooling/heating load estimation for a space and the selection and sizing of HVAC equipment and air-distribution systems.	BTL4 · Analyze
CO4	Analyze why batteries need thermal management - heat generation, temperature limits, thermal runaway - for EV and energy-storage applications.	BTL4 · Analyze
CO5	Apply battery thermal-management strategies - air, liquid and phase-change/immersion cooling, and heating - to a battery pack (using HTSD heat-transfer methods).	BTL3 · Apply
CO6	Evaluate an integrated thermal-management system design against performance, energy-efficiency, safety and sustainability criteria.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO7	PSO1
CO1	H	H	–	–	–	H
CO2	H	H	–	–	–	H
CO3	H	–	H	–	–	H
CO4	H	H	–	–	H	H
CO5	H	–	H	–	–	H
CO6	H	–	–	H	H	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Refrigeration Fundamentals** The need for cooling: comfort, process, preservation, electronics, batteries.; The vapour-compression refrigeration cycle (building on TECS cycles).; Components: compressor, condenser, expansion device, evaporator.; Refrigerants: properties, environmental impact, the shift to low-GWP.; COP and cycle performance.; Multi-stage and cascade systems (concept).; Vapour-absorption refrigeration (overview).; Analysing a refrigeration cycle for the project.	CO1
M2	**Psychrometrics** Moist-air properties: dry-bulb, wet-bulb, dew point, humidity ratio, enthalpy.; The psychrometric chart.; Air-conditioning processes: sensible/latent heating and cooling, humidification, dehumidification.; Mixing of air streams.; Human comfort and the comfort zone.; Sensible heat factor and the process line.; Apparatus dew point and bypass factor.; Plotting the project AC process on the chart.	CO2

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	Title & Topics	CO
M3	**HVAC System Design** Cooling and heating load estimation (building heat gains/losses).; Internal and external loads; the role of HTSD heat-transfer methods.; HVAC system types: split, packaged, central, VRF, chilled-water.; Air-handling units and air distribution (ducts, diffusers).; Fans, pumps and the system curve (links to FMHE).; Controls and building management systems.; Energy efficiency and standards (ECBC, star ratings).; Sizing an HVAC system for the project space.	CO3
M4	**Why Batteries Need Thermal Management** Battery heat generation: ohmic, entropic, the C-rate effect (cell context from EVBT).; Temperature limits and the optimal operating window.; Effect of temperature on performance, life and safety.; Thermal runaway: the mechanism and propagation.; Temperature uniformity across a pack.; Cold-weather operation and the need for heating.; Requirements for an EV/energy-storage BTMS.; Characterising the thermal problem for the project pack.	CO4
M5	**Battery Thermal-Management Strategies** Air cooling: passive and active; advantages and limits.; Liquid cooling: cold plates, channels, coolant selection.; Phase-change-material (PCM) cooling.; Immersion cooling (emerging).; Heating strategies for cold climates.; Heat-transfer analysis of the chosen strategy (HTSD methods applied).; Integration with the vehicle/system thermal loop.; Designing a BTMS for the project pack.	CO5
M6	**Integrated Thermal-System Design** Integrating HVAC/refrigeration and battery cooling (e.g. EV cabin + battery loop).; Heat pumps for combined heating/cooling.; Waste-heat recovery and energy efficiency.; Verification by analysis (and optional CAES/CFD simulation).; Sustainability, refrigerant choice and lifecycle impact.; Safety and standards.; Trade-offs: performance vs energy vs cost vs weight.; Evaluating and finalising the integrated thermal design for the demo.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Refrigeration and Air Conditioning**	C. P. Arora	McGraw-Hill	2009 (3rd Ed.)
2	**Principles of Refrigeration**	Roy J. Dossat	Pearson	1997 (4th Ed.)
3	**Heating, Ventilating, and Air Conditioning: Analysis and Design**	Faye C. McQuiston, Jerald D. Parker & Jeffrey D. Spitler	Wiley	2004 (6th Ed.)
4	**Thermal Management of Electric Vehicle Battery Systems**	Ibrahim Dincer, Halil S. Hamut & Nader Javani	Wiley	2017
5	**Battery Management Systems for Large Lithium-Ion Battery Packs**	Davide Andrea	Artech House	2010

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Green and Sustainable Manufacturing Technologies

25SMD3111

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S05	Mode	Regular	Category	PEC
Pre-requisite	Manufacturing Processes / Thermodynamics				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand sustainable manufacturing – the triple bottom line, resource flows, and the circular economy.	BTL2 · Understand
CO2	Apply clean and efficient processes — reducing waste, emissions, and energy in machining and forming.	BTL3 · Apply
CO3	Analyze material and energy efficiency – material flow, energy auditing, and process optimization.	BTL4 · Analyze
CO4	Analyze life-cycle assessment — cradle-to-grave impact, carbon footprint, and LCA methodology.	BTL4 · Analyze
CO5	Apply additive and near-net-shape manufacturing for material efficiency and design freedom.	BTL3 · Apply
CO6	Evaluate and redesign a manufacturing process/product for sustainability and circularity.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PO7	PSO1	PSO2
CO1	H	–	–	–	H	H	–
CO2	–	–	H	–	H	H	–
CO3	–	H	–	–	H	H	–
CO4	–	H	–	–	H	–	H
CO5	–	–	H	M	–	H	–
CO6	–	–	H	–	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Sustainable Manufacturing Foundations** The sustainability imperative for manufacturing.; The triple bottom line — economic, environmental, social.; Linear vs circular economy.; Resource and energy flows in production.; Sustainability metrics and indicators.; Regulation and standards (and India's net-zero commitments).; Green-manufacturing strategy.; Lab: audit the EcoFabLab line and quantify its energy/material/carbon footprint.	CO1
M2	**Clean & Efficient Processes** Waste streams in manufacturing.; Dry and minimum-quantity-lubrication machining.; Energy-efficient process selection.; Emission reduction and capture.; Process intensification.; Lean and its link to sustainability.; Cleaner production techniques.; Lab: redesign a machining process to cut energy and waste.	CO2

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	Title & Topics	CO
M3	**Material & Energy Efficiency** Material-flow analysis.; Energy auditing of a facility.; Identifying losses and inefficiencies.; Heat recovery and utility optimization.; Yield improvement and scrap reduction.; Water and resource management.; Setting and tracking efficiency targets.; Lab: perform an energy/material audit and propose efficiency measures.	CO3
M4	**Life-Cycle Assessment** The LCA framework (ISO 14040/14044).; Goal, scope, and the functional unit.; Life-cycle inventory analysis.; Impact assessment and carbon footprint.; Interpretation and hotspots.; LCA tools and databases.; Comparative LCA for decisions.; Lab: conduct an LCA for a product and identify impact hotspots.	CO4
M5	**Additive & Near-Net-Shape Manufacturing** Additive manufacturing processes overview.; Material efficiency of AM vs subtractive.; Design for additive manufacturing.; Near-net-shape forming and casting.; Lightweighting and topology optimization.; Remanufacturing and repair via AM.; Sustainability trade-offs of AM.; Lab: redesign a part for additive manufacturing to cut material use.	CO5
M6	**Circular Design & Capstone** Design for disassembly, reuse, and recycling.; Remanufacturing and product life extension.; Industrial symbiosis and by-product reuse.; Closing the material loop.; Business models for circularity.; Validating sustainability improvements.; The sustainable-manufacturing reference approach.; Lab/Showcase: present an EcoFabLab process/product redesigned for measurable sustainability and circularity gains.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th Ed.**	Mikell P. Groover	Wiley	2019
2	**Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives**	Rainer Stark, Günther Seliger & Jérémy Bonvoisin (Eds.)	Springer	2017
3	**Green Manufacturing: Fundamentals and Applications**	David A. Dornfeld (Ed.)	Springer	2013
4	**Life Cycle Assessment: Theory and Practice**	Michael Z. Hauschild, Ralph K. Rosenbaum & Stig Irving Olsen (Eds.)	Springer	2018
5	**Manufacturing Engineering and Technology, 7th Ed.**	Serope Kalpakjian & Steven R. Schmid	Pearson	2013
6	**Additive Manufacturing Technologies, 3rd Ed.**	Ian Gibson, David Rosen, Brent Stucker & Mahyar Khorasani	Springer	2021
7	**Sustainable Energy — Without the Hot Air**	David J. C. MacKay	UIT Cambridge	2009

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Autonomous Robotic Systems

25SMD3221

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S06	Mode	Regular	Category	PEC
Pre-requisite	SMD1				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand factory automation – industrial robots, cobots, and the automated work-cell.	BTL2 · Understand
CO2	Apply industrial robot programming – teach pendant, offline programming, and pick-and-place.	BTL3 · Apply
CO3	Apply machine vision — inspection, guidance, and quality control on the line.	BTL3 · Apply
CO4	Apply mobile plant automation — AGVs/AMRs, fleet routing, and material handling.	BTL3 · Apply
CO5	Analyze PLC and robot integration – cell controllers, interlocks, and safety systems.	BTL4 · Analyze
CO6	Evaluate and integrate a flexible automated work-cell for a manufacturing task.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
CO1	H	H	–	–	–	H	–
CO2	–	–	H	–	H	H	–
CO3	–	–	H	–	H	H	–
CO4	–	–	H	M	–	–	H
CO5	–	H	–	H	–	–	H
CO6	–	–	H	–	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Factory Automation Foundations** Levels of automation in manufacturing.; Industrial robots — types and applications.; Collaborative robots (cobots) and safety.; The automated work-cell concept.; Fixed vs flexible automation.; Automation ROI and the Indian SME reality.; The smart-factory vision.; Lab: map the FactoryBotLab cell and its coordination failures.	CO1
M2	**Industrial Robot Programming** Robot anatomy for industrial arms.; Teach-pendant programming.; Offline programming and simulation.; Coordinate frames and tool/work objects.; Pick-and-place and palletizing.; Path and motion programming.; Cycle-time optimization.; Lab: program an industrial robot for a pick-and-place task.	CO2
M3	**Machine Vision** Vision for inspection and guidance.; Lighting, optics, and image acquisition.; Feature/defect detection.; Vision-guided robotics.; Dimensional measurement and gauging.; Deep-learning vision for quality.; Integrating vision with the cell.; Lab: build a vision inspection that guides a robot pick.	CO3

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	Title & Topics	CO
M4	**Mobile Plant Automation** AGVs vs AMRs.; Navigation and guidance in the plant.; Fleet management and routing.; Material handling and intralogistics.; Safety around mobile robots.; Integration with production flow.; The Indian warehouse-automation wave (Addverb).; Lab: route an AGV/AMR to feed the work-cell.	CO4
M5	**PLC & Robot Integration** PLCs and the cell controller.; I/O, interlocks, and handshaking.; Robot-PLC communication.; Safety systems and light curtains.; Sequencing and coordination logic.; HMI and operator interface.; Diagnostics and fault handling.; Lab: integrate robot + conveyor + sensors under PLC control.	CO5
M6	**Flexible Work-Cell & Capstone** Designing a flexible automated cell.; Coordinating robot, vision, AGV, and PLC.; Changeover and flexibility.; Throughput and bottleneck analysis.; Safety certification of the cell.; Validation and commissioning.; The automated-cell reference design.; Lab/Showcase: present a FactoryBotLab cell where robot, conveyor, vision, and AGV coordinate to complete a task.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Industrial Robotics: Technology, Programming, and Applications**	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel & Nicholas G. Odrey	McGraw-Hill	2012
2	**Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Ed.**	Mikell P. Groover	Pearson	2019
3	**Introduction to Robotics: Mechanics and Control, 4th Ed.**	John J. Craig	Pearson	2017
4	**Robotics: Modelling, Planning and Control**	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani & Giuseppe Oriolo	Springer	2009
5	**Springer Handbook of Robotics, 2nd Ed.**	Bruno Siciliano & Oussama Khatib (Eds.)	Springer	2016
6	**Handbook of Manufacturing Engineering and Technology**	Andrew Y. C. Nee (Ed.)	Springer	2015
7	**Programming Robots with ROS**	Morgan Quigley, Brian Gerkey & William D. Smart	O'Reilly Media	2015

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Integrated Energy Systems for Smart Industries

25SMD3231

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S06	Mode	Regular	Category	PEC
Pre-requisite	SMD1				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand industrial energy systems — loads, power quality, and the factory energy balance.	BTL2 · Understand
CO2	Apply power-system and power-quality analysis – distribution, power factor, and harmonics.	BTL3 · Apply
CO3	Apply on-site renewables and storage — solar PV, batteries, and integration with plant loads.	BTL3 · Apply
CO4	Analyze energy management – monitoring, ISO 50001, and energy-information systems.	BTL4 · Analyze
CO5	Apply demand-side management – load shifting, peak shaving, and tariff optimization.	BTL3 · Apply
CO6	Analyze industrial microgrids — integrating generation, storage, and loads for resilience.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PO7	PSO1	PSO2
CO1	H	–	–	–	H	H	–
CO2	H	–	H	–	–	H	–
CO3	–	–	H	–	H	H	–
CO4	–	H	–	–	H	–	H
CO5	–	–	H	–	H	–	H
CO6	–	H	–	M	–	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Industrial Energy Systems** The factory energy balance.; Electrical, thermal, and mechanical energy.; Industrial loads and load profiles.; Energy costs and tariffs (Indian industrial tariffs).; Energy KPIs and benchmarking.; The role of energy in competitiveness.; The smart-energy vision for industry.; Lab: profile the EnerSysLab plant's energy use and costs.	CO1
M2	**Power Systems & Quality** Industrial power distribution.; Power factor and correction.; Harmonics and their effects.; Voltage sags, swells, and reliability.; Protection and switchgear basics.; Metering and submetering.; Power-quality improvement.; Lab: analyze power quality and design power-factor correction.	CO2
M3	**On-Site Renewables & Storage** Solar PV for industry — rooftop and ground-mount.; Sizing generation to plant load.; Battery energy storage systems.; Inverters and grid interconnection.; Self-consumption vs export.; Hybrid and captive generation.; Economics and payback (Indian context).; Lab: size an on-site solar+storage system for the plant.	CO3

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	Title & Topics	CO
M4	**Energy Management** Energy management systems and ISO 50001.; Monitoring and targeting.; Energy-information systems and dashboards.; Energy audits and conservation measures.; Continuous improvement of energy performance.; Measurement and verification.; Organizational energy management.; Lab: build an energy-monitoring dashboard with conservation targets.	CO4
M5	**Demand-Side Management** Load shifting and scheduling.; Peak shaving and demand charges.; Tariff structures and optimization.; Demand response and grid signals.; Storage for demand management.; Flexible loads in manufacturing.; Cost-optimal operation.; Lab: design a demand-side strategy to cut peak demand and cost.	CO5
M6	**Industrial Microgrids & Capstone** The microgrid concept for industry.; Integrating generation, storage, and loads.; Grid-connected vs islanded operation.; Microgrid control and energy management.; Resilience and backup power.; Economic dispatch within the plant.; The integrated-energy reference design.; Lab/Showcase: present an EnerSysLab plant with an integrated, monitored, cost-optimized energy system.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Energy Management Handbook, 9th Ed.**	Stephen A. Roosa, Steve Doty & Wayne C. Turner	Fairmont Press / River Publishers	2018
2	**Renewable and Efficient Electric Power Systems, 2nd Ed.**	Gilbert M. Masters	Wiley	2013
3	**Electric Power Distribution Engineering, 3rd Ed.**	Turan Gönen	CRC Press	2014
4	**Smart Grid: Technology and Applications**	Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama & Nick Jenkins	Wiley	2012
5	**Power Electronics: Converters, Applications, and Design, 3rd Ed.**	Ned Mohan, Tore M. Undeland & William P. Robbins	Wiley	2003
6	**Energy Management Principles, 2nd Ed.**	Craig B. Smith & Kelly E. Parmenter	Elsevier	2015
7	**Sustainable Energy — Without the Hot Air**	David J. C. MacKay	UIT Cambridge	2009

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Mechanics of Advanced Materials

25SMD3341

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S07	Mode	Regular	Category	PEC
Pre-requisite	SMD2 or SMD3				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand stress, strain, and elasticity — the continuum-mechanics basis of material behaviour.	BTL2 · Understand
CO2	Analyze mechanical behaviour — plasticity, fatigue, creep, and fracture.	BTL4 · Analyze
CO3	understand composite mechanics and manufacturing	BTL2 · Understand
CO4	Analyse the failure in composite laminates	BTL3 · Apply
CO5	Select appropriate advanced and smart materials for design	BTL3 · Apply
CO6	Analyze failure using fracture mechanics, failure criteria, and failure analysis.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
CO1	H	H	–	–	–	H	–
CO2	H	H	–	–	–	H	–
CO3	–	–	H	–	H	H	–
CO4	–	–	H	–	M	H	–
CO5	–	H	–	H	–	–	H
CO6	–	–	H	–	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	Stress, Strain & Elasticity The stress tensor and traction; strain and deformation; generalized Hooke's law and anisotropy; 3D principal stresses and Mohr's circle; plane stress and plane strain; strain energy; constitutive models overview; Lab: analyze the stress state of the MatLab component that failed.	CO1
M2	Mechanical Behaviour of anisotropic materials Elastic vs plastic behaviour; yield criteria including von Mises and Tresca; hardening and the stress-strain curve; fatigue, S-N curves and cyclic loading; creep at high temperature; strain-rate and temperature effects; testing and characterization; Lab: predict fatigue life for a cyclically-loaded part.	CO2
M3	Composite Mechanics Need for composites and strength-to-weight advantage; fibers, matrices and interfaces; manufacturing and design with composites; micromechanics and rule of mixtures; Lab: Manufacturing composites using rule of mixtures.	CO3

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	Title & Topics	CO
M4	Composite Mechanics classical laminate theory; anisotropy and ply orientation; composite failure criteria; Lab: compute laminate stiffness and predict first-ply failure.	CO4
M5	Advanced & Smart Materials Advanced alloys and high-performance metals; engineering ceramics and their mechanics; advanced polymers and elastomers; smart materials including shape memory and piezoelectric materials; functionally graded and architected materials; material selection using Ashby charts for design; emerging materials in industry; Lab: select a material for a demanding application using selection charts.	CO5
M6	Failure & Fracture Fracture mechanics including stress intensity and toughness; ductile versus brittle fracture; crack growth and fatigue-crack propagation; failure criteria for design; failure analysis methodology; case studies of real failures; damage tolerance and safe-life design; Lab: perform a fracture-mechanics assessment and failure analysis, present an FEA-validated redesign of the MatLab component that no longer fails.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Mechanics of Materials, 10th Ed.**	Russell C. Hibbeler	Pearson	2016
2	**Mechanical Behavior of Materials, 4th Ed.**	Norman E. Dowling	Pearson	2012
3	**Mechanics of Composite Materials, 2nd Ed.**	Robert M. Jones	CRC Press	1998
4	**Materials Science and Engineering: An Introduction, 10th Ed.**	William D. Callister & David G. Rethwisch	Wiley	2018
5	**Deformation and Fracture Mechanics of Engineering Materials, 5th Ed.**	Richard W. Hertzberg, Richard P. Vinci & Jason L. Hertzberg	Wiley	2012
6	**The Finite Element Method: Its Basis and Fundamentals, 7th Ed.**	O. C. Zienkiewicz, R. L. Taylor & J. Z. Zhu	Butterworth-Heinemann	2013
7	**Engineering Materials 1: An Introduction to Properties, Applications and Design, 5th Ed.**	Michael F. Ashby & David R. H. Jones	Butterworth-Heinemann	2018

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Digital Twin Engineering & Manufacturing Analytics

25SMD3351

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S08	Mode	Regular	Category	PEC
Pre-requisite	SMD3 or SMD4				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand the digital-twin and Industry-4.0 paradigm – the cyber-physical factory and the data backbone.	BTL2 · Understand
CO2	Apply industrial IoT and data acquisition — sensors, edge gateways, and the OT data pipeline.	BTL3 · Apply
CO3	Analyze digital-twin modeling – physics-based, data-driven, and hybrid twins synchronized to the asset.	BTL4 · Analyze
CO4	Analyze manufacturing analytics – OEE, SPC, and data-driven process improvement.	BTL4 · Analyze
CO5	Apply predictive and prescriptive maintenance — condition monitoring and remaining-useful-life models.	BTL3 · Apply
CO6	Evaluate and build a closed-loop smart-factory twin that monitors, predicts, and optimizes operations.	BTL5 · Evaluate

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1	PSO2
CO1	H	H	–	–	H	–
CO2	–	–	H	H	H	–
CO3	–	H	H	–	–	H
CO4	–	H	–	H	H	–
CO5	–	–	H	H	–	H
CO6	–	–	H	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Digital Twins & Industry 4.0** The Industry-4.0 vision and cyber-physical systems.; What a digital twin is — and is not.; Twin types — component, asset, process, system.; The data backbone of the smart factory.; The value case for twins.; Standards and platforms.; The Indian smart-manufacturing push.; Lab: map the TwinLab plant's data and blind spots.	CO1
M2	**Industrial IoT & Data Acquisition** Sensors and instrumentation for assets.; Edge gateways and protocol translation (ties to EEA/automation).; The OT data pipeline to the cloud.; Time-series data and historians.; Data quality from the shop floor.; Connectivity and the unified namespace.; Streaming plant data.; Lab: instrument an asset and stream its data to a time-series store.	CO2

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	Title & Topics	CO
M3	**Digital-Twin Modeling** Physics-based models of assets/processes.; Data-driven (ML) surrogate models.; Hybrid twins.; Synchronizing the twin to the real asset.; Simulation and what-if analysis.; Co-simulation and model integration.; Twin fidelity vs cost.; Lab: build a digital twin of an asset synchronized to live data.	CO3
M4	**Manufacturing Analytics** Overall equipment effectiveness (OEE).; Statistical process control (SPC).; Quality analytics and yield.; Throughput and bottleneck analytics.; Root-cause analysis with data.; Dashboards for operations.; Continuous improvement (Six Sigma) with data.; Lab: build an OEE/SPC analytics dashboard for the line.	CO4
M5	**Predictive Maintenance** Maintenance strategies — reactive to predictive.; Condition monitoring (vibration, thermal, current).; Anomaly detection on machine data.; Remaining-useful-life (RUL) models.; Failure-mode analysis (FMEA).; Prescriptive maintenance actions.; Maintenance ROI.; Lab: build a predictive-maintenance model that flags impending failure.	CO5
M6	**Closed-Loop Smart Factory & Capstone** Closing the loop — twin to decision to action.; Optimization with the twin.; Integrating analytics, twin, and control.; Human-in-the-loop operations.; Reliability and trust of the system.; Scaling across the plant.; The smart-factory reference architecture.; Lab/Showcase: present a TwinLab smart factory that monitors, predicts failures, and optimizes operations in a closed loop.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Digital Twin Driven Smart Manufacturing**	Fei Tao, Meng Zhang & A. Y. C. Nee	Academic Press	2019
2	**Industry 4.0: The Industrial Internet of Things**	Alasdair Gilchrist	Apress	2016
3	**Simulation Modeling and Analysis, 5th Ed.**	Averill M. Law	McGraw-Hill	2015
4	**Fundamentals of Data Engineering**	Joe Reis & Matt Housley	O'Reilly Media	2022
5	**Designing Machine Learning Systems**	Chip Huyen	O'Reilly Media	2022
6	**Digital Twin Technologies and Smart Cities**	Maryam Farsi, Alireza Daneshkhah, Amin Hosseinian-Far & Hamid Jahankhani (Eds.)	Springer	2020
7	**The Fourth Industrial Revolution**	Klaus Schwab	Crown Business	2017

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Annexure-

Course wise Revision as per the course Structure of Y25 & Y26 Admitted Batch Students

Course Code & Regulation	Course Name	Course Category	Existing Syllabus (as per Annexure-3)	New Syllabus	Topics Added/Removed/Replaced	Change in Outcome	Justification for the Modification	*Overall Revision Percentage
Y26-26ME1303	Computer Aided Design and Drafting	ESC	Orthographic Projections & Sectional Views Principles of Orthographic Projections, Projection of points, lines, planes, solids, Full and half sectional views for complex objects Pictorial Representation Isometric projections and drawings, Perspective views and basic rendering concepts, Visualization of complex parts from given views CAD Modelling using Fusion 360 Sketching constraints and dimensions, 3D part modeling: extrude, revolve, sweep, loft, Boolean operations and parametric constraints	Principles of Projection and Orthographic Drawing BIS standards, drawing sheets, lettering, line conventions, scales,dimensioning, Projection principles, orthographic projection, first angle and third angle projection, reference planes, quadrants and multiview representation. Lab: Orthographic drawing of machine components. Projections of Points, Lines and Planes Projection of points, lines, planes, true length, true inclination, traces, auxiliary projections and engineering visualization. Lab: Manual drafting exercises. Projection of Solids, Sections and Development of Surfaces Projection of prisms, pyramids, cylinders, cones and spheres, sections of solids, development of surfaces and assembly representation. Lab: Sectional views and developments. Isometric and Engineering Drawing Standards Dimensioning, limits and fits, GD&T basics, surface finish, welding symbols, isometric projection, orthographic isometric conversion, oblique drawing and perspective drawing. Lab: Fully dimensioned engineering drawings. Engineering Design using Fusion 360 Fusion 360 interface, sketching, constraints, parametric modelling, extrude, revolve, sweep, loft,	Topics Added: Dimensioning, limits and fits, GD&T basics, surface finish, welding symbols, Bill of Materials, design changes, cloud collaboration and AI assisted design review. Digital Manufacturing Assembly modelling, joints, motion study, interference analysis, sheet metal design, STL export, Design for Additive Manufacturing, Generative Design, Simulation overview, Reverse Engineering, Digital Twin concepts and AI assisted CAD.	CO4, CO5, CO6	As per the feedback from the stakeholders the topics on assembly drawing and basics of GD&T were added to the course, so that studetns will understand the importance graphics in mechanical design	40%

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				patterns, engineering drawing generation, annotations, Bill of Materials, design changes, cloud collaboration and AI assisted design review. Lab: Model and document individual mechanical components in Fusion 360. Advanced Fusion 360 and Digital Manufacturing Assembly modelling, joints, motion study, interference analysis, sheet metal design, STL export, Design for Additive Manufacturing, Generative Design, Simulation overview, Reverse Engineering, Digital Twin concepts and AI assisted CAD. Lab: Develop a multi component mechanical assembly, generate manufacturing drawings and export models for 3D printing.				
Y25 &Y26-25ME2120	**Material Science and Metallurgy**	**BSC**	Introduction-Testing Introduction to Engineering materials, Crystallography, Crystal systems and Bravi's lattices, Crystal imperfections, Material testing Methods-Destructive and Non Destructive MethodsDye penetrate test, Magnetic flux test, Radiography and Ultrasonic test. Materials Ferrous and Non-Ferrous Materials, Ceramics, Composites and Biomaterials- Introduction, classification and applications. Smart Materials: Introduction, shape memory effect, classification of shape memory alloys, compositions, properties applications of shape memory alloys. Alloys and Transformation Constitution of alloys, Necessity of alloying, Solid solutions, Gibb's Phase rule, Cooling Curves, Phase Diagrams-Introduction, classification based on components and	Foundations: Structure & DefectsCrystal systems and unit cells.; Metallic crystal structures (BCC/FCC/HCP).; Miller indices anddirections/planes.; Point, line (dislocation), and planar defects.; Dislocations and plasticdeformation.; Grain structure and boundaries.; Structure-property linkage.; Lab: examinemicrostructure and identify the MetalLab failure's origin. Phase DiagramsSolid solutions and the phase rule.; Binary phase diagrams.; The iron-carbon (Fe-Fe3C)diagram.; The lever rule and phase fractions.; Eutectic, eutectoid, and peritectic reactions.;Microstructure development on cooling.; Reading service-relevant diagrams.; Lab: predictmicrostructure from a phase diagram and verify. Mechanical Behaviour & Failure Stress-strain and elastic/plastic behaviour.; Strengthening mechanisms.; Hardness	Topics Added: Mechanical Behaviour & Failure Stress-strain and elastic/plastic behaviour.; Strengthening mechanisms.; Hardness andtoughness.; Fatigue and the S-N curve.; Creep at high temperature.; Fracture mechanics basics.;Failure analysis methodology , Additive manufacturing and its metallurgy.; Characterization (XRD/SEM) at intuition.;AI/ML-driven materials discovery and	CO3,CO6	As per the feedback received from the faculty the suggested topics were added so that students will be exposed to latest technological advancements in the field of material scisence	**25%**

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			transformations, construction, reactions involved in Fe-C, Cu-Ni and Al-Cu type. Heat treatment Heat Treatment of steels-Introduction, stages, classification, Annealing, Normalising, Tempering, Hardening, Harden ability test by Jominy end quench apparatus, Isothermal transformation diagrams-TTT diagram &CCT diagram, special heat treatment techniques-Introduction, classification, surface hardening and case hardening methods such as carburising, nitriding, cyaniding and carbonitriding	andtoughness.; Fatigue and the S-N curve.; Creep at high temperature.; Fracture mechanics basics.;Failure analysis methodology.; Lab: perform mechanical tests and a failure analysis. Heat Treatment Diffusion and transformations.; TTT and CCT diagrams.; Annealing, normalizing, hardening,tempering.; Hardenability.; Surface hardening (carburizing, nitriding).; Quenching and residualstress.; Property control via heat treatment.; Lab: heat-treat a steel sample and measureproperty changes. Ferrous & Non-Ferrous MetallurgySteels — plain carbon and alloy.; Cast irons.; Stainless and tool steels.; Aluminium, copper, andtheir alloys.; Titanium and superalloys at intuition.; Extraction and processing at intuition.; Alloyselection for applications.; Lab: identify and compare engineering alloys. Advanced Materials (AI) + CapstoneComposites and reinforcement.; Nanomaterials and their properties.; Smart and functionalmaterials.; Additive manufacturing and its metallurgy.; Characterization (XRD/SEM) at intuition.;AI/ML-driven materials discovery and ICME.; The advanced-materials landscape (India).;Lab/Showcase: present a MetalLab materials solution — selection/heat-treatment/redesign —with a modern-materials + AI-discovery angle.	ICME.; The advanced-materials landscape			
Y25-25Me21	**Mechanics of**	**PCC**	Introduction: Types of Stress, Strains, Stress Strain Diagram, Hooke's Law.	Module 1: Stress and Strain Foundations Stress definitions, normal stress, shear stress, stress at a	**Topics Added:**	CO1, CO6	As per the feedback from faculty person	**25%**

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05 & Y26-26ME2104	**Deformable Solids**		Axially Loaded Members: Uniaxial Loading and Material Properties, Force-deformation Relationships and Static Indeterminacy; Compound Bars, Stress-strain-temperature Relationships. Trusses and their Deformations - Statically Determinate and Indeterminate Trusses. Torsion: Introduction, Torsion of a Circular Bar, Non- Uniform Torsion, Transmission of Power by Circular Shafts, Strain Energy in Pure Shear and Torsion. Multi axial stresses and strains: Multiaxial Stress and Strain- Relationships, Stress and Strain Transformations and Principal Stresses. Failure of Materials and Examples Shearing Forces and Bending Moments: Shear Force and Bending Moment, Relationship Between Load, Shear Force and Bending Moment, Shear Force and Bending Moment Diagrams. Beam Deflection: Symmetry, Superposition, and Statically Indeterminate Beams. Stresses in Beams: Normal Stresses in Beams, Cross Section Shapes of Beams, Shear Stresses in Rectangular Beams, Shear Stresses in The Webs of Beams with Flanges. Thin-walled Pressure Vessels: Concepts of Hoop and Longitudinal Stresses, Simple Problems for Cylinders and Shells. Columns: Buckling and Stability.	point, 2D and 3D stress representation, strain definitions, Hooke's law, elastic constants, Young's modulus, Poisson's ratio, shear modulus, tensile testing, engineering stress–strain curve, yield strength, ultimate strength, fracture behavior, and Mohr's circle for 2D stress analysis. Laboratory work includes tensile testing of mild steel specimens using UTM and evaluation of material properties. Module 2: Axial Loading Axial deformation of bars, deformation of stepped bars, statically indeterminate axial loading problems, equilibrium and compatibility methods, thermal stress and strain, strain energy due to axial loading, and composite bars. Laboratory experiments include measurement of axial deformation and verification of elastic modulus. Module 3: Beam Bending Types of beam loading, shear-force and bending-moment diagrams, flexure formula, section modulus, beam deflection by direct integration, Macaulay's method, superposition principle, and introductory strain-energy methods including Castigliano's theorem. Laboratory work includes deflection measurement of simply supported beams under different loading conditions. Module 4: Torsion Torsion of circular shafts, torsional shear stress, polar moment of inertia for solid and hollow shafts, angle of twist, composite shafts, statically indeterminate torsion problems, power transmission through shafts, and combined bending and torsion theories for shaft design. Laboratory experiments include torsion testing and evaluation of shear modulus. Module 5: Columns and Buckling Buckling of columns, Euler's buckling theory, critical load, effective length for different end conditions, slenderness ratio, classification of columns, Rankine's formula,	Theories of Failure and Modern Tools Theories of failure including Rankine, Tresca, and von Mises criteria, comparison of failure theories, fatigue concepts, S–N curves, Goodman and Soderberg criteria, introductory fracture mechanics, stress intensity factor, crack growth concepts, AI-assisted stress analysis, and introductory finite element analysis using modern engineering software tools. Thermal Stresses and power transmission		the suggested topics were added to the syllabus to educate the students on various theories of failure	

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				eccentric loading, and engineering applications of columns. Laboratory work includes experimental verification of buckling behavior in slender columns. Module 6: Theories of Failure and Modern Tools Theories of failure including Rankine, Tresca, and von Mises criteria, comparison of failure theories, fatigue concepts, S–N curves, Goodman and Soderberg criteria, introductory fracture mechanics, stress intensity factor, crack growth concepts, AI-assisted stress analysis, and introductory finite element analysis using modern engineering software tools. Laboratory/design activity includes stress analysis and FEA-based verification of machine components.				
Y25-25ME2106 & Y26-26ME2105	**Thermodynamics and Energy Conversion Systems**	**PCC**	Fundamental Concepts and Definitions: Thermodynamic system, processes, thermodynamic equilibrium and quasi-static process, Reversible and irreversible processes, Zeroth law, Work and Heat in flow and non-flow processes First Law of Thermodynamics for Non-Flow Systems: First law of thermodynamics for flow and non-flow processes, PMM-1. Second Law of Thermodynamics: Thermal reservoirs, Kelvin-Plank and Clausius statements of second law of thermodynamics; Equivalence of Kelvin-Plank and Clausius statements, PMM-2; Carnot cycle, Carnot engine. Entropy: Definition of entropy, Clausius theorem, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, availability and irreversibility, Maxwell's and Tds relations. PURE SUBSTANCE: Vapour-liquid-solid phase equilibrium,	**Thermodynamic Fundamentals — Zeroth and First Laws** Thermodynamic system and surroundings — closed vs open systems; the canonical engineering examples.; Properties — intensive (T, P) vs extensive (V, U);state functions vs path functions.; Equilibrium and the zeroth law.; Work and heat; the canonical processes; Specific heats Cp and Cv ,First law for closed systems; the canonical energy-conservation principle.; First law for open systems — steady-flow energy equation; the canonical applications (turbines, compressors, throttling, nozzles).; **Properties of Pure Substances** Pure substance — fixed composition; the canonical examples (water, air, R-134a).; P-v-T surface— the 3D thermodynamic surface.; Phase change— saturated liquid, saturated vapor, two-phase mixture, superheated, subcooled.; Steam tables.; Quality x — mass fraction of vapor in two-phase mixture; canonical formulas.; Ideal gas equation — PV = nRT; range of validity.; Real-gas equations at intuition — Van der Waals, compressibility factor.	**Topics Added Ideal gas and real gas equation, Vander waals intuition and compressibility factor** Brayton cycle improvements — reheating, regeneration, intercooling Rankine cycle-supercritical and ultra supercritical operation, Combined cycle (Brayton + Rankine)	CO2, CO5, CO6	As per the feedback received from faculty, the concepts were rearranged and few topics were added so that all advance concepts are included in the course	**25%**

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			independent properties, Equations of state, Tables of thermodynamic properties. VAPOUR POWER CYCLES: Rankine cycle, Effect of pressure and temperature, Reheat & Regenerative cycle, Binary vapour cycle. Air standard cycles: Assumptions, P-v & T-s diagrams of Otto, diesel, dual and Brayton cycle. Mean effective pressure, efficiency and performance comparison of the cycles.	**Second Law** Second-law statements — Kelvin-Planck (heat engine), Clausius (refrigerator); and equivalence.; Ideal heat pump and refrigerator COP, Carnot cycle — the canonical reversible heat engine; the universal efficiency limit;.; Reversible vs irreversible processes — the canonical engineering concept of "lost work".; **Entropy** Entropy — definition; the canonical isentropic process.; Entropy change of ideal gas — TdS equations and the canonical application formulas.; Available energy and exergy at intuition — the canonical "useful work" framework. **Gas Power Cycles** Otto cycle (SI engine) — derivation, efficiency formula, the canonical p-V and T-s diagrams.; Diesel cycle (CI engine) — derivation, efficiency formula, comparison with Otto at same compression ratio.; Dual cycle — the more realistic representation; the canonical engineering compromise.; Brayton cycle (gas turbine) — derivation, efficiency formula, the canonical jet-engine basis.; Brayton cycle improvements — reheating, regeneration, intercooling; the canonical efficiency-boost techniques.; **Vapour Power Cycles** Rankine cycle (steam power plant) — derivation, efficiency formula; the canonical thermal-power-plant cycle.; Rankine cycle improvements —reheating, regeneration, supercritical / ultra-supercritical operation; the canonical modern thermal-plant techniques.; Combined cycle (Brayton + Rankine) — the canonical 60+%-efficient natural-gas plant.				
Y25-25ME2007 &	**Fluid Mechanics and**	**PCC**	Fluid Properties: Definition of fluid, properties of fluid -density, specific weight, specific gravity, viscosity,	**Fluid Properties & Fluid Statics** Definition of a fluid — continuum hypothesis; Fluid properties — density, specific weight,	**Topics Added:** **Reciprocating Pumps-** Construction, types, slip,	CO5, CO6	As per the discussions in Energy group meeting the	25%

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Y26-26ME2208	**Hydraulic Machines**		classification of fluids, surface tension and capillarity Vapour pressure. Fluid Statics: Introduction, pressure, Pascal's law, hydrostatic law, measurement of pressure, simple and differential manometers, Total pressure and center of pressure on vertical, horizontal, inclined and curved surfaces. Buoyancy: Buoyancy, forces on submerged bodies, stability of floating bodes. Fluid kinematics: Introduction, types of fluid flow, Discharge, Continuity equation, velocity potential function and stream function. Fluid dynamics: Introduction, Euler's equation of motion, Bernoulli's equation and applications, Venturimeter, Orifice meter, Nozzles. Flow through pipes: Introduction, major and minor energy losses, friction coefficient in laminar and turbulent flow, Hagen-Poiseuille law, Hydraulic gradient and total energy line, pipes in series and parallel, power transmission through pipes, Reynold's experiment and water hammer. Dimensional analysis and model similitude Boundary layer theory: Introduction, laminar, turbulent boundary layer, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer separation, methods of preventing separation. Impact of jets: Introduction to impulse-momentum equation and its applications, Force exerted by jet on fixed target, moving target, and series of	specific gravity, viscosity, surface tension, compressibility, bulk modulus; Newtonian-vs-non-Newtonian classification. Pressure measurement —manometers, Pascal's law and hydrostatic-pressure variation, Total pressure and centre-of-pressure on plane submerged surfaces; Pressure on curved surfaces, Buoyancy, Archimedes' principle, metacentric height and stability of floating bodies; Lab — measure metacentric height of a model pontoon by the shifting-weight method; verify against BG/BM formula. **Fluid Kinematics & Fluid Dynamics** Classification of fluid flow, Streamline, streakline and pathline. Continuity equation, mass conservation for steady incompressible flow; applications in nozzle / diffuser design.; Velocity potential function ϕ and stream function ψ; Euler's equation of motion along a streamline, Bernoulli's equation — derivation, assumptions, limitations, Engineering applications of Bernoulli — Venturimeter, orifice meter, Pitot tube, discharge coefficients; Lab: Flow measurement using Venturi and orificemeter. **Flow Through Pipes — Major & Minor Losses** Laminar and turbulent flow in pipes; Reynolds' experiment; Hagen-Poiseuille equation for laminar pipe flow; Darcy-Weisbach equation and Moody chart for turbulent flow; friction-factor dependence on Re and relative	percentage slip, negative slip, air vessels, and comparison with roto-dynamic pumps. **Modern Turbomachinery & CFD-**Introduction to compressors and gas turbines, aerospace and power-generation applications, Brayton cycle overview, and CFD-based hydraulic machinery design using OpenFOAM, ANSYS Fluent, and STAR-CCM+ with RANS (k-ε/k-ω SST) models.		proposed topics are incorporated into the syllabus as per the requirements of CFD concepts by thermal related companies	

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			curved vanes. Fluidics: Applications, principles and components. Hydraulic Machines-Turbines: Introduction, types and classification Pelton wheel, Francis turbine, Kaplan turbine-theory, work done and efficiency, design parameters, problems. Hydraulic Machines-Centrifugal pumps: Definition of pump, classification, description & general principle of working, priming, work done & efficiencies of a centrifugal pump, Minimum starting speed, cavitation in centrifugal pumps, Multistage pumps, problems on centrifugal pumps.	roughness; Minor losses, equivalent-pipe-length Pipes in series, parallel and branched; equivalent-resistance approach; Power transmission through pipes — maximum-power condition,; Flow measurement for ME applications — Venturimeter, orifice meter. Lab: Measurements of losses in pipe flows (Major and minor losses) **Dimensional Analysis & Similitude (Model Testing)** Fundamental and derived dimensions; the M-L-T system; dimensional homogeneity of fluid-mechanics equations.; Rayleigh's method of dimensional analysis; Buckingham π theorem — procedure, Dimensionless numbers — Reynolds, Froude, Euler, Mach, Weber, Geometric, kinematic and dynamic similarity; the "scale-model and prototype" relationship. Lab: Reynolds experiment-Laminar and turbulent flow **Hydraulic Turbines — Pelton, Francis, Kaplan** **Hydraulic Turbines -** Classification based on action/reaction, flow direction, and head; construction, working, velocity triangles, work done, efficiency, and design of **Pelton, Francis, and Kaplan turbines. Performance & Selection** - Specific speed, turbine selection charts, and characteristic curves (constant-head and constant-speed). Lab: Performance testing of Pelton wheel, Francis and Kaplan turbines **Pumps & Modern Turbomachinery** **Centrifugal Pumps**-Construction, velocity				

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				triangles, Euler's pump head, manometric head, efficiency, performance characteristics (H–Q, efficiency, power curves), specific speed, multistage pumps, and series/parallel operation. **Pump Performance-**System and pump curves, NPSH, cavitation prevention, and operating point analysis. **Reciprocating Pumps-** Construction, types, slip, percentage slip, negative slip, air vessels, and comparison with roto-dynamic pumps. **Modern Turbomachinery & CFD-I**ntroduction to compressors and gas turbines, aerospace and power-generation applications, Brayton cycle overview, and CFD-based hydraulic machinery design using OpenFOAM, ANSYS Fluent, and STAR-CCM+ with RANS (k-ε/k-ω SST) models. Lab: Performance testing of single, multi stage centrifugal pumps and reciprocating pump				
Y25-25ME2208 & Y26-26ME2206	**Manufacturing and Production Systems**	**PCC**	Module 1: Pattern design considerations; Gating system design, Special casting processes, Advanced welding techniques, Concepts of hot and cold working processes. Module 2:Mechanics of metal cutting, tool geometry, tool wear and life, Grinding operations, reciprocating machine tools. Machining time calculations and power required on conventional machine tools. Module 3:Unconventional Machining Processes: Wire Electric Discharge Machining, Plasma cutting machine, CO2 Laser machine, Abrasive jet machining, Ultra sonic Machining, Electrochemical Machining Module 4:Introduction to GD	**M1 Casting and Metal Forming:** Casting fundamentals — pattern, mold, core, sand-casting process, Casting types — sand, investment (lost-wax), die casting, centrifugal, Casting defects — porosity, hot tears, shrinkage, cold shut, canonical causes and remedies, Forging — open-die vs closed-die, hot vs cold forging, Rolling — hot rolling and cold rolling, Extrusion — direct, indirect, hydrostatic , Sheet-metal forming — bending, deep drawing, stretch forming , Casting and Metal Forming — Applications. Lab: Study of Casting and Metal Forming Processes and Identification of Casting Defects. **M2** Joining Processes: Fundamentals and classification of joining processes; welding principles and terminology; fusion welding processes—	**Topics Added:** Forging — open-die vs closed-die, hot vs cold forging, Rolling — hot rolling and cold rolling, Extrusion — direct, indirect, hydrostatic , Sheet-metal forming — bending, deep drawing, stretch forming , Casting and Metal Forming — Application. **Production Planning and Control:** Introduction to production planning and	CO1, CO5, CO6	As per the feedback of stakeholders the poposed topics are added to the course as these are the topics which are not covered in any course and are needed for GATE	50%

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			& T, Limits , Fits and Tolerances, Hole and shaft basis system, Gauges, Taylor's Principle, Linear and angular measurements.	Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW/MIG), Gas Tungsten Arc Welding (GTAW/TIG), friction welding, friction stir welding, brazing and soldering principles, adhesive bonding. Lab: Practice of Joining Processes. **M3 Machine Tools:** Introduction to machine tools; classification and constructional features of conventional machine tools; working principles, operations, tooling, and applications of centre lathe, drilling machine, shaper, planer, slotter, milling machine, boring machine, grinding machines. Lab: Job work on Conventional Machine Tools. **M4 Metal Cutting and Mechanics:** Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life and Taylor's equation, surface finish, cutting fluids and Machinability. Lab: Mechanics of Chip Formation and Cutting Tool Geometry. **M5: Production Planning and Control:** Introduction to production planning and control (PPC), forecasting methods, process planning, routing, scheduling, loading, sequencing, dispatching, follow-up, inspection, and production control; capacity planning, inventory management. Lab: Study of Production Planning and Control. **M6: Materials and quality Management:** Material requirement planning (MRP), Just-in-Time (JIT) production, Total Quality Management (TQM) at intuition, Six Sigma at depth — DMAIC and shop floor control; fundamentals of Lean Manufacturing, principles and benefits of lean thinking, lean performance metrics, and industrial applications for	control (PPC), forecasting methods, process planning, routing, scheduling, loading, sequencing, dispatching, follow-up, inspection, and production control; capacity planning, inventory management. **Materials and quality Management:** Material requirement planning (MRP), Just-in-Time (JIT) production, Total Quality Management (TQM) at intuition, Six Sigma at depth — DMAIC and shop floor control; fundamentals of Lean Manufacturing, principles and benefits of lean thinking, lean performance metrics, and industrial applications for enhancing productivity, quality, flexibility, and operational efficiency. Lab: Study of Quality Management			

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				enhancing productivity, quality, flexibility, and operational efficiency. Lab: Study of Quality Management				
Y25-25ME2209 & Y26 22EC3112	**Robotics and Mechatronic Systems**	**PCC**	CO-1: Introduction to Robotics and Mechatronics: Definition and Scope, History, Major components, Applications. Classification of Robots: Classification by coordinate system and by control method. End Effectors: Introduction, types of end effectors: grippers and tools, considerations in the selection and design of end-effectors. CO-2: Sensors and Transducers: Introduction, Classification, Position and Displacement, Proximity, Force and Pressure, Velocity, Temperature, Vision sensors, Touch & Slip, Selection of Sensors. Actuators: Pneumatic and hydraulic actuators systems, Electrical actuators. CO-3: Positions and orientations, Transformations, Homogeneous Transformation matrix. Robot Kinematics: Introduction, kinematic parameters, Link Description, Denavit- Hartenberg (DH) representation, Concept of forward and inverse kinematics. Robot Dynamics: Forward dynamics: Lagrangian (Lagrange-Euler) and Newton-Euler formulations, Inverse dynamics. CO-4: Control System: Open and closed loop control system, PID control system. System modeling: Modelling of one and two order Mechanical and Electrical Systems, transfer function of Mechanical and	Robot Fundamentals & Mechatronic Systems, Robot anatomy, classifications, workspace, end effectors, industrial robots, sensors, actuators and mechatronic system architecture. Lab: Industrial robot familiarization and component identification. Introduction to robot kinematics, coordinate systems and reference frames, Transformation matrices, homogeneous transformations, D-H representation, forward and inverse kinematics using analytical and geometric methods, Jacobian (intro), velocity and singularity analysis, manipulability and basic applications of robot kinematics in industrial manipulators. Introduction to robot dynamics, generalized coordinates, kinetic and potential energy of robotic systems, equations of motion, Newton–Euler formulation (introduction), Lagrangian formulation (introduction), dynamic modeling of serial manipulators, joint forces and actuator torques, trajectory and motion planning, joint-space and Cartesian-space trajectories, point-to-point and continuous path motion, polynomial trajectory planning (introduction), velocity and acceleration profiles, and applications of robot dynamics in industrial automation and motion control. Lab: Robot Dynamics and Trajectory Planning of	**Topics Added:** Robotic pick-and-place systems, automatic sorting systems, material handling systems, packaging automation, assembly line automation, and integration of PLCs with robotic manipulators. Python programming, Robo Analyzer, trajectory planning, workspace visualization, robot simulation and computational modelling, ROS2 fundamentals, mobile robots, AGVs, collaborative robots, SLAM (intro), robot vision, AI in robotics,	CO5 & CO6	As per the feedback of faculty it is necessary to include Robo programming in Robotic and Mechatronic Systems to increase the opportunities in placement drives	25%

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			Electrical Systems. PLC: Introduction, basic structure, programming of PLC, selection of a PLC. Case Study: Pick and place Robot, CNC Machine, etc. CO-5: Computational exercises using Python for Transformations, Denavit- Hartenberg (DH) representation, Kinematics. Simulations of Kinematic and Dynamic models using Robo Analyzer. Transfer function of Mechanical and Electrical Systems using Octave PLC Programming using OpenPLC Editor.	a Two-Link Manipulator Using MATLAB/Python. Sensors, Actuators & Embedded Systems Encoders, IMU, force and vision sensors, servo, BLDC and stepper motors, hydraulic and pneumatic actuators, Arduino, STM32 and ESP32 interfacing. Lab: Sensor interfacing and actuator control. Control Systems & PLC Open/closed-loop control, PID control, transfer functions, PLC architecture and hardware components, ladder logic programming, logic instructions, timers, counters, OpenPLC, Industrial automation case studies involving conveyor systems, robotic pick-and-place systems, automatic sorting systems, material handling systems, packaging automation, assembly line automation, and integration of PLCs with robotic manipulators. Lab: PLC programming and PID implementation. Robot Programming & Modern Robotics Python programming, Robo Analyzer, trajectory planning, workspace visualization, robot simulation and computational modelling, ROS2 fundamentals, mobile robots, AGVs, collaborative robots, SLAM (intro), robot vision, AI in robotics, Lab: ROS2/Turtlesim simulation and simple autonomous navigation.				
Y25-25ME2210 & Y26-	**Kinematics of Machines**	**PCC**	Mechanisms and Machines: Introduction to Plane and Space Mechanisms, Kinematic Pairs, Kinematic Chains and their Inversions, Mobility and range of	Introduction to machines and mechanisms, links, kinematic pairs, kinematic chains, degrees of freedom, Gruebler/Kutzbach criterion, inversions of four-bar chain, slider-crank chain and double	**Topics removed: Gyroscope and balancing**	CO5 & CO6	Based on the feedback of Engineering Design group head the	25%

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26ME2207			movement - Kutzbach and Grubler's criterion, Grashof's criterion. Velocity analysis: Velocity analysis using IC and relative velocity method. Acceleration analysis. Cams: cam profiles of knife edge, roller and offset followers of reciprocating motion. Gears and Gear trains: Gears – terminology, fundamental law of gearing, involute profile. Interference and undercutting. Gear Trains – simple, compound and epicyclic gear trains. Balancing: Introduction, Static balancing, dynamic balancing, transferring of a Force from one plane to another, Balancing of Several Masses in Different planes, Balancing of Reciprocating Mass, Secondary Balancing. Dynamic force analysis: Force analysis of Slider crank mechanism. Gyroscopes: Gyroscopic Effect on Naval Ships, Stability of an Automobile, Stability of a Two-Wheel vehicle, Four-Wheeler.	slider and quick-return mechanisms. Relative velocity method, instantaneous centre method, Kennedy theorem, velocity analysis of four-link mechanisms. Relative acceleration method, radial and tangential acceleration components, Coriolis acceleration, acceleration analysis of slider-crank, four link mechanism. Classification of cams and followers, follower displacement diagrams, uniform velocity, SHM, uniform acceleration-retardation and cycloidal motion, cam profile construction. Law of gearing, involute tooth profile, gear terminology, interference, simple gear trains, compound gear trains, reverted and planetary gear trains. Introduction to synthesis, dimensional synthesis, path and function generation, coupler curves, computer-aided mechanism analysis	**Topics added:** planetary gear trains. Introduction to synthesis, dimensional synthesis, path and function generation, coupler curves, computer-aided mechanism analysis		course Kinematics and Dynamics of machines course is split into two courses and the topics are rearranged by removing certain topics and adding few concepts	
Y25-25ME3114 & Y26-26ME2309	**Heat Transfer and System Design**	**PCC**	Introduction to fundamental processes of heat transfer and their governing laws. 1-D steady state heat conduction in single and multi-layered plane walls, cylinders and spheres along with concepts of thermal contact resistance and critical thickness of insulation. Fins-applications and performance analysis; Transient conduction-lumped capacitance, semi-infinite body and application of Heisler and Grober charts. Elementary convection including laminar and turbulent boundary layers in external flows and internal flows	**Steady-State Conduction** Modes of heat transfer and the energy balance.; Fourier's law and thermal conductivity.; Plane-wall, cylindrical and spherical conduction.; Composite walls and the thermal-resistance network.; Contact resistance.; Extended surfaces (fins): fin equation, efficiency, effectiveness.; Critical radius of insulation.; A conduction analysis of the project component. **Transient Conduction** The lumped-capacitance method and the Biot number.; Validity of the lumped model.; One-dimensional transient conduction (Heisler charts / analytical).; Semi-infinite solids.; The thermal time	**Topics Added;** Numerical (finite-difference) transient solution intuition. The radiation network method.; Combined conduction-convection-radiation.; Solar and environmental radiation (concept). The thermal-design process: requirements to specification.;	CO2, CO4, CO6	Based on the feedback given by faculty members new concept on new transient intuition, combined-convection-radiation and thermal systems design which includes electronics cooling and design is added as these are identified as the	30%

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			of forced convection, natural convection. Heat transfer in boiling and condensation. Basic concepts of heat exchangers; Thermal radiation-Stefan-Boltzmann law, small object in a large enclosure, parallel plates and shape factor.	constant.; Multidimensional transient effects (concept).; Numerical (finite-difference) transient solution intuition.; A transient thermal problem relevant to the project. **Convection** The convection coefficient and Newton's law of cooling.; Boundary layers (thermal and velocity); links to FMHE fluid concepts.; Dimensionless numbers: Reynolds, Prandtl, Nusselt, Grashof.; Forced convection: external (flat plate, cylinder) and internal (pipe flow).; Empirical correlations and their ranges.; Free/natural convection.; Boiling and condensation (introduction).; Finding convection coefficients for the project. **Radiation** Blackbody radiation: Planck, Stefan-Boltzmann, Wien.; Emissivity, absorptivity, real surfaces.; View (shape) factors and their algebra.; Radiation exchange between surfaces.; The radiation network method.; Combined conduction-convection-radiation.; Solar and environmental radiation (concept).; Including radiation in the project thermal analysis. **Heat Exchangers** Heat-exchanger types: double-pipe, shell-and-tube, compact, plate.; Overall heat-transfer coefficient and fouling.; The LMTD method and correction factors.; The effectiveness-NTU method.; Parallel-flow vs counter-flow performance.; Heat-exchanger sizing and rating.; Pressure drop and pumping cost (links to FMHE).; Analysing/sizing a heat exchanger for the project. **Thermal-System Design** The thermal-design process: requirements to specification.; Electronics/component cooling and heat-sink design.; Trade-offs: performance vs size vs weight vs cost.; Thermal management	Electronics/component cooling and heat-sink design.; Trade-offs: performance vs size vs weight vs cost.; Thermal management strategies (passive vs active).; Verification by hand calc and (where used) CAES simulation.; Sustainability and energy efficiency in thermal design		need of thermal based industries	

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				strategies (passive vs active).; Verification by hand calc and (where used) CAES simulation.; Sustainability and energy efficiency in thermal design. Designing and evaluating the project thermal system for the demo.				
Y25-25ME3216 & Y26-26ME3113	**Machine Design and Product Development**	**PCC**	Shafts: Design of solid and hollow shafts for strength and rigidity, Design of shaft for variable load, Design of shafts for gear and belt drives. Design of Helical springs, Torsion springs, Spiral springs, Leaf springs. Design of Welded joints: Design of Welded joints, Strength of welded joints, Circular fillet welds-bending and torsion, Welded joint with eccentric loading. Design of Bolted joints: Design of bolts with pre-stresses - Design for leak Proof Joints – Design of joints under eccentric loading - Bolt of uniform strength. Belt Drives: Selection of flat and V-belts from manufacturer's catalogue, Belt tensioning methods, Construction, and applications of timing belts. Bearings: modes of Lubrication, sliding contact bearing design, bearing materials, selection of lubricant. Rolling contact bearings- selection of ball, roller bearings-under static load, dynamic load. Brakes: Analysis and Design of Block brakes, internal shoe Brakes, End shoe Brakes, Pivoted shoe Brakes, Band Brakes, Temperature raise, Friction materials. Spur Gears: Force analysis, Beam strength (Lewis) equation, Estimation of module based on beam and wear strength, Helical gear Design.	Design Against Static Failure Engineering design process, material selection, static and combined loading, stress concentration, factor of safety, failure theories including Rankine, St. Venant, Tresca, strain energy, von Mises and Coulomb Mohr theory. Lab: Static design verification using analytical methods and Fusion 360 Simulation. Fatigue and Variable Load Design Fatigue phenomenon, S N curves, endurance limit, modifying factors, Goodman, Gerber and Soderberg criteria, Miner rule and fatigue design of machine components. Lab: Fatigue analysis using Fusion 360 Simulation. Shafts, Keys, Splines, Couplings and Fasteners Design of shafts, keys, splines, flexible and rigid couplings, threaded fasteners, welded joints and power screws using standard design procedures. Lab: Design and validation of shafts and fastened joints using Fusion 360. Bearings, Springs and Mechanical Power Transmission Rolling contact bearings, bearing life estimation, journal bearings overview, helical gears, bevel gears, flexible and rigid couplings, belt and chain drives, helical compression, extension, leaf and torsion springs, lubrication fundamentals and manufacturer catalogue based selection. Lab: Fusion 360 assembly modelling and design validation of transmission components. Product Development Process	**Topics Added:** Engineering design process, material selection, static and combined loading, stress concentration, factor of safety, failure theories including Rankine, St. Venant, Tresca, strain energy, von Mises and Coulomb Mohr theory. Fatigue phenomenon, S N curves, endurance limit, modifying factors, Goodman, Gerber and Soderberg criteria, Miner rule and fatigue design of machine components. Customer needs, product specifications, concept generation, morphological chart, Pugh matrix, DFMA, FMEA, sustainable product design, prototyping and design reviews. Integrated Product Design and Validation	CO1,CO2, CO5,CO6	Based on the feedback of faculty product Development concepts are added also topics on failure theories, material selection are included so that the student is made well equipped with all the concepts related to machine design	70%

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				Customer needs, product specifications, concept generation, morphological chart, Pugh matrix, DFMA, FMEA, sustainable product design, prototyping and design reviews. Lab: Product concept development and prototype planning. Integrated Product Design and Validation Fusion 360 assembly modelling, engineering drawings, Bill of Materials, design validation, Fusion 360 Simulation, topology optimization introduction, Design for Additive Manufacturing, AI assisted design review and engineering documentation. Lab: Complete product assembly and design documentation using Fusion 360.	Fusion 360 assembly modelling, engineering drawings, Bill of Materials, design validation, Fusion 360 Simulation, topology optimization introduction, Design for Additive Manufacturing, AI assisted design review and engineering documentation.			
Y25-25ME3218 & Y26-26ME3112	**Geometric Dimensioning and Tolerancing**	**PCC**	Calculation involves determining the limits and fits of tolerances specified in standards, ensuring components fit and function correctly within defined parameters. Interpretation involves understanding and applying GD&T symbols within industrial drawings, ensuring precise communication of design requirements for manufacturing and assembly processes. Calculation involves deriving various tolerance values from GD&T drawings and using specialized software to create industrial drawings incorporating GD&T symbols accurately.	Terminology: nominal, limits, tolerance, allowance, deviation.; Types of fit: clearance, transition, interference.; The ISO system of limits and fits; hole-basis and shaft-basis.; Tolerance grades and fundamental deviations.; Selecting fits for function.; Surface finish and its specification.; Tolerancing the mating parts of the project. The limits of coordinate (+/-) tolerancing: square tolerance zones, ambiguity.; The case for geometric tolerancing.; ASME Y14.5 and ISO GPS standards.; The feature control frame anatomy.; The 14 geometric characteristics overview. Form controls: straightness, flatness, circularity, cylindricity.; The datum concept and datum features.; The datum reference frame and degrees of freedom.; Orientation controls: parallelism, perpendicularity, angularity.; Location controls: position, concentricity, symmetry.; Profile controls: profile of a line/surface.; Runout: circular and total.; Fully GD&T-defining the	Topics Added: Material Conditions and Metrology and Inspection concepts	CO5 & CO6	Based on the feedback of faculty, Material Conditions and Metrology and Inspection concepts are included in the course to cover all the topics related to dimensioning	50%

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				project part. Maximum Material Condition (MMC) and Least Material Condition (LMC).; Regardless of Feature Size (RFS).; Bonus tolerance and how it is earned.; The effect of material modifiers on functional gauging.; Virtual condition and resultant condition.; Datum feature modifiers.; When to use each modifier.; Applying material conditions to the project part for assembly. Why stack-up matters: tolerances accumulate in assemblies.; Worst-case (arithmetic) stack-up.; Statistical (RSS) stack-up and process capability (Cp, Cpk).; Loop diagrams and the stack-up procedure.; Stack-up with GD&T (translating geometric tolerances).; Allocating tolerances to meet an assembly requirement.; Cost vs tolerance trade-off.; A tolerance stack-up for the project assembly. Measurement fundamentals: accuracy, precision, traceability.; Conventional metrology: gauges, micrometers, height gauges.; Functional gauging and go/no-go gauges.; Coordinate Measuring Machines (CMM) and how they verify GD&T.; Optical and 3-D-scanning metrology.; Measurement uncertainty and gauge R&R.; Inspection planning from the drawing.; Inspecting the project part against its GD&T and reporting for the demo.				

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DEPARTMENT OF MECHANICAL ENGINEERING
Y26 B.Tech ME - REGULAR LIST OF COURSES

Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACON YM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	NEW / Revised / Retained	% of Revision	Revision Proposed by	Justification
1	S01	HSS	26UC1137	DESIGN THINKING FOR INNOVATION & ENTREPRENEURSHIP	DTIE	0	0	4	0	2	4	NIL		Entrepreneurship	Retained			
2	S01	HSS	26UC1102	LANGUAGE SKILLS FOR ENGINEERS	LSFE	0	0	4	0	2	4	NIL			Retained			
3	S01	BSC	26MT1101	MATHEMATICS FOR COMPUTATION	MTCP	2	2	0	0	4	4	NIL			Retained			
4	S01	ESC	26SC1102	PROBLEM SOLVING USING PROGRAMMING (JAVA)	PSPP	2	0	0	8	4	10	NIL	PBL	Employability	Retained			
5	S01	ESC	26ME1101	MECHANICAL ENGINEERING WORKSHOP	MEWS	1	0	4	0	3	5	NIL	PBL	Skill Development	Retained			
6	S01	ESC	26EC1101	FUNDAMENTALS OF IOT & SENSORS	FOIS	2	0	4	0	4	5	NIL		Employability	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
7	S02	HSS	26UC1204	COMMUNICATION SKILLS FOR ENGINEERS	CSFE	0	0	4	0	2	4	NIL			Retained			
8	S02	BSC	26MT1202	MATHEMATICS FOR AI AND ENGINEERING APPLICATIONS	MTAE	2	2	0	0	4	4	NIL		Employability	New	100%	Faculty	Based on the thrust areas identified for the present industries the course is proposed to make students understand the Maths in AI
9	S02	ESC	26ME1202	ENGINEERING MECHANICS	ENMC	3	0	0	0	3	3		PBL	Employability	Retained			
10	S02	ESC	26SC1306	COMPUTATIONAL FOUNDATIONS FOR AI	CFAI	2	0	0	4	3	6	MTAE		Employability	New	100%	Faculty	Based on the thrust areas of present industries AI related foundations is required for the students
11	S02	ESC	26SC1203	DATA STRUCTURES & ALGORITHMS – 1	DSA1	2	0	0	4	3	6	PSPP	PBL	Skill Development	Retained			
12	S02	BSC	SCE-1	SCIENCE ELECTIVE – 1		3	0	2	0	4	5				Retained			
13	S03	BSC	26MT1306	MATHEMATICS FOR MECHANICAL SYSTEMS	MTMS	S	2	0	0	4	4				New	100%	Faculty	Suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.
14	S03	ESC	26SC1308	FULL STACK WEB DEVELOPMENT	FSWD	2	0	4	0	4	6	PSPP	FULL	Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems

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Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	NEW / Revised / Retained	% of Revision	Revision Proposed by	Justification
15	S03	ESC	26ME1303	COMPUTER-AIDED DESIGN AND DRAFTING	CADD	0	0	2	4	2	6			Skill Development	Revised	25%	Design group	As per the feedback,, assembly drawing and digital manufacturing bascis are included in the syllabus
16	S03	BSC	SCE-2	SCIENCE ELECTIVE – 2 (MATERIAL SCIENCE AND METALLURGY)		3	0	2	0	4	5			Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added so that students will be exposed to latest technological advancements in the field of material scisence
17	S03	PCC	26ME2104	MECHANICS OF DEFORMABLE SOLIDS	MODS	3	0	2	0	4	5	ENMC	CAPS	Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added to the syllabus to educate the students on various theories of failure
18	S03	PCC	26ME2105	THERMODYNAMICS AND ENERGY CONVERSION SYSTEMS	TECS	3	1	0	0	4	4	NIL		Employability	Revised	25%	Faculty	As per the feedback received, concepts were rearranged and few topics were added so that all advance concepts are included in the course
19	S04	PCC	26ME2208	FLUID MECHANICS AND HYDRAULIC MACHINES	FMHE	3	0	2	0	4	5	NIL	CASE	Skill Development	Revised	25%	Faculty	As per the discussions in Energy group meeting the proposed topics are incorporated into the syllabus as per the requirements of CFD concepts by thermal related companies
20	S04	PCC	26ME2206	MANUFACTURING AND PRODUCTION SYSTEMS	MAPS	3	0	2	0	4	5	NIL	CAPS	Skill Development	Revised	50%	Faculty	As per the feedback of stakeholders the poposed topics are added to the course as these are the topics which are not covered in any course and are needed for GATE
21	S04	PCC	26EC3112	ROBOTICS AND MECHATRONIC SYSTEMS	RAMS	3	0	2	0	4	5	FOIS	CASE	Skill Development	Revised	25%	Faculty	As per the feedback of faculty it is necessary to include Robo programming in Robotic and Mechatronic Systems to increase the opportunities in placement drives
22	S04	PCC	26ME2207	KINEMATICS OF MACHINES	KOMS	2	1	0	4	4	7	ENMC	CAPS	Skill Development	Revised	25%	Faculty	Based on the feedback of Engineering Design group head the course Kinematics and Dynamics of machines course is split into two courses and the topics are rearranged by removing certain topics and adding few concepts
23	S04	ESC	26SC2110	MACHINE LEARNING FOR MECHANICAL APPLICATIONS	MLMA	2	0	4	0	4	6	CFAI		Skill Development	New	100%	Faculty	As pe the feedback machine lerning techniques are necessary for mechanical engineering studetns as per the industry requirement
24	S04	ESC	26EC2106	EMBEDDED SYSTEM DESIGN & IOT	EBSD	2	0	0	4	3	6	FOIS	FULL	Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
25	S05	PCC	26IN2201	IOT FOR SMART MANUFACURING	IFSM	3	0	2	0	4	5	FOIS	FULL	Skill Development	New	100%	Industry person	Suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the industries

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Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	NEW / Revised / Retained	% of Revision	Revision Proposed by	Justification
26	S05	PCC	26ME3214	COMPUTER AIDED ENGINEERING AND SIMULATION	CAES	0	0	2	4	2	6	MODS	CAPS	Skill Development	New	100%	Academic Peers	Suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.
27	S05	PCC	26ME3111	DIGITAL MANUFACTURING	DGMF	3	0	2	0	4	5	MAPS	CASE	Employability	New	100%	Industry person	Suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.
28	S05	PCC	26ME2309	HEAT TRANSFER AND SYSTEM DESIGN	HTSD	3	0	2	0	4	5	TECS	CASE	Skill Development	Revised	30%	Faculty	Based on the feedback given by faculty members new concept on new transient intuition, combined-convection-radiation and thermal systems design which includes electronics cooling and design is added as these are identified as the need of thermal based industries
29	S05	PCC	26ME2310	MACHINE DYNAMICS AND VIBRATIONS	MDAV	3	0	2	0	4	5	ENMC	CASE	Skill Development	New	100%	Faculty	Based on the feedback from facutly ane w course is offered with the concepts of Dynamics of machines and vibrations which is the requirement in many design related industries
30	S05	PEC	26SMD3111	GREEN AND SUSTAINABLE MANUFACTURING TECHNOLOGIES	PEC1	2	0	0	4	3	6	Nil		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
31	S06	PCC	26ME3113	MACHINE DESIGN AND PRODUCT DEVELOPMENT	MDPD	3	0	0	4	4	7	MODS	CAPS	Skill Development	Revised	70%	Faculty	Based on the feedback of faculty product Development concepts are added also topics on failure theories, material selection are included so that the student is made well equipped with all the concepts related to machine design
32	S06	PCC	26ME3112	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	3	0	2	0	4	5	ENGP		Skill Development	Revised	50%	Faculty	Based on the feedback of faculty, Material Conditions and Metrology and Inspection concepts are included in the course to cover all the topics related to dimensioning
33	S06	HSS	FLP	FOREIGN LANGUAGE PROFICIENCY	FLNG	0	0	4	0	2	4	NIL						
34	S06	PRI	26IE4101	TERM PAPER	TMPR	0	0	6	0	3	6	NIL						
35	S06	PEC	26SMD3221	AUTONOMOUS ROBOTIC SYSTEMS	PEC2	3	0	0	0	3	3	PEC1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
36	S06	PEC	26SMD3231	INTEGRATED ENERGY SYSTEMS FOR SMART MANUFACTURING	PEC3	2	0	0	4	3	6	PEC1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
37	S07	PCC	26AD2202	GENERATIVE AI FOR ENGINEERING DESIGN	GAED	3	0	2	0	4	5	CAES	CASE	Skill Development	New	100%	Faculty	Suggested to offer AI based Design to make students future ready with the new AI technologies in the Mechanical Design field
38	S07	AUC	26UC0008	INDIAN CONSTITUTION	INCT	2	0	0	0	0	2	NIL		Entrepreneurship				
39	S07	OEC	OE-1	OPEN ELECTIVE – 1	OEC1	2	0	2	0	3	4	NIL						
40	S07	OEC	OE-2	OPEN ELECTIVE – 2	OEC2	2	0	2	0	3	4	NIL						

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Sl No	SEM	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	NEW / Revised / Retained	% of Revision	Revision Proposed by	Justification
41	S07	PCC	26ME3315	HVAC & BATTERY THERMAL MANAGEMENT SYSTEMS	HBMS	3	0	2	0	4	5	TECS	CASE	Skill Development	New	100%	Faculty	As per the suggestion of faculty, a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centers/EV's etc.,
42	S07	PEC	26SMD3341	MECHANICS OF ADVANCED MATERIALS	PEC4	3	0	0	0	3	3	PEC1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
43	S07	PRI	26IE4053	CAPSTONE PROJECT – 1	CAP1	0	0	12	0	6	12	TMPR		Skill Development				
44	S08	HSS	26UC0038	HUMAN VALUES, ETHICS AND GENDER INCLUSION FOR TECHNOLOGY	HVEG	2	0	0	0	2	2	NIL		Entrepreneurship				
45	S08	OEC	OE3	OPEN ELECTIVE – 3	OEC3	2	0	2	0	3	4	NIL						
46	S08	HSS	ME	MANAGEMENT ELECTIVE	MGMT	2	0	2	0	3	4	NIL		Entrepreneurship				
47	S08	PEC	26SMD3351	DIGITAL TWIN ENGINERING & MANUFACTURING ANALYTICS	PEC5	3	0	0	0	3	3	PEC1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
48	S08	PRI	26IE4054	CAPSTONE PROJECT – 2	CAP2	0	0	12	0	6	12	CAP1		Skill Development				
49	1S	PRI	26IE2040	SOCIAL INTERNSHIP	INTS	0	0	4	0	0	4	NIL		Skill Development				
50	1S	AUC	26UC0032	INSIGHTS TO SUSTAINABLE DEVELOPMENT GOALS	SDGL	2	0	0	0	0	2	NIL		Entrepreneurship				
51	2S	PRI	26IE3041	TECHNICAL INTERNSHIP	INTT	0	0	4	0	0	4	NIL		Skill Development				
52	2S	AUC	26UC0017	INDIAN KNOWLEDGE SYSTEMS	IKSL	2	0	0	0	0	2	NIL						
53	3S	AUC	26UC0009	ECOLOGY & ENVIRONMENT	ECEN	2	0	0	0	0	2	NIL						
54	S03	VAC	VAC-1	VALUE ADDED COURSE 1 - SPORTS	VAC1	0	0	0	2	0	2	NIL		Skill Development	Retained			
55	S04	VAC	VAC-2	VALUE ADDED COURSE 2 - TECHNICAL GLOBAL CERTIFICATION 1	VAC2	0	0	0	2	0	2	NIL		Skill Development	Retained			
56	S05	VAC	VAC-3	VALUE ADDED COURSE 3 - TECHNICAL GLOBAL CERTIFICATION 2	VAC3	0	0	0	2	0	2	NIL		Skill Development	Retained			
57	S06	VAC	VAC-4	VALUE ADDED COURSE 4 - TECHNICAL GLOBAL CERTIFICATION 3	VAC4	0	0	0	2	0	2	NIL		Skill Development	Retained			
				TOTAL CREDITS						163								

No. of New courses	18
No. of revised courses	11
Total No. of courses	57
% of syllabus revision	50.88
% of courses focussing on Entrepreneurship	8.772
% of courses foucing on Employability	17.54
% of courses focussing on Skill Development	52.63

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DEPARTMENT OF MECHANICAL ENGINEERING
Y26 B.Tech ME - TRIMESTER PBL LIST OF COURSES

Sl No	TRI	CAT	COURSE CODE	COURSE TITLE	ACONYM	L	T	P	S	Cr	CH	PRE-REQ	PBL	Entrepreneurship/ Employability/ Skill Development	NEW / Revised / Retained	% of Revision	Revision Proposed by	Justification
1	T01	ESC	26SC1102E	PROBLEM SOLVING USING PROGRAMMING (JAVA)	PSPP	3	0	6	0	4	9	NIL		Employability	Retained			
2	T01	HSS	26UC1137E	DESIGN THINKING FOR INNOVATION & ENTREPRENEURSHI	DTIE	3	0	0	0	2	3	NIL		Entrepreneurship	Retained			
3	T01	HSS	26UC1102E	LANGUAGE SKILLS FOR ENGINEERS	LSFE	3	0	0	0	2	3	NIL			Retained			
4	T01	ESC	26ME1101E	MECHANICAL ENGINEERING WORKSHOP	MEWS	3	3	0	0	4	6	NIL			Retained			
5	T01	BSC	26MT1101E	MATHEMATICS FOR COMPUTATION	MTCP	3	3	0	0	4	6	NIL		Employability	New	100%	Faculty	Based on te thrust areas identified the suggested courses are included
6	T02	ESC	26SC1203E	DATA STRUCTURES & ALGORITHMS – 1	DSA1	3	0	0	6	3	9	PSPP		Skill Development	Retained			
7	T02	BSC	SCE-1	SCIENCE ELECTIVE – 1		3	0	6	0	4	9	NIL						
8	T02	BSC	26MT1202E	MATHEMATICS FOR AI AND ENGINEERING APPLICATIONS	MTAE	3	3	0	0	4	6	NIL		Employability	New	100%	Faculty	Based on te thrust areas identified the suggested courses are included
9	T02	ESC	26ME1202E	ENGINEERING MECHANICS	ENMC	3	0	6	0	4	9	NIL		Employability	Retained			
10	T02	HSS	26UC1204E	COMMUNICATION SKILLS FOR ENGINEERS	CSFE	3	0	0	0	2	3	NIL			Retained			
11	T03	ESC	26SC1306E	COMPUTATIONAL FOUNDATIONS FOR AI	CFAI	3	0	0	6	3	9	MTAE		Skill Development	New	100%	Faculty	Based on te thrust areas identified the suggested courses are included
12	T03	ESC	26ME1303E	COMPUTER-AIDED DESIGN AND DRAFTING	CADD	3	0	6	0	4	9	NIL		Skill Development	Revised	25%	Group Heads (Faculty)	Based on the suggestion of design group members topics on assembly drawings and digital manufacturing design are included
13	T03	ESC	26SC1308E	FULL STACK WEB DEVELOPMENT	FSWD	3	0	6	0	4	9	PSPP		Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
14	T03	BSC	26MT1306E	MATHEMATICS FOR MECHANICAL SYSTEMS	MTMS	3	3	0	0	4	6	NIL			New	100%	Faculty	Suggested to offer a mathematics course for mechanical students focusing on numerical methods and modern simulation tools like ANSYS, ABACUS, COMSOL etc.
15	T03	HSS	FLP-1	FOREIGN LANGUAGE PROFICIENCY – 1	FLG1	3	0	0	0	2	3	NIL		Employability				
16	T04	ESC	26SC2110E	MACHINE LEARNING FOR MECHANICAL APPLICAT	MLMA	3	0	6	0	4	9	CFAI		Skill Development	New	100%	Faculty	Based on te thrust areas identified the suggested courses are included
17	T04	PCC	26ME2104E	MECHANICS OF DEFORMABLE SOLIDS	MODS	3	0	6	0	4	9	ENMC	CAPS	Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added to the syllabus to educate the students on various theories of failure
18	T04	PCC	26ME2105E	THERMODYNAMICS AND ENERGY CONVERSION	TECS	3	0	6	0	4	9	NIL		Employability	Revised	25%	Faculty	As per the feedback received, concepts were rearranged and few topics were added so that all advance concepts are included in the course
19	T04	HSS	FLP-2	FOREIGN LANGUAGE PROFICIENCY – 2	FLG2	3	0	0	0	2	3	FLG1		Employability				
20	T04	ESC	26EC1101E	FUNDAMENTALS OF IOT & SENSORS	FOIS	3	3	0	0	4	6	NIL		Employability	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems

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21	T05	PCC	26ME2206E	MANUFACTURING AND PRODUCTION SYSTEMS	MAPS	3	0	6	0	4	9	NIL	CAPS	Skill Development	Revised	50%	Faculty	As per the feedback of stakeholders the poposed topics are added to the course as these are the topics which are not covered in any course and are needed for GATE
22	T05	PCC	26ME2207E	KINEMATICS OF MACHINES	KOMS	3	3	0	0	4	6	ENMC	CAPS	Skill Development	Revised	25%	Faculty	Based on the feedback of Engineering Design group head the course Kinematics and Dynamics of machines course is split into two courses and the topics are rearranged by removing certain topics and adding few concepts
23	T05	PCC	26EC2106E	EMBEDDED SYSTEM DESIGN & IOT	EBSD	3	0	6	0	4	9	FOIS	FULL	Skill Development	New	100%	Group Heads (Faculty)	Based on the thrust areas identified, it was suggested by the group heads to offer new courses related to IOT and Sensors, Embedded Systems and Full stack. It was suggested that these topics need to be studied by every engineer irrespective of their branch to take up multi disciplinary projects and bring solutions to the societal problems
24	T05	PCC	26ME2208E	FLUID MECHANICS AND HYDRAULIC MACHINES	FMHE	3	3	3	0	5	9	NIL	CASE	Skill Development	Revised	25%	Faculty	As per the discussions in Energy group meeting the proposed topics are incorporated into the syllabus as per the requirements of CFD concepts by thermal related companies
25	T05	BSC	SCE-2	SCIENCE ELECTIVE – 2 (MATERIAL SCIENCE AND METALLURGY)		3	0	6	0	4	9	NIL		Skill Development	Revised	25%	Faculty	As per the feedback received, suggested topics were added so that students will be exposed to latest technological advancements in the field of material scisence
26	T05	VAC	VAC-1	VALUE ADDED COURSE 1 - SPORTS	VAC1	0	0	0	2	0	2	NIL						
27	T06	PCC	26IN2201E	IOT FOR SMART MANUFACURING	IFSM	3	0	6	0	4	9	FOIS	FULL	Skill Development	New	100%	Industry person	Suggested to include IOT related manufacturing course, to enable students pace with the automation processes in the industries
28	T06	PCC	26EC3112E	ROBOTICS AND MECHATRONIC SYSTEMS	RAMS	3	0	0	6	3	9	FOIS	CASE	Skill Development	Revised	25%	Faculty	As per the feedback of faculty it is necessary to include Robo programming in Robotic and Mechatronic Systems to increase the opportunities in placement drives
29	T06	PCC	26ME2309E	HEAT TRANSFER AND SYSTEM DESIGN	HTSD	3	3	3	0	5	9	TECS	CASE	Skill Development	Revised	30%	Faculty	Based on the feedback given by faculty members new concept on new transient intuition, combined-convection-radiation and thermal systems design which includes electronics cooling and design is added as these are identified as the need of thermal based industries
30	T06	PCC	26ME2310E	MACHINE DYNAMICS AND VIBRATIONS	MDAV	3	3	0	0	4	6	ENMC	CASE	Skill Development	New	100%	Faculty	Based on the feedback from facutly ane w course is offered with the concepts of Dynamics of machines and vibrations which is the requirement in many design related industries
31	T06	VAC	VAC-2	VALUE ADDED COURSE 2 - TECHNICAL GLOBAL CERTIFI	VAC2	0	0	0	2	0	2	NIL						
32	T07	PCC	26ME3111E	DIGITAL MANUFACTURING	DGMF	3	3	0	0	4	6	IFSM	CASE	Employability	New	100%	Industry person	Suggested to include topics on additive manufacturing , Digital twin, computer integrated manufacturing, metrology in manufacturing related courses.
33	T07	PCC	26ME3112E	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	3	0	6	0	4	9	ENGP		Skill Development	Revised	50%	Faculty	Based on the feedback of faculty, Material Conditions and Metrology and Inspection concepts are included in the course to cover all the topics related to dimensioning
34	T07	PCC	26ME3113E	MACHINE DESIGN AND PRODUCT DEVELOPMENT	MDPD	3	0	6	0	4	9	MODS	CAPS	Skill Development	Revised	70%	Faculty	Based on the feedback of faculty product Development concepts are added also topics on failure theories, material selection are included so that the student is made well equipped with all the concepts related to machine design
35	T07	PEC	PE-1	PROFESSIONAL ELECTIVE – 1 (GREEN AND SUSTAINABLE MANUFACTURING TECHNOLOGIES)		3	0	0	6	3	9	NIL		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas

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36	T07	VAC	VAC-3	VALUE ADDED COURSE 3 - TECHNICAL GLOBAL CERTIFI	VAC3	0	0	0	2	0	2	NIL						
37	T08	PCC	26ME3214E	OMPUTER AIDED ENGINEERING AND SIMULATIO	CAES	0	0	6	6	3	12	MODS	CAPS	Skill Development	New	100%	Academic Peers	Suggested to offer a simulation based course covering design and thermal related simulation tools, so that students will be well equipped with the latest simulation tools.
38	T08	PCC	26EC3214E	ROBOTIC PERCEPTION, COMPUTER VISION & SEN	RBPR	3	0	6	0	4	9	RBFN	CASE	Skill Development	New	100%	Faculty	As per the feedback from the placements division to increase the job oppurtunities in robotics field the course is introduced
39	T08	PEC	PE-2	PROFESSIONAL ELECTIVE – 2 (AUTONOMOUS ROBOTIC SYSTEMS)		3	0	0	6	3	9	PE-1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
40	T08	PEC	PE-3	PROFESSIONAL ELECTIVE – 3 (INTEGRATED ENERGY SYSTEMS FOR SMART MANUFACTURING)		3	0	0	6	3	9	PE-1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
41	T08	VAC	VAC-4	VALUE ADDED COURSE 4 - TECHNICAL GLOBAL CERTIFI	VAC4	0	0	0	2	0	2	NIL						
42	T09	PCC	26EC3316E	ROBOTIC MOTION PLANNING, NAVIGATION & CON	RBMT	3	0	6	0	4	9	RBFN	CASE	Skill Development	New	100%	Group Heads (Faculty)	As per the feedback from the placements division to increase the job oppurtunities in robotics field the course is introduced
43	T09	PCC	26ME3315E	HVAC & BATTERY THERMAL MANAGEMENT SYSTEMS	HBMS	3	0	6	0	4	9	TECS	CASE	Skill Development	New	100%	Faculty	As per the suggestion of faculty, a new course on air conditioning and battery management as core course as these concepts are helpful in the cooling of buildings/Data centers/EV's etc.,
44	T09	PEC	PE-4	PROFESSIONAL ELECTIVE – 4 (MECHANICS OF ADVANCED MATERIALS)		3	0	0	6	3	9	PE-1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
45	T09	PEC	PE-5	PROFESSIONAL ELECTIVE – 5 (DIGITAL TWIN ENGINERING & MANUFACTURING ANALYTICS)		3	0	0	6	3	9	PE-1		Skill Development	New	100%	Group Heads (Faculty)	New Specialization proposed based on thrust areas
46	T09	VAC	VAC-5	JE ADDED COURSE 4 - TECHNICAL GLOBAL CERTIFICATI	VAC4	0	0	0	2	0	2	NIL						
47	T10	PCC	26EC4117E	AUTONOMOUS ROBOTIC SYSTEMS & HUMAN-ROI	ARBS	3	0	3	0	3	6	RBPR	CASE	Skill Development	New	100%	Group Heads (Faculty)	As per the feedback from the placements division to increase the job oppurtunities in robotics field the course is introduced
48	T10	PRI	26IE4101E	TERM PAPER	TMPR	0	3	3	0	3	6	NIL			Retained			
49	T10	OEC	OE-1	OPEN ELECTIVE – 1		3	0	3	0	3	6	NIL			Retained			
50	T10	AUC	26UC0008E	INDIAN CONSTITUTION	INCT	3	0	0	0	0	3	NIL		Entrepreneurship	Retained			
51	T11	PRI	26IE4053E	CAPSTONE PROJECT – 1	CAP1	0	0	12	12	6	12	TMPR	FULL	Skill Development	Retained			
52	T11	HSS	26UC0038E	HUMAN VALUES, GENDER EQUALITY & PROFESS	HGPE	3	0	0	0	2	3	NIL			Retained			
53	T11	OEC	OE-2	OPEN ELECTIVE – 2		3	0	3	0	3	6	NIL			Retained			
54	T11	PCC	26AD2202E	GENERATIVE AI FOR ENGINEERING DESIGN	GAED	3	0	6	0	4	9	CAES	CASE		Retained			
55	T12	PRI	26IE4054E	CAPSTONE PROJECT – 2	CAP2	0	0	12	12	6	12	CAP1	FULL	Skill Development	Retained			
56	T12	HSS	ME	MANAGEMENT ELECTIVE	MGMT	3	0	3	0	3	6	NIL		Entrepreneurship	Retained			
57	T12	OEC	OE-3	OPEN ELECTIVE – 3		3	0	3	0	3	6	NIL			Retained			
58	1S	PRI	26IE2040E	SOCIAL INTERNSHIP	INTS	0	0	6	0	0	6	NIL		Skill Development	Retained			
59	1S	AUC	26UC0032E	INSIGHTS TO SUSTAINABLE DEVELOPMENT GOAL	SDGL	3	0	0	0	0	3	NIL			Retained			
60	2S	PRI	26IE3041E	TECHNICAL INTERNSHIP	INTT	0	0	6	0	0	6	NIL		Skill Development	Retained			
61	2S	AUC	26UC0017E	INDIAN KNOWLEDGE SYSTEMS	IKSL	3	0	0	0	0	3	NIL			Retained			
62	3S	PRI	26IE4042E	RESEARCH / INDUSTRIAL INTERNSHIP	INTR	0	0	0	0	0	0	NIL		Skill Development	Retained			
63	3S	AUC	26UC0009E	ECOLOGY & ENVIRONMENT	ECEN	3	0	0	0	0	3	NIL			Retained			
Total Credits										**183**								

No. of New Courses	21
No. of revised courses	11
Total No. of courses	63
% of Syllabus Revision	50.794
% of courses focussing on Entrepreneurship	4.7619
% of courses focussing on Emplpoyability	14.286
% of courses focussing on Skill Development	50.794

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Computer-Aided Design and Drafting

CADD 26ME1303

L-T-P-S	0-0-4-0	Credits	2	Contact Hrs/Wk	4
Trimester	S03	Mode	REGULAR	Category	ESC
Pre-requisite	None				

Course Outcomes (COs)

	Statement	BTL
CO1	Understand principles of projection and orthographic drawing standards.	BTL2 · understand
CO2	Apply projections of points, lines and planes in engineering visualization.	BTL3 · Apply
CO3	Apply projection, sectioning and development of solids.	BTL3 · Apply
CO4	Apply isometric drawing and engineering drawing standards for machine components representation.	BTL3 · Apply
CO5	Create engineering designs and drawings using modelling software.	BTL4 · Analyze
CO6	Create assemblies and digital manufacturing models using advanced software tools.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PO6	PO9	PO10
CO1	M	–	M	M	–	–	M
CO2	M	–	M	H	–	–	M
CO3	M	–	H	H	–	–	–
CO4	M	–	H	H	–	M	–
CO5	M	–	H	M	M	–	–
CO6	–	M	H	H	–	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	Principles of Projection and Orthographic Drawing BIS standards, drawing sheets, lettering, line conventions, scales,dimensioning, Projection principles, orthographic projection, first angle and third angle projection, reference planes, quadrants and multiview representation. Lab: Orthographic drawing of machine components.	CO1
M2	Projections of Points, Lines and Planes Projection of points, lines, planes, true length, true inclination, traces, auxiliary projections and engineering visualization. Lab: Manual drafting exercises.	CO2

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	Title & Topics	CO
M3	Projection of Solids, Sections and Development of Surfaces Projection of prisms, pyramids, cylinders, cones and spheres, sections of solids, development of surfaces and assembly representation. Lab: Sectional views and developments.	CO3
M4	Isometric and Engineering Drawing Standards Dimensioning, limits and fits, GD&T basics, surface finish, welding symbols, isometric projection, orthographic isometric conversion, oblique drawing and perspective drawing. Lab: Fully dimensioned engineering drawings.	CO4
M5	Engineering Design using Fusion 360 Fusion 360 interface, sketching, constraints, parametric modelling, extrude, revolve, sweep, loft, patterns, engineering drawing generation, annotations, Bill of Materials, design changes, cloud collaboration and AI assisted design review. Lab: Model and document individual mechanical components in Fusion 360.	CO5
M6	Advanced Fusion 360 and Digital Manufacturing Assembly modelling, joints, motion study, interference analysis, sheet metal design, STL export, Design for Additive Manufacturing, Generative Design, Simulation overview, Reverse Engineering, Digital Twin concepts and AI assisted CAD. Lab: Develop a multi component mechanical assembly, generate manufacturing drawings and export models for 3D printing.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Engineering Drawing / Engineering Graphics**	N. D. Bhatt	Charotar	2019
2	**Technical Drawing with Engineering Graphics**	Giesecke et al.	Pearson	2016
3	**AutoCAD 2024 (A Problem-Solving Approach)**	Sham Tickoo	CADCIM	2023
4	**SOLIDWORKS / Fusion 360 (learning guide)**	Sham Tickoo / Autodesk Press	CADCIM / Autodesk	2023
5	**Geometric Dimensioning and Tolerancing (ASME Y14.5)**	ASME / Krulikowski	ASME / Cengage	2018

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Computational Foundations for AI

CFAI 26SC1306

L-T-P-S	2-0-0-4	Credits	3	Contact Hrs/Wk	6
Semester	S02	Mode	Regular	Category	ESC
Pre-requisite	None				

Course Outcomes (COs)

	Statement	BTL
CO1	Write Python programs for data and AI - building on prior programming experience - and work fluently in the modern computational environment (notebooks, packages, version control).	BTL3 · Apply
CO2	Represent and manipulate data as arrays with NumPy, and realise the linear algebra of AI (vectors, matrices, operations) computationally and efficiently.	BTL4 · Analyze
CO3	Load, clean, transform and combine real-world tabular data with pandas - the data-wrangling skills that dominate real AI work.	BTL4 · Analyze
CO4	Explore and visualise data and compute its descriptive statistics - exploratory data analysis (EDA) - to understand a dataset before modelling it.	BTL4 · Analyze
CO5	Implement the mathematics of learning in code - probability and statistics, a loss function, and gradient-descent optimisation - the computational engine that trains a model.	BTL6 · Create
CO6	Build, train and evaluate a first machine-learning model and assemble the end-to-end pipeline, and explain what machine learning is - the bridge to the Machine Learning course.	BTL6 · Create

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO8	PO9	PO11
CO1	H	M	M	L	H	–	–	M
CO2	H	H	M	M	H	–	–	M
CO3	H	H	M	H	H	–	M	M
CO4	H	H	H	M	H	–	–	M
CO5	H	H	H	H	H	–	–	M
CO6	H	H	H	M	H	M	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Module 1 - From Java to Python & the Computational Environment** The north star (Outside-In framing): how does a computer learn from data? - the end-to-end pipeline (raw data -> wrangle -> explore -> learn -> predict) you will build, and the branch-flexible running project.; Why Python for data and AI: its role as the lingua franca of data science, AI and scientific computing.; Python for those who already program (the Java bridge): syntax, dynamic typing, indentation, and the key differences from Java.; Core Python: data types, variables, operators, strings; control flow; functions and arguments.; Python's data containers: lists, tuples, dictionaries and sets, and when to use each.; Pythonic idioms: list/dict comprehensions, slicing, iteration, and writing clean, readable Python.; Modules, packages and the ecosystem: import, pip, and the scientific stack overview (NumPy, pandas, matplotlib, scikit-learn).; The computational environment: Jupyter notebooks (and Colab), the REPL, and reproducible workflows.; Version control with Git/GitHub: tracking and sharing code and notebooks (reproducibility).; Reading and writing data and files in Python - the entry point to the data pipeline.	CO1

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	Title & Topics	CO
M2	**Module 2 - Data as Arrays: NumPy & the Math of AI in Code** Opening the first stage: data in AI is numbers in arrays - the NumPy ndarray as the fundamental data structure.; Creating and inspecting arrays; shape, dimensions and data types.; Indexing, slicing and boolean masking of arrays.; Vectorisation and why it matters: replacing loops with array operations for speed and clarity.; Broadcasting: how arrays of different shapes combine.; Realising linear algebra in code (from Mathematics for AI): vectors, matrices, element-wise operations, the dot product and matrix multiplication.; Common numerical operations: aggregations (sum, mean, min/max), axis operations, and reshaping.; Random numbers and reproducible randomness (seeds) - needed for sampling and ML.; Numerical thinking: floating-point, precision and efficiency awareness.; Representing a real dataset as arrays - the project data in numerical form.	CO2
M3	**Module 3 - Working with Real Data: pandas & Data Wrangling** Opening the wrangle stage: real data arrives messy - pandas is the tool to tame it.; The pandas Series and DataFrame: the tabular data structures of data science.; Loading data: reading CSV and other formats; inspecting and summarising a DataFrame.; Selecting and filtering: by label and position (loc/iloc), and by condition.; Cleaning data: handling missing values, duplicates, and incorrect types.; Transforming data: creating and modifying columns, applying functions, and mapping.; Grouping and aggregation: split-apply-combine (groupby) to summarise data.; Combining data: merging and joining datasets, and concatenation.; Tidy data and reshaping (pivoting/melting) - getting data into a usable form.; Wrangling the project's real dataset into clean, analysis-ready form.	CO3
M4	**Module 4 - Seeing the Data: Visualisation & Exploratory Data Analysis** Opening the explore stage: before modelling, understand the data - the purpose of exploratory data analysis (EDA).; Plotting with matplotlib: the figure/axes model; line, scatter and bar plots; labels and titles.; Statistical visualisation with seaborn: distributions, histograms, box plots and pair/relationship plots.; Descriptive statistics in code (from Mathematics for AI): mean, median, variance, standard deviation, quantiles.; Distributions and their shape: skew, spread and outliers - and what they mean for modelling.; Relationships between variables: correlation, scatter relationships, and the caution that correlation is not causation.; Visualising categories and groups; comparing subgroups.; The EDA workflow: questions, plots, summaries and the insights that guide modelling.; Communicating findings: clear, honest, well-labelled visualisations.; A full EDA of the project's dataset - the insights that will shape the model.	CO4
M5	**Module 5 - The Math of Learning: Probability, Statistics & Optimisation in Code** Opening the learning stage: what does it mean for a machine to learn? - fitting a model to data by minimising error.; Probability in code (from Mathematics for AI): random variables, common distributions, sampling and simulation.; Statistics in code: estimating quantities from data, sampling variability, and the idea of inference.; The idea of a model: parameters, predictions, and the gap between prediction and truth.; The loss (cost) function: measuring how wrong a model is (e.g., mean squared error).; Optimisation - the engine of learning: minimising the loss; the gradient and what it tells us.; Gradient descent: implementing the update rule that improves the model step by step; the learning rate.; Watching learning happen: tracking the loss as it decreases, and convergence.; Why this is the heart of machine learning: nearly all of ML is loss + optimisation.; Implementing a loss and gradient descent on the project data - the learning engine, built by hand.	CO5

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	Title & Topics	CO
M6	**Module 6 - A First Learning Machine: Features, Model, Evaluation & the AI Frontier** Opening the model stage: from data to features - the feature matrix and the target.; Training and testing: the train/test split and why we never evaluate on training data (generalisation).; A first model from the foundations: linear regression trained by the gradient descent of Module 5 (the from-scratch model).; A first model with scikit-learn: the fit/predict workflow, and a simple classifier (e.g., k-nearest neighbours).; Evaluating a model: regression and classification metrics (error, accuracy) and reading them honestly.; Underfitting and overfitting (introduction): why a model can fail to generalise - the central ML concern.; The end-to-end pipeline integrated (the project): raw data -> wrangle -> explore -> learn -> evaluate.; What machine learning is (and is not): an honest framing and the bridge to the Machine Learning course.; Responsible AI (awareness): data bias, fairness and the ethics of learning from data.; The forward map: how this foundation feeds Machine Learning and the deep-learning, NLP, generative-AI and branch-specific AI courses ahead.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Python for Data Analysis**	Wes McKinney	O'Reilly	2022 (3rd ed.)
2	**Python Data Science Handbook**	Jake VanderPlas	O'Reilly	2023 (2nd ed.)
3	**Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow**	Aurelien Geron	O'Reilly	2022 (3rd ed.)
4	**Mathematics for Machine Learning**	Marc Peter Deisenroth, A. Aldo Faisal & Cheng Soon Ong	Cambridge University Press	2020
5	**Automate the Boring Stuff with Python**	Al Sweigart	No Starch Press	2019 (2nd ed.)

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Machine Learning for Mechanical Applications

MLMA 26SC2111

L-T-P-S	2-0-4-0	Credits	4	Contact Hrs/Wk	6
Semester	S04	Mode	Regular	Category	ESC
Pre-requisite	CFAI				

Course Outcomes (COs)

	Statement	BTL
CO1	Explain the ML workflow framed by mechanical-engineering problems.	BTL2 · Explain
CO2	Apply regression/classification to mechanical datasets (materials, faults, quality).	BTL3 · Apply
CO3	Apply feature engineering to sensor/simulation data.	BTL3 · Apply
CO4	Analyze model performance and build surrogate models for FEA/CFD.	BTL4 · Analyze
CO5	Evaluate time-series and anomaly methods for predictive maintenance.	BTL4 · Evaluate
CO6	Build an end-to-end ML pipeline for a mechanical prediction task.	BTL5 · Create

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO5	PSO1
CO1	H	M	M	M
CO2	H	M	M	M
CO3	H	M	M	M
CO4	H	M	M	M
CO5	H	M	M	M
CO6	H	M	M	M

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**ML for Mechanical Data** Workflow; data sources (sensors, FEA/CFD, test rigs, manufacturing logs).; Regression vs classification vs clustering by mechanical example.; No-overlap note: CFAI owns AI/Python foundations; MLMA is applied ML on mechanical data.	CO1
M2	**Regression & Materials Prediction** Linear/tree/ensemble regression.; Materials-property and fatigue-life prediction.; Process-parameter to property mapping.	CO2
M3	**Feature Engineering** Cleaning sensor/simulation data.; Vibration features (FFT, envelope); image features for inspection.; Scaling and selection.	CO3
M4	**Surrogate Models & Evaluation** Surrogate/ROM models for FEA/CFD.; Validation, metrics, uncertainty.; Design-of-experiments + ML.	CO4
M5	**Predictive Maintenance** Time-series and anomaly detection.; Fault diagnosis from vibration/acoustic data.; Remaining-useful-life estimation.	CO5

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	Title & Topics	CO
M6	**End-to-End Pipeline** Reproducible pipeline; interpretability.; Responsible use and limits.; Deployment basics.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow**	Aurélien Géron	O'Reilly	2022
2	**Machine Learning in Mechanical Engineering**	various	Springer	2023
3	**An Introduction to Statistical Learning**	James, Witten, Hastie, Tibshirani	Springer	2021
4	**Condition Monitoring and Predictive Maintenance**	R. B. Randall	Wiley	2011
5	**Python Machine Learning**	Sebastian Raschka	Packt	2019

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Mathematics for AI

MTAI

26MT1202

L-T-P-S	2-2-0-0	Credits	4	Contact Hrs/Wk	4
Semester	S02	Mode	Regular	Category	BSC
Pre-requisite	MTCP				

Course Outcomes (COs)

	Statement	BTL
CO1	Represent and manipulate data and transformations with vectors and matrices, and reason geometrically about vector spaces - the language in which AI represents data and models.	BTL3 · Apply
CO2	Apply eigen-analysis and matrix decompositions to understand variance, dimensionality and structure in data - the mathematics behind techniques like PCA.	BTL4 · Analyze
CO3	Use single- and multivariable calculus - derivatives, partial derivatives, gradients and the chain rule - to quantify how a model's output and error change, the basis of learning.	BTL3 · Apply
CO4	Formulate and solve optimization problems - especially gradient-based minimisation of a loss - which is how AI models are trained.	BTL6 · Create
CO5	Reason quantitatively under uncertainty using probability - random variables, distributions, expectation and Bayes' theorem - the basis of probabilistic AI.	BTL3 · Apply
CO6	Integrate linear algebra, calculus, optimization and probability to follow and explain the end-to-end mathematics of a simple learning algorithm.	BTL6 · Create

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO11
CO1	H	H	M	M	M	M
CO2	H	H	M	M	M	M
CO3	H	H	M	M	M	M
CO4	H	H	M	H	M	M
CO5	H	H	M	M	M	M
CO6	H	H	M	M	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

Module-wise Syllabus

	Title & Topics	CO
M1	**Module 1 - Linear Algebra I: Vectors, Matrices & Linear Systems** Vectors as data: vectors in R^n, vector operations, linear combinations, and the geometric meaning (a data point / feature vector as a vector).; Dot product, norms and distance: length, angle, cosine similarity - and why these measure similarity between data points in AI.; Matrices as data and as transformations: a dataset as a matrix; matrix-vector and matrix-matrix multiplication and their meaning.; Linear transformations: how a matrix maps vectors (rotation, scaling, projection); composition of transformations.; Systems of linear equations: representation Ax=b, Gaussian elimination, and solution existence/uniqueness.; Matrix inverse and determinant: meaning, computation for small matrices, and when an inverse exists.; Vector spaces, subspaces, span, linear independence and basis (foundational, applied not abstract-heavy).; Rank and the column/row space; the idea of dimensionality of data.; Orthogonality and orthonormal bases; projection onto a subspace (the basis of least-squares, used in Module 3).; AI/ML meaning throughout: features as vectors, datasets as matrices, similarity, and why linear algebra is the language of AI.	CO1

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	Title & Topics	CO
M2	**Module 2 - Linear Algebra II: Eigenvalues, Decompositions & Their AI Meaning** Eigenvalues and eigenvectors: definition, computation for small matrices, and geometric meaning (directions a transformation preserves).; Diagonalisation and its use; symmetric matrices and their special properties.; Quadratic forms and positive-definiteness (foundational) - and why they appear in optimization (Module 4).; Singular Value Decomposition (SVD): concept, what the singular values/vectors mean, and its central role in data.; Principal Component Analysis (PCA) - the mathematics: variance, covariance (link to Module 5), and how eigen/SVD finds the directions of greatest variance.; Dimensionality reduction conceptually: why high-dimensional data can often be compressed, and what is preserved/lost.; Matrix factorisation as a recurring AI idea (recommendation, embeddings) - at a mathematical-foundation level.; Numerical reality (awareness): why exact hand-computation gives way to algorithms for large matrices (verified with NumPy).; Norms of matrices and conditioning (awareness): why some computations are sensitive.; AI/ML meaning throughout: PCA, embeddings and why eigen/SVD underlie how AI finds structure in data.	CO2
M3	**Module 3 - Calculus for Learning: Derivatives, Gradients & the Chain Rule** Limits, continuity and the derivative (consolidation): the derivative as a rate of change and as a slope.; Differentiation rules and the single-variable chain rule, reframed as the engine of sensitivity analysis.; Functions of several variables: surfaces, level sets, and the idea of a multivariable function (a model's error as a function of its parameters).; Partial derivatives: how output changes with one variable at a time.; The gradient vector: direction of steepest ascent/descent, and its central role in training.; The multivariable chain rule: composing derivatives - the mathematical heart of backpropagation (concept, not the algorithm).; Jacobian and Hessian (foundational): first- and second-order multivariable derivative information and what they tell us.; Taylor approximation (single and intro multivariable): approximating functions locally - the basis of many optimization methods.; Integration essentials and the area-under-a-curve idea, with the probability link (expected values, densities in Module 5).; AI/ML meaning throughout: the loss function, why gradients drive learning, and a first glimpse of backpropagation as the chain rule.	CO3
M4	**Module 4 - Optimization: Minimising Loss & Training Models** Optimization as the core of learning: 'training a model' = minimising a loss function; framing problems as optimization.; Unconstrained optimization: critical points, the role of the gradient (=0) and the Hessian (convexity/curvature) in finding minima.; Convexity: convex sets and functions, why convex problems are 'nice', and recognising convexity (foundational).; Gradient descent: the algorithm by hand - update rule, learning rate, and convergence intuition.; Variants conceptually: stochastic gradient descent, momentum (awareness) - why and when, without deep algorithmics.; Least squares as optimization: deriving the normal equations (linking to projection from Module 1) - a fully worked AI-relevant example.; Constrained optimization (foundational): the idea of constraints and Lagrange multipliers at an introductory level.; Regularisation as an optimization idea (foundational): penalising complexity (L1/L2) - the mathematics, link to ML later.; Common pitfalls: local vs global minima, learning-rate effects, and what can go wrong (intuition for debugging models).; AI/ML meaning throughout: gradient descent IS how neural networks and many models learn; this module is the mathematical core of training.	CO4

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Mathematics for Computation

MTCP 26MT1101

L-T-P-S	2-2-0-0	Credits	4	Contact Hrs/Wk	4
Semester	S01	Mode	Regular	Category	BSC
Pre-requisite	None				

Course Outcomes (COs)

	Statement	BTL
CO1	Apply propositional and predicate logic and construct rigorous mathematical proofs using standard proof techniques, building the computational-logic foundation for reasoning about correctness.	BTL4 · Analyze
CO2	Use set theory, relations and functions to model and reason about structured collections, equivalences, orderings and mappings that underpin data, types and access control.	BTL4 · Analyze
CO3	Apply combinatorial principles to count, arrange and bound discrete configurations, reasoning about key-spaces, complexity of choices, and collision probabilities at a structural level.	BTL4 · Analyze
CO4	Apply number theory and modular arithmetic to reason about divisibility, primes, congruences and the mathematical machinery underlying modern public-key cryptography.	BTL6 · Create
CO5	Model systems and networks with graphs and trees and reason about connectivity, traversal structure, colouring and spanning properties that underpin networks, dependencies and routing.	BTL4 · Analyze
CO6	Reason with algebraic and discrete structures - Boolean algebra, recurrence relations, and elementary groups/fields - that underpin digital logic, error-correcting codes, pseudo-randomness and cryptography.	BTL6 · Create

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO11
CO1	H	H	M	L	L	M
CO2	H	H	M	M	L	M
CO3	H	H	M	M	L	M
CO4	H	H	M	M	M	M
CO5	H	H	M	M	M	M
CO6	H	M	M	M	M	M

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

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Module-wise Syllabus

	Title & Topics	CO
M1	**Module 1 - Mathematical Logic & Proof Techniques** Propositions, logical connectives (negation, conjunction, disjunction, implication, biconditional) and truth tables.; Tautologies, contradictions, contingencies; logical equivalence and the principal laws (De Morgan, distributive, contrapositive).; Conditional and biconditional reasoning; converse, inverse, contrapositive; necessary vs sufficient conditions.; Rules of inference and validity of arguments (modus ponens, modus tollens, syllogism, resolution) - the logical core of automated reasoning.; Predicates and quantifiers (universal, existential); nested quantifiers and negation of quantified statements.; Normal forms (CNF, DNF) and their role in logic-based computation (conceptual link to SAT, circuits, query logic).; Methods of proof: direct proof, proof by contraposition, proof by contradiction, proof by cases, and disproof by counterexample.; Mathematical induction and strong induction; the well-ordering principle.; Reasoning about program/protocol correctness informally via logic (pre/post-conditions and invariants stated as logical assertions - no code).; Common proof pitfalls and the standards of a rigorous mathematical argument.	CO1
M2	**Module 2 - Set Theory, Relations & Functions** Sets, subsets, power sets, set operations (union, intersection, difference, complement) and Venn reasoning; set identities and their proofs.; Cartesian products; cardinality of finite sets; the inclusion-exclusion principle (foundational form).; Countable vs uncountable sets; Cantor's diagonalisation argument (conceptual link to limits of computation).; Relations: definition, representation (matrix and digraph), and properties (reflexive, symmetric, antisymmetric, transitive).; Equivalence relations and partitions; equivalence classes (link to hashing buckets, data partitioning).; Partial orders, total orders, Hasse diagrams; least/greatest elements and lattices (foundation for type hierarchies and dependency ordering).; Closure of relations (reflexive, symmetric, transitive closure) and their meaning.; Functions: domain, codomain, range; injective, surjective, bijective functions; composition and inverse.; Special functions relevant to computing: floor, ceiling, modulo as a function, and hashing functions as set-to-set mappings (modelled mathematically).; Pigeonhole principle and its surprising consequences (collision arguments foundational to hashing and cryptography).	CO2
M3	**Module 3 - Combinatorics & Counting** The fundamental counting principles: sum rule and product rule; counting by cases.; Permutations and combinations; permutations with repetition; circular permutations.; Combinations with repetition; counting selections and distributions (stars-and-bars).; The binomial theorem and binomial coefficients; Pascal's identity and combinatorial identities.; The inclusion-exclusion principle (general form) and derangements.; The pigeonhole principle (generalised) and its counting consequences.; Counting and key-space sizing: how counting bounds the size of password/key spaces (mathematical sizing, link to cryptographic strength).; The birthday problem and collision counting (combinatorial reasoning foundational to hash collisions and cryptographic attacks - argued by counting, not probability theory).; Recurrence relations as counting tools: formulating recurrences for combinatorial quantities.; Generating-function viewpoint (introductory) as a counting device; Catalan numbers as a structural counting example.	CO3
M4	**Module 4 - Number Theory & its Cryptographic Foundations** Divisibility, the division algorithm, GCD and LCM; the Euclidean algorithm and the extended Euclidean algorithm (as mathematical procedures, hand-executed).; Primes, the fundamental theorem of arithmetic, and the infinitude of primes (Euclid's proof).; Modular arithmetic: congruences, residue classes, and arithmetic in Z_n.; Properties of congruences; modular addition, multiplication and exponentiation (fast exponentiation by squaring as a mathematical method).; Modular inverses and solving linear congruences; the Chinese Remainder Theorem.; Fermat's Little Theorem and Euler's theorem; the Euler totient function.; Primality and the mathematical basis of primality reasoning (Fermat test idea - mathematically, not as code).; The mathematics of public-key cryptography: derivation and correctness proof of RSA (key generation, encryption, decryption) from Euler's theorem.; Discrete logarithm problem and the Diffie-Hellman key-exchange mathematics (why hardness gives security).; Hash-function and one-way-function mathematics conceptually; how number-theoretic hardness assumptions underpin contemporary security.	CO4

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	Title & Topics	CO
M5	**Module 5 - Graph Theory & Trees** Graphs: definitions, types (simple, multigraph, directed, weighted), degree, and the handshaking lemma.; Graph representations: adjacency matrix and adjacency list (as mathematical representations) and isomorphism of graphs.; Walks, paths, cycles, connectivity, and components; reasoning about reachability.; Euler paths and circuits (with the existence theorem and proof) and Hamiltonian paths and cycles (existence reasoning) - link to routing and the structure of hard problems.; Shortest-path and minimum-spanning-tree as mathematical structures and properties (existence/optimality reasoning; not algorithm complexity, which is DSA-1's).; Planar graphs, Euler's formula, and graph colouring; the chromatic number (link to register allocation, scheduling, frequency assignment - structurally).; Trees: definitions, properties, and the count of edges; rooted trees, binary trees, and tree terminology (as mathematical objects).; Spanning trees and their counting (Cayley's formula, conceptually) and the cut/cycle properties.; Bipartite graphs and matchings (Hall's theorem, conceptual) - link to assignment problems.; Graphs in technology, reasoned mathematically: key-distribution topologies, social/network structure, and dependency graphs.	CO5
M6	**Module 6 - Algebraic & Discrete Structures** Boolean algebra: axioms, Boolean functions, and identities; duality.; Representation and simplification of Boolean functions (algebraic simplification and Karnaugh-map reasoning) - the mathematics behind digital logic and circuit minimisation.; Recurrence relations: formulation, and solving linear homogeneous recurrences with constant coefficients (characteristic-equation method).; Solving non-homogeneous recurrences; using recurrences to model discrete processes (link to algorithm cost equations - mathematically, not Big-O).; Algebraic structures: binary operations, semigroups, monoids and groups; properties (closure, associativity, identity, inverse).; Subgroups, cyclic groups, and the order of an element; modular groups (Z_n, +) and (Z_p*, x) as worked examples linking back to number theory.; Introduction to rings and fields; finite fields GF(p) and the idea of GF(2^n) (conceptual) - the algebra behind AES and coding.; Mathematics of error-detecting and error-correcting codes: parity, Hamming distance, and the Hamming bound (linear-code reasoning, structurally).; Generating pseudo-randomness mathematically: linear congruential and linear-feedback structures (as algebraic recurrences).; Synthesis: how Boolean algebra, finite fields and recurrences jointly underpin contemporary cryptography, coding and digital design.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Discrete Mathematics and Its Applications**	Kenneth H. Rosen	McGraw-Hill	2019 (8th ed.)
2	**Discrete Mathematics with Applications**	Susanna S. Epp	Cengage	2019 (5th ed.)
3	**Concrete Mathematics: A Foundation for Computer Science**	Ronald Graham, Donald Knuth & Oren Patashnik	Addison-Wesley	1994 (2nd ed.)
4	**Elements of Discrete Mathematics**	C. L. Liu & D. P. Mohapatra	McGraw-Hill	2017 (4th ed.)
5	**An Introduction to the Theory of Numbers**	G. H. Hardy & E. M. Wright	Oxford University Press	2008 (6th ed.)
6	**Introduction to Graph Theory**	Douglas B. West	Pearson	2017 (2nd ed.)

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Autonomous Robotic Systems & Human-Robot Interaction

ARBS
26EC4117
E

L-T-P-S	3-0-3-0	**Credits**	3	**Contact Hrs/Wk**	6
Trimester	T10	**Mode**	PBL (Project-Based)	**Category**	PCC
Pre-requisite	RBPR				

Course Outcomes (COs)

	Statement	BTL
CO1	Evaluate autonomous-robot-system architectures – purely deliberative, layered hybrid (Brooks-style subsumption to modern Three-Layer), behaviour-tree-orchestrated, foundation-model-orchestrated – against task complexity, real-time requirements, and safety needs.	BTL5 · Evaluate
CO2	Apply robot autonomy architecture — mission management with behaviour trees, task planning at intuition level, deliberative-reactive hybrid execution, the mode-switching state machine — to give a robot multi-task capability.	BTL3 · Apply
CO3	Apply human-robot interaction patterns — voice recognition + LLM-based intent understanding, gesture recognition at intuition level, visual feedback (display, lights), the intent-disclosure principle, social-signal recognition — to enable natural human-robot communication.	BTL3 · Apply
CO4	Apply social and human-aware navigation — proxemics-aware cost maps, the social-force model, person-tracking-aware planning, the freezing-robot problem revisited at social depth, group-aware navigation — to operate robots safely around humans.	BTL3 · Apply
CO5	Analyze learning-based autonomy at intuition level — reinforcement learning for robotics, the sim-to-real gap and how it is bridged, imitation learning, foundation models for robotics (RT-2, Open X-Embodiment) — and reason about when learning-based components belong in a robot stack.	BTL4 · Analyze
CO6	Apply safety, reliability, and deployment-lifecycle practices — independent safety supervisors at depth, the certification landscape (ISO 13482 for personal-care robots, ISO 10218 for industrial) at preview level, the field-deployment lifecycle, the post-deployment monitoring discipline — to deliver robots that are safe in the real world.	BTL3 · Apply

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1
CO1	H	H	H	H	–	–	–	H
CO2	H	–	H	–	H	–	–	H
CO3	H	–	H	–	–	H	M	H
CO4	H	–	H	–	–	H	–	H
CO5	H	H	M	–	–	–	–	H
CO6	H	–	H	H	–	H	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

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Module-wise Syllabus

	Title & Topics	CO
M1	**The Autonomous Robot as a System** A working HelpBot on day one — students give the robot a voice command ("HelpBot, go meet me at the printer"), watch it confirm intent on its display, navigate there socially, and announce arrival before any internals.; The complete autonomous-robot stack visible: HRI (voice in, TTS out, display) → autonomy (behaviour-tree mission manager) → navigation (RMNC stack) → perception (RPCS stack) → safety supervisor (always watching) → hardware (FRMS-built KartBot).; Robot autonomy architecture history: Brooks-style subsumption (purely reactive), classical deliberative (sense-plan-act), the modern Three-Layer architecture (deliberative + executive + reactive), behaviour-tree orchestrated (current mainstream), foundation-model orchestrated (research frontier).; The autonomy-vs-supervision trade-off in robotics: tele-op, shared autonomy, supervised autonomy, full autonomy; how each is chosen by application.; The Three-Laws-of-Robotics naivety vs the real safety-engineering discipline: hard-coded safety supervisors, layered safety, formal-verification-where-it-counts.; A reading of HelpBot's architecture: how the HRI layer feeds the mission manager, how the mission manager invokes the Nav2 stack, how the safety supervisor monitors everything from outside.; Tracing one user request end-to-end: voice → STT → LLM intent classifier → mission manager → behaviour tree → Nav2 → KartBot motors → arrival announcement.; What this course owns vs upstream: ARHR owns autonomy + HRI + safety + deployment; the upstream chain owns foundations + perception + motion.	CO1
M2	**Robot Autonomy Architecture** Mission management as the highest-level concern: a queue of tasks, the currently-executing task, the abort/resume semantics.; Behaviour trees revisited at the autonomy depth: composite nodes for mission decomposition, decorators for retry/timeout/fallback, the integration with Nav2 already seen in RMNC.; BehaviorTree.CPP at depth: writing custom nodes, plugging into the Nav2 BT navigator, the testability discipline.; Task planning at intuition level: HTN (Hierarchical Task Networks), PDDL (Planning Domain Definition Language); when planning beats hand-coded behaviour trees.; The deliberative-reactive split in modern robots: a deliberate plan at low frequency (1Hz), a reactive controller at high frequency (50Hz), the decoupling that makes both work.; Mode-switching state machines: the canonical states (idle, navigating, interacting, recovering, faulted); the transitions and the guards.; Foundation models for high-level robot reasoning: using a cloud LLM to interpret novel commands; the latency-and-reliability discipline that wraps it.; A walk-through of HelpBot's mission manager: the BT structure, the modes, the transitions; how a user request becomes an executed mission.	CO2
M3	**Human-Robot Interaction** Voice input on a robot: revisiting EATM's on-device keyword-spotting (for wake-word) + cloud STT (for the body of the command); the offline-fall-through mode.; LLM-based intent understanding: using a cloud LLM (continuation of AAAE) to map free-form voice to structured intent; the discipline of validating before acting.; Speech output: TTS quality matters; on-device options vs cloud TTS; the intelligibility-vs-latency trade-off.; Visual feedback on a small robot display: the discipline of showing what the robot is about to do (intent disclosure).; Light-based feedback: ring LEDs as a low-bandwidth status display; the design language (waiting, listening, moving, error).; Gesture recognition at intuition level: pointing, "stop" gestures, beckoning; the deep-learning-for-gestures landscape.; Social signal recognition: detecting "the human is busy", "the human is engaging", "the human looks distressed"; the responsibility this confers.; The intent-disclosure principle: the robot must communicate what it intends to do BEFORE doing it; the design pattern that makes humans trust robots.	CO3

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	Title & Topics	CO
M4	**Social and Human-Aware Navigation** Proxemics: Hall's zones (intimate, personal, social, public); how robots respect them.; Proxemics-aware cost maps: inflating obstacles around tracked humans more than around walls; the layered-cost-map plug-in for Nav2.; The social-force model revisited from RMNC at depth: humans as agents in a force field; the robot navigates as one such agent.; Person tracking integration: the RPCS tracker outputs feed into a social-cost-map; identities persist across short occlusions.; The freezing-robot problem at social depth: the robot must maintain forward progress in a corridor with oncoming people; the merge-or-yield decision.; Group-aware navigation: don't walk through a group of people having a conversation; the conversational-formation detector at intuition level.; Speed-and-acceleration discipline near humans: hard caps; the comfort-vs-progress trade-off.; Cultural variation in proxemics at preview level: the same robot may need different defaults for different deployment regions; the design discipline.	CO4
M5	**Learning-Based Autonomy at Intuition Level** Reinforcement learning for robotics at intuition level: state, action, reward; the policy and value-function abstractions.; The sim-to-real gap: why a policy trained in simulation often fails on real hardware; domain randomisation as the canonical mitigation.; Imitation learning: behavioural cloning, DAgger; learning from human demonstrations.; Inverse RL at intuition level: learning the reward function from demonstrations, then planning under it.; Diffusion policies: the recent trend of generating trajectories with diffusion models; why it beats simple behavioural cloning on multimodal tasks.; Foundation models for robotics: RT-2, Open X-Embodiment, the embodied-LLM trend; the capability frontier as of 2026.; The hybrid pattern: classical planning-and-control for the safety-critical core, learning-based perception on top, learning-based high-level reasoning for novel tasks; the layered-trust architecture.; When NOT to use learning: for the core safety supervisor, for hard real-time control loops, for any function that must be certified; the discipline of "use learning where the alternative is worse, not because it's fashionable".	CO5
M6	**Safety, Reliability, and Deployment** The independent safety supervisor at depth: a separate process (or chip) that monitors the system and can override; the design principle of "the supervisor cannot be bypassed by the autonomy stack".; Hardware safety: e-stop button, safety-rated bumpers, safety-rated speed limiters; the discipline of "if the software fails, the hardware contains the failure".; The certification landscape at preview level: ISO 13482 (personal-care robots), ISO 10218 (industrial robots), ISO 26262 (automotive functional safety), DO-178C (aviation); what each requires.; Functional-safety reasoning at intuition level: hazard analysis, ASIL/SIL levels, failure-mode analysis; the discipline that gets a robot through compliance.; Real-world deployment lifecycle: pilot deployment → controlled rollout → general availability → fleet operation; the staged-trust pattern.; Post-deployment monitoring: per-deployment telemetry, anomaly detection, the field-incident response process.; The continuous improvement loop: deployments produce data → data trains better models → models go through the entire safety pipeline → deployed; the rate at which robots get better is governed by this loop.; Case studies of real-world robot deployments and their failure modes: Knightscope, Roomba, Boston Dynamics Spot in industrial settings; the lessons.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Springer Handbook of Robotics**	Bruno Siciliano & Oussama Khatib (eds.)	Springer	2016 (2nd Ed.)
2	**Probabilistic Robotics**	Sebastian Thrun, Wolfram Burgard & Dieter Fox	MIT Press	2005
3	**Human-Robot Interaction — An Introduction**	Christoph Bartneck, Tony Belpaeme, Friederike Eyssel, Takayuki Kanda, Merel Keijsers & Selma Šabanović	Cambridge University Press	2024 (2nd Ed.)
4	**Behavior Trees in Robotics and AI — An Introduction**	Michele Colledanchise & Petter Ögren	CRC Press	2018

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#	Title	Authors	Publisher	Year
5	**Robot Learning — Algorithms and Applications**	Pieter Abbeel et al. (eds., open lecture-notes compilation)	UC Berkeley / Free PDF	2024
6	**A Survey of Behavior Trees in Robotics and AI (Robotics and Autonomous Systems journal article)**	Matteo Iovino, Edvards Scukins, Jonathan Styrud, Petter Ögren & Christian Smith	Elsevier	2022
7	**Modern Robotics — Mechanics, Planning, and Control**	Kevin M. Lynch & Frank C. Park	Cambridge University Press	2017

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Robotic Motion Planning, Navigation & Control Systems RBMT 26EC3316E

L-T-P-S	3-0-6-0	Credits	4	Contact Hrs/Wk	9
Trimester	T09	Mode	PBL (Project-Based)	Category	PCC
Pre-requisite	RBFN				

Course Outcomes (COs)

	Statement	BTL
CO1	Evaluate motion-planning and navigation architectures – purely reactive, deliberative-then-execute, hybrid hierarchical, anytime planners – against environment characteristics (static vs dynamic, structured vs unstructured) and select an appropriate stack.	BTL5 · Evaluate
CO2	Apply sampling-based motion planning — Probabilistic Roadmaps (PRM), Rapidly-exploring Random Trees (RRT, RRT*), the asymptotic-optimality argument — to plan in high-dimensional configuration spaces.	BTL3 · Apply
CO3	Apply search-based motion planning – A*, weighted A*, hybrid A* for non-holonomic vehicles, D* Lite for replanning under map updates – to compute paths with optimality guarantees.	BTL3 · Apply
CO4	Apply local planning and trajectory generation — Dynamic Window Approach (DWA), Timed Elastic Band (TEB), polynomial-and-spline trajectories, the planner-controller boundary — to follow global plans while reacting to local conditions.	BTL3 · Apply
CO5	Analyze optimal-control techniques – Linear Quadratic Regulator (LQR), Model Predictive Control (MPC) at depth, constraints handling, the differentiable-control connection to learning — to design controllers that minimise a cost while respecting constraints.	BTL4 · Analyze
CO6	Apply navigation in dynamic and uncertain environments – social-navigation patterns, behaviour-tree integration, recovery behaviours and fallback hierarchies, safety supervisors, the freezing-robot problem — to operate robots in real workplaces.	BTL3 · Apply

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO9	PSO1
CO1	H	H	H	H	–	H
CO2	H	H	H	–	–	H
CO3	H	H	H	–	–	H
CO4	H	–	H	–	–	H
CO5	H	H	–	–	–	H
CO6	H	–	H	H	M	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

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Module-wise Syllabus

	Title & Topics	CO
M1	**Autonomous Navigation as a System** A working NavBot on day one — students place KartBot in a multi-room arena, give it a goal pose in another room, and watch it navigate autonomously through doorways and around obstacles before any internals.; The canonical autonomous-navigation stack: high-level goal → behaviour tree → global planner → local planner → controller → actuator (closing the loop with sensors via RPCS).; The Nav2 framework: the modern ROS 2 navigation stack; the planner-server, controller-server, behaviour-tree-navigator architecture.; The reactive-vs-deliberative spectrum: pure reactive (Braitenberg vehicles), pure deliberative (plan-then-execute), modern hybrid; what each is good for.; Anytime planners: produce a plan quickly, refine with more time; RRT* and ARA* as canonical examples.; Choosing a planning architecture by environment: static + structured (warehouse) → grid-based A*; static + unstructured (outdoor) → sampling-based RRT*; dynamic indoor → hybrid with DWA local planner.; A reading of NavBot's codebase: the Nav2 configuration, the custom RRT* planner plugin, the custom DWA-equivalent controller, the behaviour tree.; What this course owns vs upstream/downstream: planning + control here; perception in RPCS (already done); social autonomy in ARHR.	CO1
M2	**Configuration Space and Sampling-Based Planning** Configuration space (C-space): the abstract space of all robot configurations; the obstacle inflation that maps physical obstacles to C-space.; Why C-space matters: what looks like a 2D robot in a 2D world is really a 3D problem (x, y, theta) for a non-circular robot; manipulators have 6+ dimensions.; Probabilistic Roadmap (PRM): build a graph of valid configurations and connect them; query by connecting start/goal to the graph; multi-query advantage.; Rapidly-exploring Random Tree (RRT): grow a tree from start toward goal by sampling and extending; the single-query workhorse.; RRT*: the asymptotically-optimal variant; how rewiring works; the convergence to optimal as samples → infinity.; Bidirectional RRT and RRT-Connect: growing two trees toward each other; the practical speedup.; Sampling strategies: uniform sampling, goal biasing, narrow-passage sampling.; Kinodynamic planning at intuition level: planning under dynamics constraints (e.g. car can't teleport); kinodynamic RRT.	CO2
M3	**Search-Based Planning** Grid-based representation: the discrete C-space; the resolution-vs-memory trade-off.; A* revisited from DSA-2 at the robot scale: state space, heuristic design (Euclidean, Manhattan, octile for 8-connected grids).; Weighted A* and ARA*: trading optimality for speed; the anytime nature.; Hybrid A*: search in continuous-state grids for non-holonomic vehicles (cars, differential drive at speed); the trick that makes A* work for vehicles that can't turn in place.; D* Lite: incremental replanning when the map updates; reusing previous computation.; Lifelong Planning A* (LPA*): the algorithmic foundation under D* Lite.; Theta* and any-angle path planning: paths that aren't restricted to grid-aligned moves; smoother trajectories.; When search-based beats sampling-based: low-dimensional, structured environments where optimality matters.	CO3
M4	**Local Planning and Trajectory Generation** The local-vs-global planner split: global plans the path; local turns the path into commands while reacting to immediate obstacles.; Dynamic Window Approach (DWA): sample feasible velocity commands within the dynamic window; score by goal-progress + obstacle-clearance + speed; pick the best.; Timed Elastic Band (TEB): the optimisation-based local planner; treats the trajectory as an elastic band that deforms around obstacles.; Polynomial trajectories: quintic and septic polynomials for smooth start-to-goal motion; jerk-bounded variants for comfort.; Spline trajectories: cubic splines, B-splines; the C2-continuity property.; Differential flatness at intuition level: when a system is differentially flat, trajectory generation in a flat output space is much simpler.; Trajectory smoothing: post-processing a piecewise-linear path into a feasible smooth trajectory.; The planner-controller boundary: what the planner outputs (sequence of poses, velocity profile) and what the controller consumes.	CO4

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	Title & Topics	CO
M5	**Optimal Control** Optimal control as the unifying lens: minimise a cost over a horizon, subject to dynamics and constraints.; Linear Quadratic Regulator (LQR): the canonical analytical solution for linear systems with quadratic cost; the Riccati equation.; LQR for trajectory tracking: linearise the dynamics around the reference, use LQR locally; the gain-scheduling pattern.; Model Predictive Control (MPC) at depth: receding horizon, the optimisation problem solved at every step, the warm-start trick.; Constraints in MPC: input limits (max steering angle), state limits (stay in lane), obstacle constraints (stay away from points); how each is encoded.; Linear MPC vs nonlinear MPC (NMPC): when to linearise, when to bite the nonlinear bullet.; MPC solver landscape: OSQP, acados, CasADi; the open-source MPC toolchain.; Differentiable control: the gradient-friendly variant; the bridge to learning controllers from data; the connection to reinforcement learning at intuition level.	CO5
M6	**Navigation in Dynamic and Uncertain Environments** The freezing-robot problem: when conservative planning prevents the robot from moving in a crowd; the engineering of "graceful navigation around people".; Social navigation patterns: the social-force model, the human-aware-cost-map approach, the proxemics-aware planning.; Behaviour trees revisited at depth: composite nodes (sequence, fallback, parallel), decorators, the BehaviorTree.CPP library used in Nav2.; Recovery behaviours: clear-cost-map, spin, back-up; the layered fallback hierarchy that prevents the robot from getting stuck.; Safety supervisors: independent watchdog logic that overrides the navigator if a critical condition is met (low battery, collision detected, geo-fence violation).; Localisation failure recovery: detecting that AMCL has gotten lost; the global-relocalisation behaviour.; Multi-goal missions: queueing goals, mission cancellation, the API the operator uses.; A glance at policy learning for navigation: end-to-end learned policies, hybrid approaches (learned local planner with classical global planner); the deeper coverage in ARHR.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Planning Algorithms**	Steven M. LaValle	Cambridge University Press / Free PDF	2006
2	**Principles of Robot Motion — Theory, Algorithms, and Implementations**	Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki & Sebastian Thrun	MIT Press	2005
3	**Modern Robotics — Mechanics, Planning, and Control**	Kevin M. Lynch & Frank C. Park	Cambridge University Press	2017
4	**Predictive Control for Linear and Hybrid Systems**	Francesco Borrelli, Alberto Bemporad & Manfred Morari	Cambridge University Press	2017
5	**Optimization-Based Control**	Richard M. Murray (lecture notes)	Caltech / Free PDF	2023
6	**Probabilistic Robotics**	Sebastian Thrun, Wolfram Burgard & Dieter Fox	MIT Press	2005
7	**Robotics, Vision and Control — Fundamental Algorithms in Python**	Peter Corke	Springer	2023 (3rd Ed.)

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Robotic Perception, Computer Vision & Sensor Fusion RBPR 26EC3214E

L-T-P-S	3-0-6-0	Credits	4	Contact Hrs/Wk	9
Trimester	T08	Mode	PBL (Project-Based)	Category	PCC
Pre-requisite	RBFN				

Course Outcomes (COs)

	Statement	BTL
CO1	Analyze a robotic perception stack as a layered system — scene understanding, segmentation, detection-and-tracking, sensor fusion, calibration, raw sensor data — and trace one perception event from a sensor frame to a planner-consumable scene description.	BTL4 · Analyze
CO2	Apply camera models – pinhole, distortion correction, intrinsic and extrinsic calibration, stereo matching, epipolar geometry, depth from disparity – to extract 3D structure from images.	BTL3 · Apply
CO3	Apply visual object detection and tracking on a robot — adapting deep detectors from DLAC for on-robot inference, multi-object tracking (Hungarian assignment, ByteTrack), tracking-by-detection vs tracking-by-regression – to maintain identities across frames.	BTL3 · Apply
CO4	Analyze 3D perception with lidar – point-cloud representations (raw, voxelised), point-cloud filtering and segmentation, 3D detection at intuition level, ground-plane extraction, the lidar / camera / depth-from-stereo trade-off – to reason about the 3D scene structure.	BTL4 · Analyze
CO5	Apply multi-sensor fusion — the Kalman filter at depth, extended (EKF) and unscented (UKF) variants, factor graphs at intuition level, the multi-sensor calibration discipline, time synchronisation — to produce a single coherent state estimate.	BTL3 · Apply
CO6	Analyze SLAM (Simultaneous Localisation and Mapping) – feature-based visual SLAM (ORB-SLAM3), lidar-inertial SLAM (LIO-SAM), loop closure, the front-end / back-end architecture — to enable a robot to build a map of an unknown environment while localising in it.	BTL4 · Analyze

CO–PO / PSO Articulation Matrix

	PO1	PO2	PO3	PO5	PSO1
CO1	H	H	H	–	H
CO2	H	H	–	–	H
CO3	H	–	H	–	H
CO4	H	H	–	–	H
CO5	H	–	H	M	H
CO6	H	H	H	–	H

H = High (3) · M = Moderate (2) · L = Low (1) · blank = no significant correlation

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Module-wise Syllabus

	Title & Topics	CO
M1	**The Perception System as a Whole** A working SeeBot on day one — students teleoperate KartBot through a dynamic environment and watch the perception stack identify, track, and map.; The canonical robotic-perception stack: scene description (semantic + geometric) ← segmentation ← detection-and-tracking ← sensor fusion ← raw sensor frames.; The contrast between FRMS's perception (a-priori map + AMCL) and RPCS's perception (online mapping + understanding); what becomes possible.; The autonomous-vehicle perception stack as the canonical reference: AV-grade is over-engineered, but understanding it gives the right vocabulary.; Sensor selection: camera (rich, computationally expensive, lighting-dependent), lidar (precise depth, expensive hardware, sparse), radar (robust to weather, low resolution), depth camera (close-range RGBD); the multi-sensor norm.; Latency budget for a robot: 100ms is fast, 1000ms is too slow; how the perception stack must be carved up.; A reading of SeeBot's codebase: detector node, tracker node, lidar processor, fusion node, SLAM node; how data flows across the ROS graph.; What this course owns vs upstream/downstream: perception here; vision DL in DLAC; motion planning in RMNC.	CO1
M2	**Camera Models and Multi-View Geometry** The pinhole camera model: focal length, principal point, intrinsic matrix K; the projection from world to image.; Lens distortion: radial and tangential coefficients; the OpenCV calibration pipeline.; Camera calibration in practice: checkerboard, ChArUco, the calibration_camera ROS package; what good calibration looks like.; Extrinsic calibration: locating one camera relative to another, or relative to a lidar; the hand-eye calibration problem.; Stereo geometry: rectification, epipolar lines, the baseline-disparity-depth relationship.; Stereo matching: block matching, semi-global matching (SGBM), the modern deep-learning approaches at intuition level.; Depth-from-stereo in practice: the depth-camera (Intel RealSense, ZED) as the integrated commercial answer.; Triangulation from multiple views: the bedrock technique for visual SLAM.	CO2
M3	**Visual Detection and Tracking** Adapting DLAC's detector to the robot: model selection (YOLOv8-n, MobileNet-SSD), hardware target (Pi 4 CPU, Jetson Orin Nano GPU), latency budget.; Detection on streaming video: temporal coherence, double-detection avoidance, NMS across frames.; Multi-object tracking by detection: the assignment problem, Hungarian algorithm, the cost matrix design (IoU + appearance).; Modern trackers: SORT, DeepSORT, ByteTrack; the motion-model-plus-appearance pattern.; Tracking by regression: Siamese trackers, the single-target case; when to use which paradigm.; Re-identification: maintaining identity through occlusion; appearance-feature-extractor backbones.; 3D bounding boxes from 2D detections + depth: the practical recipe; the limits when depth is wrong.; Action recognition at intuition level: temporal aggregation; the bridge to behaviour prediction (which lives more fully in ARHR).	CO3
M4	**Lidar Processing and 3D Perception** Point clouds: the data structure, the standard ROS PointCloud2 message, intensity vs RGB.; Point Cloud Library (PCL): filtering (voxel grid downsample, statistical outlier removal), segmentation (RANSAC plane fitting), clustering (Euclidean cluster extraction).; Ground-plane extraction: the canonical first-step for autonomous driving and warehouse robots.; Voxelisation and occupancy grids in 3D: octrees (OctoMap), the trade-off between resolution and memory.; 3D object detection at intuition level: PointPillars, CenterPoint; the challenge of working in continuous 3D space.; Lidar odometry at intuition level: ICP (Iterative Closest Point), generalised ICP, NDT; the algorithm that runs every 100ms in autonomous vehicles.; Camera-lidar fusion at point-cloud level: projection of lidar into image, fusion of detections.; When lidar wins, when camera wins, when both are needed: the practical fusion-strategy menu.	CO4

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	Title & Topics	CO
M5	**Sensor Fusion** The Kalman filter at depth: state-space model, predict step, update step, the optimal-linear-estimator derivation.; The Extended Kalman Filter (EKF): linearising around the current estimate; the workhorse of practical robotics.; The Unscented Kalman Filter (UKF): sigma-point sampling; better accuracy on non-linearities at moderate cost.; Particle filter at intuition level (already seen in FRMS for AMCL): when non-Gaussian beats Gaussian.; Factor graphs and pose-graph optimisation at intuition level: the foundation of modern SLAM back-ends; GTSAM as the standard library.; Multi-sensor calibration: time synchronisation (PTP, ROS's message_filters approximate sync), spatial calibration (the extrinsics from M2 revisited).; Sensor failure handling: detecting that a sensor is misbehaving (covariance explosion, innovation gating) and downgrading gracefully.; A walk-through of SeeBot's fusion node: combining wheel odometry, IMU, and visual odometry into a single state estimate.	CO5
M6	**SLAM** The SLAM problem: simultaneously map an unknown environment AND localise within the partial map you're building.; The front-end / back-end architecture: front-end finds correspondences (features, scan-matching); back-end optimises the global pose graph.; Visual SLAM: ORB-SLAM3 as the modern reference; feature detection (ORB), descriptor matching, tracking, mapping, loop closure.; Lidar SLAM: LOAM lineage (LIO-SAM, FAST-LIO); the lidar-IMU coupling that makes it robust.; Loop closure: detecting when the robot returns to a previously-mapped place; the dramatic accuracy improvement; bag-of-visual-words and modern learned alternatives.; The kidnapped-robot problem and global relocalisation: when a robot is teleported and must re-localise from scratch.; SLAM in dynamic environments at intuition level: the moving-objects problem; the masking-of-dynamic-pixels mitigation.; A practical SLAM walkthrough: running ORB-SLAM3 on SeeBot's recorded bag and comparing the produced map against the ground-truth FRMS map.	CO6

Reference Books

#	Title	Authors	Publisher	Year
1	**Computer Vision — Algorithms and Applications**	Richard Szeliski	Springer	2022 (2nd Ed.)
2	**Multiple View Geometry in Computer Vision**	Richard Hartley & Andrew Zisserman	Cambridge University Press	2004 (2nd Ed.)
3	**Probabilistic Robotics**	Sebastian Thrun, Wolfram Burgard & Dieter Fox	MIT Press	2005
4	**State Estimation for Robotics**	Timothy D. Barfoot	Cambridge University Press	2024 (2nd Ed.)
5	**Robotics, Vision and Control — Fundamental Algorithms in Python**	Peter Corke	Springer	2023 (3rd Ed.)
6	**An Invitation to 3-D Vision — From Images to Geometric Models**	Yi Ma, Stefano Soatto, Jana Košecká & S. Shankar Sastry	Springer	2003
7	**Introduction to Visual SLAM — From Theory to Practice**	Xiang Gao & Tao Zhang	Springer	2021

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KLEF
DEPRTMENT OF MECHANICAL ENGINEERING
Y26 M.TECH-MD COURSE STRUCTURE

S.No.	Trimester #	Category	Course Code	Course Title	Acronym	L	T	P	S	Cr	CH	Pre-requisite	Entrepreneurship/ Employability/ Skill Development	New/Retained/Revised	Revision %	Revision Proposed by	Justification
1	T01	PCC	26MD5101E	CONTINUUM MECHANICS OF DEFORMABLE SOLIDS	CMDS	3	1	3	0	3.5	7	NIL	Skill Development	Revised	25%	Alumni & Faculty	Syllabus of the course was modified by incorporating the latest concepts
2	T01	PCC	26MD5102E	DIGITAL ENGINEERING AND PLM FOR PRODUCT DESIGN	DEPL	3	1	3	0	3.5	7	NIL	Skill Development	New	100%	Alumni & Faculty	As per the feedback from Alumni product Design concepts are included with digital manufacturing
3	T01	PCC	26MD5103E	ADVANCED STRENGTH OF MATERIALS AND COMPUTATIONAL DESIGN	AMDO	3	1	3	0	3.5	7	NIL	Skill Development	Revised	25%	Alumni & Faculty	Syllabus of the course was modified by incorporating the latest concepts
4	T01	PCC	26MD5104E	NONLINEAR FINITE ELEMENT METHODS AND MULTIPHYSICS	NFIM	3	1	3	0	3.5	7	NIL	Employability	New	100%	Faculty	As per te feedback recived from Alumni Group head suggested this new course witht the concepts of multiphysics
5	T01	AUC	26UC5101E	COMMUNICATION SKILLS AND TECHNICAL WRITING	CSTW	0	0	0	3	0	3	NIL		Retained			
6	T02	PCC	26MD5205E	AI BASED ENGINEERIGN DESIGN OPTIMIZATION	AIDE	3	1	3	0	3.5	7	AMDO	Skill Development	Revised	100%		Syllabus of the course was modified by incorporating AI concepts
7	T02	PCC	26MD5206E	ROBOT MODELLING AND DESIGN ANALYSIS	RMDA	3	1	3	0	3.5	7	NIL	Skill Development	Revised	100%		Syllabus of the course was modified by incorporating AI concepts
8	T02	PCC	26MD5207E	MECHANICAL VIBRATIONS	MVIB	3	1	3	0	3.5	7	CMDS	Skill Development	Retained			
9	T02	PEC	PE-1	PROFESSIONAL ELECTIVE-1	PE-1	3	1	3	0	3.5	7						
10	T02	PRI	26IE5201E	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	RMIP	3	0	0	0	2	3	NIL		Retained			
11	T03	PCC	26MD5308E	SMART MATERIALS AND STRUCTURES	SMAS	3	1	3	0	3.5	7	CMDS	Employability	New	100%	Faculty	Based on the discussion in Design group meeting this course is proposed so that students will learn about smart materials
12	T03	PCC	26MD5309E	DESIGN OF PRESSURE VESSELS AND PIPING	DPVP	3	1	3	0	3.5	7	AMDO	Employability	Revised	25%	Faculty	As per the feedback received concepts of design on piping is included
13	T03	PCC	2MD5310E	TRIBOLOGY	TRBO	3	1	3	0	3.5	7	AMDO	Employability	Retained			
14	T03	PEC	PE-2	PROFESSIONAL ELECTIVE-II	PE-2	3	1	3	0	3.5	7						
15	T03	AUD	26UC5302E	PLACEMENT TRAINING AND PROFESSIONAL READINESS	PTPR	0	0	0	3	0	3	NIL	Employability				
16	T04	PCC	26MD6112E	RELIABILITY ANALYSIS AND PREDICTIVE MAINTENANCE	RAPM	3	1	3	0	3.5	7	NIL	Skill Development	New	100%	Alumni	Based on the discussion in Design group meeting this course is proposed so that students will learn the concepts of reliability & maintenance
17	T04	PCC	26MD6111E	COMPOSITE STRUCTURES AND ENGINEERING MATERIALS	CSEM	3	1	3	0	3.5	7	NIL	Employability	New	100%	Alumni	Based on the discussion in Design group meeting this course is proposed so that students will learn the concepts of composite strucures and the emerging materials

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18	T04	PEC	PE-3	PROFESSIONAL ELECTIVE-III	PE-3	3	1	3	0	3.5	7						
19	T04	PEC	PE-4	PROFESSIONAL EELCTIVE-IV	PE-4	3	1	3	0	3.5	7						
20	T05	PRI	26IE6202E	CAPSTONE PROJECT/INDUSTRY PROJECT PHASE-I	CAP1	0	0	36	0	12	36		Skill Development				
21	T06	PRI	26IE6303E	CAPSTONE PROJECT/INDUSTRY PROJECT PHASE-II	CAP2	0	0	36	0	12	36	CAP-1	Skill Development				
TOTAL						**51**	**16**	**120**	**6**	**82**	**193**						

List of Professional Electives

Stearm A: Vehicle and Mobility design

S.No.	Trimester #	Category	Course Code	Course Title	Acronym	L	T	P	S	Cr	CH	Pre-requisite	Entrepreneurship/ Employability/ Skill	New/Retained/Revised	Revision %	Revision Propos	Justification
1	T02	PE-1	26MD52A1E	AUTOMOTIVE VEHICLE DESIGN	AVDE	3	1	3	0	3.5	7		Skill Development	New	100%	Group head	Based on the discussion on feedback from students it was proposed to introduce a stream of specialization on Automobiles with latest market trend and EV and Hybrid vehicles
2	T03	PE-2	26MD53A2E	POWERTRAIN ENGINEERING FOR EV'S AND HYBRIDS	PEEH	3	1	3	0	3.5	7	AVDE	Skill Development	New	100%		
3	T04	PE-3	26MD61A3E	VEHICLE DYNAMICS AND SUSPENSION SYSTEMS	VDSS	3	1	3	0	3.5	7	AVDE	Skill Development	New	100%		
4	T04	PE-4	26MD61A4E	DRONE AND UAV MECHANICAL DESIGN	DUMD	3	1	3	0	3.5	7	AVDE	Skill Development	New	100%		

Stearm B: Manufacturing and Industrial Engineering

S.No.	Trimester #	Category	Course Code	Course Title	Acronym	L	T	P	S	Cr	CH	Pre-requisite					
1	T02	PE-1	26MD52B1E	ADDITIVE MANUFACTURING AND DESIGN FOR AM	AMDA	3	1	3	0	3.5	7		Skill Development	New	100%	Group head	Based on the discussion on feedback from students it was proposed to introduce a stream of specialization on manufacturing with latest conepts like additive manufacturing, mechatronic, generative AI, precision engineering
2	T03	PE-2	26MD53B2E	MECHATRONICS, IOT AND SMART SYSTEMS	MISS	3	1	3	0	3.5	7	AMDA	Skill Development	New	100%		
3	T04	PE-3	26MD61B3E	GENERATIVE DESIGN AND TOPOLOGY OPTIMIZATION	GDTO	3	1	3	0	3.5	7	AMDA	Skill Development	New	100%		
4	T04	PE-4	26MD61B4E	PRECISION ENGINEERING AND METROLOGY	PEMT	3	1	3	0	3.5	7	AMDA	Skill Development	New	100%		

No. of New Courses	13
No. of revised Courses	5
Total No. of courses	25
% of Syllabus revision	**72**
% of course focusiing of Emloyability	24
% of courses focussing on Entrpreneurship	0
% of courses focussing on Skill development	68

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6 · Course Content (Trimester-wise)

Trimester 1

26MD5101E Continuum Mechanics of Deformable Solids

Acronym: CMDS L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Apply tensor concepts and deformation measures to describe stress and strain states in continuous bodies.	3 · Apply	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Analyze stress equilibrium, compatibility conditions and constitutive relations for elastic solids.	4 · Analyse	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Formulate and solve two dimensional elasticity problems using appropriate analytical methods.	4 · Analyse	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Analyze axisymmetric and three dimensional elasticity problems encountered in engineering components.	4 · Analyse	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO5	Apply energy methods and approximate techniques for solving elasticity problems.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Evaluate analytical elasticity solutions using computational approaches for engineering applications.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)

MODULE-WISE SYLLABUS

Module 1 · Mathematical Foundations and Stress Analysis

The mathematical language of the continuum — the continuum concept, Cartesian tensors and index notation, tensor transformation, principal values and invariants, then the stress tensor, Cauchy's stress principle, traction and the differential equations of equilibrium. Students build fluency in tensor manipulation and set up the stress state and equilibrium for continuous bodies as the foundation for all that follows.

Module 2 · Strain Analysis and Constitutive Relations

Kinematics and material behaviour — the displacement field, the strain tensor and strain- displacement relations, compatibility equations, strain transformation and principal strains, followed by constitutive relations (generalized Hooke's law), elastic constants and material symmetry. Students connect deformation to stress through the elastic constitutive law for isotropic and anisotropic solids.

Module 3 · Two Dimensional Problems in Elasticity

Two-dimensional elasticity — the Airy stress function, polynomial solutions, bending of beams by the elasticity approach, plane-stress and plane-strain idealisations, and problems in polar coordinates (Lamé thick-cylinder, stress concentration around holes, Kirsch solution). Students formulate and solve 2D boundary-value problems and compare with elementary theory.

Module 4 · Axisymmetric and Three Dimensional Elasticity Problems

Axisymmetric and three-dimensional elasticity — thick cylinders and rotating discs, spheres and pressurised shells, and contact stresses including the Hertzian solution. Students analyse axisymmetric and 3D stress states in real engineering components such as pressure vessels, discs and contacting bodies.

Module 5 · Advanced Torsion and Energy Methods

Advanced torsion and energy methods — Saint- Venant torsion, the Prandtl stress function and membrane analogy, torsion of non- circular and thin- walled sections, together with energy methods (virtual work, Castigliano's theorems) and approximate techniques (Rayleigh-Ritz). Students solve torsion and elasticity problems using both exact and energy-based approaches.

Module 6 · Computational Elasticity Applications

Computational elasticity — the weak (variational) form, the elasticity basis of the finite element method, discretisation and element formulation, and the use of computational approaches to analyse elasticity problems that lack closed-form solutions. Students verify analytical elasticity results against a finite- element model and apply the methods to a real engineering

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component.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Malvern L.E.	Introduction to the Mechanics of a Continuous Medium (Prentice-Hall)
2	Holzapfel G.A.	Nonlinear Solid Mechanics (Wiley)
3	Timoshenko S.P., Goodier J.N.	Theory of Elasticity (McGraw-Hill)
4	Bonet J., Wood R.D.	Nonlinear Continuum Mechanics for FEA (Cambridge)
5	Reddy J.N.	Energy Principles and Variational Methods in Applied Mechanics (Wiley)

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26MD5102E Digital Engineering and PLM for Product Design

Acronym: DEPL L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse modern CAD and the parametric vs direct paradigm.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer advanced assembly, surfacing, and sheet-metal/weldments for auto/ consumer.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO3	Engineer Model-Based Definition and GD&T digital tolerancing.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer Product Lifecycle Management covering Teamcenter/ Windchill/ ENOVIA/3DEXPERIENCE architecture, vault, and workflow.	5 · Create	PO1(M), PO3(H), PO4(M), PO5(H), PO6(M)
CO5	Engineer simulation and manufacturing integration covering CAM/ CAPP integration, tolerance simulation, and additive-design workflows.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)
CO6	Engineer the digital thread, digital twin, and Indian deployment.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Modern CAD: Parametric vs Direct + Interoperability

Foundations of digital product modelling — the parametric/history-based paradigm (SolidWorks, Creo, CATIA, NX, Fusion 360 — sketches, features, parent/child feature trees, design intent, parametric robustness and best practices); the direct/synchronous paradigm (NX Synchronous, SpaceClaim push/ pull edits for legacy/ imported geometry) and hybrid modelling; top- down skeleton versus bottom- up assembly; large- assembly performance (lightweight, simplified rep, suppress, envelope); and interoperability (neutral STEP AP242, IGES, JT, Parasolid formats, translation pitfalls and healing); Indian context — Indian OEMs run mixed CAD (Tata Motors NX/ CATIA, Mahindra CATIA/ Creo, Bosch CATIA/ NX, HAL CATIA, ISRO NX/ CATIA), making interoperability a daily survival skill.

Module 2 · Advanced Assembly, Surfacing & Specialised Environments

Beyond simple parts — large complex assemblies (top- down skeleton/ master models versus bottom- up, mates/ constraints, sub- assembly hierarchy, flexible sub- assemblies, envelopes and lightweight representations essential past 10k parts, and interference/clearance checks); Class-A surfacing (Bezier/NURBS surfaces, G0-G3 tangent/curvature continuity, zebra/reflection analysis, via CATIA ICEM and Autodesk Alias); sheet metal (flanges, bends, reliefs, unfold, flat pattern); weldments (structural-member frameworks and cut-lists); and mould/die and tooling environments; Indian context — Tata, Mahindra, Bosch and Indian Tier-1s rely on top-down assembly, Class-A, sheet-metal and weldment daily.

Module 3 · MBD, GD&T & Digital Tolerancing

From drawings to the model as truth — Model- Based Definition (embedding Product and Manufacturing Information — dimensions, tolerances, datums, notes, finish — directly on the 3D model, eliminating 2D drawings and enabling downstream CAM/ CMM/ PLM in the Model- Based Enterprise); ASME Y14.5 and ISO 1101 GD&T (datums and datum reference frames, the fourteen geometric tolerances across form, orientation, location, runout and profile, material conditions MMC/LMC with bonus tolerance, datum targets, virtual condition); and tolerance stack- up; Indian context — Indian OEMs (Tata Motors, Mahindra, Bosch, HAL) are aggressively transitioning to MBD and ASME Y14.5, making GD&T a top-three recruitment skill.

Module 4 · PLM Architecture, BOM & Change Management

The system of record for the product — PLM platforms (Siemens Teamcenter, PTC Windchill, Dassault ENOVIA/3DEXPERIENCE — the database, file vault, workflow engine, roles and permissions, revision/maturity states and sign-off workflows); multi-CAD integration (the Indian- OEM reality); bills of materials (engineering eBOM from CAD, manufacturing mBOM from ERP/ MES, service sBOM, BOM transformations, variant/150% BOM, and effectivity); and change management (ECR to ECN to ECO, the Change Control Board, impact assessment and propagation); Indian context — Tata Technologies, L&T Technology Services and Wipro deploy and customise Teamcenter, Windchill and 3DEXPERIENCE for global OEMs, making PLM a top- five Indian engineering-IT export.

Module 5 · Simulation + Manufacturing Integration

Closing the design-simulate-make loop — CAD-in-CAE (Abaqus, ANSYS Workbench and Altair Inspire integrated into CATIA/NX/ Creo, with update-in-CAD propagating to simulation, DOE and optimisation loops, and the simulation-driven-design paradigm);

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CAM integration (NX/ Creo CAM and Mastercam reading MBD to drive toolpaths, G- code, tool libraries and Vericut machine simulation); DFM/ DFA (process rules for machining, casting, forging, sheet- metal and moulding, via Boothroyd- Dewhurst); tolerance simulation (3DCS/ VSA Monte Carlo on GD&T predicting assembly yield); and CMM inspection planning from MBD; Indian context — the closed CAD-CAE-CAM-CMM loop is the modern Indian OEM standard at Tata Motors, Mahindra, Bosch and HAL.

Module 6 · Digital Thread, Digital Twin & Indian PLM Deployment (Capstone)

From digital file to live digital twin — the digital thread (the continuous flow of product data across requirements, design, simulation, manufacturing, service and end- of- life, with as- designed/ as- built/ as- maintained traceability and change propagation); the digital twin with PLM as the spine, integrated with IoT/OT platforms under cybersecurity and IP governance; a capstone: the modern frontier of generative AI- assisted CAD, AR/ VR review and cloud- CAD; Indian deployment — among the largest Indian engineering- services and IT exports, with Tata Technologies, L&T Technology Services, Wipro, KPIT and Cyient employing tens of thousands of PLM/CAD engineers, commanding premium salaries.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Stark J.	Product Lifecycle Management (Springer)
2	Saaksvuori A., Immonen A.	Product Lifecycle Management (Springer)
3	Krulikowski A.	Fundamentals of GD&T (Cengage)
4	Shih R.H.	Parametric Modeling with [SolidWorks/Creo/NX] (SDC Publications)
5	Boothroyd G., Dewhurst P.	Product Design for Manufacture and Assembly (CRC)

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26MD5103E Advanced Strength of Materials and Computational Design

Acronym: ASMC L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyze statically indeterminate structures using advanced mechanics approaches.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Analyze stresses in curved beams, unsymmetrical bending and non standard structural members.	4 · Analyse	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Evaluate torsional behaviour of circular, non circular and thin walled sections.	5 · Evaluate	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)
CO4	Analyze failure, fatigue and fracture behaviour of engineering components.	4 · Analyse	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Apply optimization methods for improving mechanical component performance.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Develop optimized mechanical designs using analytical and computational approaches.	6 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Advanced analysis of Beams

Advanced analysis of statically indeterminate structures using energy methods and matrix approaches — Castigliano's theorems, unit- load method, the force (flexibility) and displacement (stiffness) formulations, three- moment equation and analysis of continuous beams, rings and frames. Emphasis is on choosing the right redundant, building compatibility equations correctly, and verifying hand solutions against a computational model for real machine and structural members.

Module 2 · Unsymmetrical Bending and Shear Center

Stresses in members that violate the assumptions of elementary beam theory — curved beams (Winkler- Bach theory, crane hooks, chain links), unsymmetrical bending about non- principal axes, the shear centre of open thin- walled sections and combined bending-plus-torsion loading. Students learn to locate the shear centre, resolve loads onto principal axes, and predict stress distributions in real structural and machine members.

Module 3 · Advanced Torsion and Contact Problems

Advanced torsion beyond the circular shaft — Saint- Venant torsion of non- circular and thin- walled open and closed sections, Prandtl's stress- function and membrane analogy, warping and torsion constants, plus an introduction to contact mechanics (Hertzian point and line contact, subsurface stresses) relevant to gears, cams, bearings and wheel-rail interfaces.

Module 4 · Failure, Fatigue and Fracture Mechanics

Why components fail and how to predict life — static failure theories, stress concentration, linear- elastic fracture mechanics (stress- intensity factor, fracture toughness, crack growth), high- and low- cycle fatigue (S- N and ε- N), mean- stress corrections and damage-tolerant design. The module ties failure prediction to real automotive and aerospace component-life requirements.

Module 5 · Design Optimization Methods

Formal optimization for mechanical design — problem formulation (objective, design variables, constraints), classical methods (Lagrange multipliers, KKT conditions), gradient and gradient- free numerical optimization, and weight/ stress/ cost trade- offs. Students set up and solve constrained design problems with Python (scipy.optimize) and interpret Pareto trade- offs for real parts.

Module 6 · Computational Design Optimization

Computational design optimization in practice — Design of Experiments, response- surface and surrogate models, an introduction to topology optimization, and AI- assisted and CAE- driven optimization loops. Students run a complete optimize-analyze- verify cycle on a real component using CAE tools and document the design decision, closing the loop from advanced mechanics to a verified, optimized design.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher

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#	Author(s)	Title, Edition & Publisher
1	Boresi A.P., Schmidt R.J.	Advanced Mechanics of Materials (Wiley)
2	Timoshenko S.P., Goodier J.N.	Theory of Elasticity (McGraw-Hill)
3	Shigley J.E., Budynas R.G., Nisbett J.K.	Mechanical Engineering Design (McGraw-Hill)
4	Arora J.S.	Introduction to Optimum Design (Elsevier)

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26MD5104E Nonlinear Finite Element Methods and Multiphysics

Acronym: NFIM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse FE foundations and linear element library.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer geometric nonlinearity covering large displacement/ rotation/ strain, Green-Lagrange, and PK stress.	5 · Create	PO1(M), PO3(M), PO4(M), PO5(H), PO6(M)
CO3	Engineer material nonlinearity covering metal plasticity, hyperelasticity, and damage and fracture.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer contact and nonlinear dynamics covering contact mechanics and implicit Newmark vs explicit central-difference.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer multiphysics and V&V covering thermal- structural, fluid- structure interaction, and acoustic-structure.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer real- Indian- OEM nonlinear/ multiphysics CAE and bridge to design, advanced, and Indian deployment.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)

MODULE-WISE SYLLABUS

Module 1 · FE Foundations & Linear Element Library

The mathematics under the software — the strong form to the weighted- residual/ weak variational form to Galerkin discretisation; shape functions (Lagrange, Serendipity, C0/C1), isoparametric elements with the Jacobian mapping, and Gauss-Legendre integration; element stiffness via B- transpose- D- B integration and assembly; convergence requirements (completeness, compatibility, the patch test, h- versus p-refinement, error estimation); the element library (1D bar/beam/frame, 2D plane and axisymmetric CST/LST/Q4/Q8, plate/shell Kirchhoff/Mindlin, 3D tet/hex); and element pathologies with remedies; Indian context — the engine inside Abaqus, ANSYS, LS- DYNA and Altair, where correct element/ mesh choice is everyday CAE practice at Tata Motors, Mahindra, Bharat Forge and HAL.

Module 2 · Geometric Nonlinearity

When deformations are large — the sources (large displacements/ rotations, large strain, stress stiffening, follower loads); kinematics (the deformation gradient, polar decomposition, Green-Lagrange strain and PK1/PK2 stress from CMDS, and Total versus Updated Lagrangian formulations); the tangent stiffness as material plus geometric stress-stiffening; and stability (linear eigenvalue buckling versus nonlinear post-buckling, snap- through/ snap- back in shells and closures, imperfection sensitivity where a small imperfection drastically reduces slender/shell capacity, and the arc-length Riks method tracing equilibrium past limit points); applications; Indian context — sheet-metal forming, crash and thin-walled stability at Tata Motors, Mahindra, HAL and ISRO, and plastic snap-fits at Bosch India.

Module 3 · Material Nonlinearity

When the material yields, cracks or stretches — metal plasticity (von Mises yield and associative flow, isotropic/kinematic/mixed hardening with Bauschinger, the return-mapping algorithm and consistent tangent from CMDS, rate-dependent Johnson-Cook/ Cowper-Symonds for crash/forming, and anisotropic Hill/Yld2000 for sheet-metal); hyperelasticity (Neo-Hookean, Mooney-Rivlin, Ogden, Arruda- Boyce and Yeoh for rubbers and bushings, with parameter ID from uniaxial/ biaxial/ planar tests); damage and fracture (cohesive- zone for delamination and adhesives, continuum damage Lemaitre/ Gurson, XFEM crack propagation); viscoplasticity and creep; and Newton- Raphson/ line- search/ arc- length convergence and troubleshooting; Indian context — sheet- metal forming, crash, rubber bushings, turbine creep and composite damage at Tata Motors, Mahindra, Bharat Forge, Bosch, HAL and BHEL.

Module 4 · Contact & Nonlinear Dynamics

Interfaces and time — contact mechanics (node- to- surface versus surface- to- surface, penalty versus Lagrange- multiplier enforcement, Coulomb friction, contact search, and rigid-body/master-slave/general contact, for gear-meshing, bearings, seals, snap-fits, crash, brake-pad interface and metal-forming); nonlinear dynamics (implicit Newmark/HHT with per-step iteration for slow- loading structural dynamics versus conditionally- stable explicit central- difference for very- short- duration crash/ impact/ forming/ blast, with mass scaling checked against energy balance, hourglass control and element- deletion erosion); and applications (automotive crash in the industry-standard LS-DYNA and Abaqus Explicit, drop tests, bird strike, and metal forming in LS- DYNA/ AutoForm/ PamStamp); Indian context — crash, forming and impact dominate Indian auto/ aero CAE, where LS-

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DYNA expertise is highly sought.

Module 5 · Multiphysics & V&V

Coupling and credibility — multiphysics (thermal- structural for welding, braking and engine thermal- fatigue, fluid- structure interaction for aero- elastic flutter and cooling channels via ANSYS Fluent and STAR- CCM+, acoustic- structure for NVH, electromagnetic-structural for motors, one- versus two-way coupling); and Verification and Validation, the ASME V&V framework of code verification, solution verification via mesh/ time convergence never trusting an un- converged result, validation against experiment and analytical benchmarks, uncertainty and sensitivity, and the CAE engineer's reporting responsibility versus colourful pictures; Indian context — V&V discipline separates senior CAE engineers at Tata Technologies, Ansys India, Altair India, HAL and ISRO from junior button-pushers.

Module 6 · Indian-OEM Capstone + Advanced + Deployment

Integration on a real component — the full nonlinear/multiphysics workflow end-to-end (problem definition, analytical pre-check, meshing, element and nonlinearity strategy, solution, post-processing, V&V, design implications and DEPL handover); real Indian-OEM applications; and the bridge to DOE, optimisation, ML surrogates, digital twins and reduced- order models; Indian deployment — Tata Technologies, L&T Technology Services, Ansys/ Altair India, KPIT and Cyient CAE teams do a significant fraction of global nonlinear-CAE work, one of the highest-paid portable Indian mechanical skills.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bathe K.J.	Finite Element Procedures (Prentice-Hall)
2	Zienkiewicz O.C., Taylor R.L., Zhu J.Z.	The Finite Element Method (3 vols, Elsevier)
3	Crisfield M.A.	Non-linear Finite Element Analysis of Solids and Structures (Wiley)
4	Belytschko T., Liu W.K., Moran B.	Nonlinear Finite Elements for Continua and Structures (Wiley)
5	Simo J.C., Hughes T.J.R.	Computational Inelasticity (Springer)

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26UC5101E Communication Skills and Technical Writing

Acronym: CSTW L-T-P-S: 0-0-0-3 Credits: 0 CH: 3 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Write clear, structured technical documents covering design docs, ADRs, and RFCs.	3 · Apply	PO1(H), PO3(M), PO4(L)
CO2	Engineer technical presentations using narrative arc, slide composition, demo design and audience adaptation.	3 · Apply	PO1(H), PO3(M), PO4(M)
CO3	Communicate effectively in async-first professional channels.	3 · Apply	PO1(M), PO3(H), PO4(L)
CO4	Produce professional technical content covering blog posts, video tutorials, and conference talks.	4 · Analyse	PO1(H), PO2(L), PO3(M), PO4(M)
CO5	Deliver high- stakes verbal communication covering public speaking, panel discussions, and conference Q&A.	4 · Analyse	PO1(L), PO2(M), PO3(H)
CO6	Build a coherent professional engineering identity across resume, LinkedIn, GitHub, personal site, and public artifacts.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Technical Writing — The Engineering Document Stack

Document types — design doc, architecture decision record (ADR), RFC, post- mortem, runbook, README, API docs, release notes; structured writing — TL;DR, executive summary, body, appendix; active versus passive voice; the inverted pyramid and the one-screen rule; the Diataxis framework (tutorials, how-tos, reference, explanation); clarity, concision and editing for the reader.

Module 2 · Presentation Engineering

Narrative arc — situation, complication, resolution; slide composition — Tufte principles, signal versus noise, data- ink ratio; visualisation — when to chart, when to diagram, when to show code; live- demo design — fail- safes, recovery paths, recorded fallback; audience adaptation — engineer versus product manager versus executive versus investor; talk pacing, timing and rehearsal; handling nerves and stage presence.

Module 3 · Async-First Professional Communication

Email — subject lines, structure, ask placement, reply discipline; Slack — channel etiquette, threaded versus main, async-friendly long-form; GitHub pull-request descriptions — context, change, test, screenshot; code-review etiquette — tone, specificity, action versus opinion; status updates — concise, ship-friendly format; documentation as communication; writing for a distributed, time-zone-spread team; and writing that is skimmable, unambiguous and decision-ready.

Module 4 · Public Technical Content

Engineering blog posts — hook, problem, journey, lesson; video tutorials — script, screen recording, voice-over; conference talks — call- for- proposals writing, talk structure, storytelling; README engineering — installation, usage, contribution, badges; developer relations and community building; engagement metrics — read- throughs, claps, stars, conversions; building an audience and content cadence; and turning technical work into public, reusable knowledge.

Module 5 · High-Stakes Verbal Communication

Public speaking — voice, body, pace, presence; panel discussions — preparation, listening, well-timed intervention; question-and-answer handling — bridging, redirecting, admitting the unknown; podcast interviews — talking points, soundbites, story arcs; crisis communication — incident updates, customer comms, executive briefings; storytelling for engineers; persuasion and influence without authority; and reading the room to adapt a message in real time.

Module 6 · Engineering Identity & Personal Brand

Resume engineering — Context- Action- Result bullets, quantification, formatting, ATS- friendliness; LinkedIn — headline, about, experience, content cadence; GitHub — pinned repos, profile README, contribution-graph hygiene; personal site — landing, bio, projects, blog, contact; engineering presence on Twitter/ X and Bluesky; portfolio strategy; managing an authentic, consistent professional identity online; and building a credible track record recruiters can find.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher

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#	Author(s)	Title, Edition & Publisher
1	Williams J., Bizup J.	Style: Lessons in Clarity and Grace (12th ed., Pearson, 2024)
2	Reynolds G.	Presentation Zen (3rd ed., New Riders, 2023)
3	Schwabish J.	Better Data Visualizations (Columbia, 2021)
4	Chazelle B.	Pyramid Principle (Minto) — applied to engineering writing
5	Pinker S.	The Sense of Style (Penguin, 2014)

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Trimester 2

26MD5205E AI-Based Engineering Design Optimization

Acronym: AIOE L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse optimization foundations and classification covering convex vs nonconvex, Lagrange multipliers, and duality.	4 · Analyse	PO1(H), PO2(M), PO4(M), PO5(L), PO6(M)
CO2	Engineer gradient, evolutionary, Bayesian, and multi-objective optimization.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO3	Engineer ML foundations for engineering and data.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer surrogate models and surrogate-assisted optimization.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer physics-informed ML, neural operators, and reliability/UQ for solution-operator learning.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer generative, AI- assisted design, digital twins, and Indian- OEM capstone.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Optimization Foundations & Classification

Mapping design problems to optimisation — the general formulation (minimise an objective subject to inequality and equality constraints and bounds, over continuous, integer and categorical variables); problem classes (linear programming via simplex/ interior-point, the nonlinear NLP engineering workhorse, integer/MILP, combinatorial, and convex versus multimodal nonconvex); optimality conditions (KKT and Lagrange multipliers, second-order sufficiency, duality); sensitivity and post-optimality (Lagrange multipliers as sensitivity revealing what binds the design, active versus inactive constraints); and why engineering optimisation is hard; Indian context — every CAE engineer at Tata Technologies, Ansys/Altair India, Tata Motors, Mahindra, Bosch, HAL and BHEL formulates an optimisation problem weekly.

Module 2 · Gradient, Evolutionary, Bayesian & Multi-Objective Optimization

The solver toolkit — gradient-based methods (steepest descent, Newton, quasi-Newton BFGS/L-BFGS, conjugate-gradient, and constrained penalty/ augmented- Lagrangian/ SQP/ interior- point via scipy, IPOPT and SNOPT, with line search/ trust region and gradients from finite-difference or automatic differentiation/adjoint); evolutionary and population methods (genetic algorithms, differential evolution, particle swarm, simulated annealing, for nonconvex/ nondifferentiable/ discrete problems, paired with surrogates); Bayesian optimisation (a Gaussian-process surrogate with an acquisition function, the gold standard for expensive black- boxes under 100 evaluations, via BoTorch/ Optuna); and multi- objective optimisation; Indian context — multi- objective NSGA-II applied to weight, cost and fatigue at Tata Motors, Bharat Forge, Mahindra and BHEL is daily practice.

Module 3 · ML Foundations for Engineering

The ML toolkit for a CAE/ design engineer — supervised learning (regression via linear/ ridge/ lasso and tree- based random-forest/gradient-boosting/XGBoost, classification, neural networks with backpropagation and Adam/L-BFGS, CNNs for CAE-field and defect images, and RNN/LSTM/Transformer for sensor time-series); the ML workflow (data preparation, train/val/test splits, cross- validation, regularisation, the bias- variance tradeoff, hyperparameter tuning via Optuna, metrics R2/ RMSE and F1/ AUC, and avoiding leakage); feature engineering for engineering data and unsupervised PCA/clustering; and practical Python; Indian context — Tata Motors, Mahindra, Bosch India and HAL are building ML- augmented design teams, the skill rapidly becoming required for senior roles at Tata Technologies and Ansys/Altair India.

Module 4 · Surrogate Models + Surrogate-Assisted Optimization

Replacing the expensive CAE, the highest- impact AI technique in design — the bottleneck (a nonlinear/ multiphysics CAE evaluation takes hours, making thousands-of-call optimisation infeasible); the surrogate response (training a fast surrogate on a small set of CAE runs); design of experiments (full/ fractional factorial, Latin Hypercube, Sobol/ Halton quasi- random, and adaptive sampling); surrogate methods; validation; active- learning and multi- fidelity combining coarse and fine models; and surrogate- assisted optimisation; Indian context — surrogate- assisted optimisation is the dominant AI- CAE technique at Tata

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Technologies, Ansys/Altair India and auto/aero OEMs.

Module 5 · Physics-Informed ML + Neural Operators + Reliability/UQ

Embedding physics and handling uncertainty — physics- informed neural networks (a network approximating the solution field with a loss including the PDE residual — elasticity, the equation of motion, heat conduction, Navier- Stokes — plus boundary/ initial conditions via automatic differentiation, solving forward surrogate and inverse parameter- identification problems mesh-free with little data); neural operators; hybrid physics-ML; and reliability and uncertainty quantification; Indian context — PINNs and operators emerging at the IITs/IISc, Tata Technologies and Ansys India, with reliability/UQ critical for aerospace, crash and nuclear at HAL, Tata Motors and BARC.

Module 6 · Generative Design, Digital Twins & Indian-OEM Capstone

AI creates and monitors design — generative design (geometry generated from objectives, constraints and manufacturing process via Altair Inspire, Fusion 360 and nTopology, for lightweighting and additive, the cousin of topology optimisation); reinforcement learning for design; AI design assistants; ML-driven digital twins; a capstone; the modern frontier of engineering foundation models and autonomous design; Indian deployment — AI-for-engineering is the highest-growth, highest-paid Indian mechanical specialism for 2025-2030 at Tata Technologies, L&T Technology Services, Ansys/ Altair India, Dassault SIMULIA India and OEM AI-R&D, a scarce strategic skill.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Boyd S., Vandenberghe L.	Convex Optimization (Cambridge)
2	Nocedal J., Wright S.J.	Numerical Optimization (Springer)
3	Deb K.	Multi-Objective Optimization Using Evolutionary Algorithms (Wiley)
4	Forrester A., Sobester A., Keane A.	Engineering Design via Surrogate Modelling (Wiley)
5	Brunton S.L., Kutz J.N.	Data-Driven Science and Engineering (Cambridge)

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26MD5206E Robot Modelling, Design and Analysis

Acronym: RMDA L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Apply homogeneous transformations and Denavit Hartenberg parameters for robot manipulators.	3 · Apply	PO1(H), PO2(M), PO4(M), PO5(L), PO6(M)
CO2	Apply forward and inverse kinematics to robot manipulators.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Apply rigid body dynamics and dynamic modelling to robot manipulators.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Design mechanical systems for robot manipulators.	6 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Apply configuration space and motion planning for robotic systems.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Apply robot programming and simulation tools for manipulator analysis.	5 · Evaluate	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Introduction to Robotics and Robot Kinematics

The foundations of robot geometry — spatial descriptions, rotation matrices, homogeneous transformations, and the Denavit-Hartenberg (DH) convention for assigning frames to a serial manipulator. Students build the link- transformation chain for real manipulators, understand joint types and workspace, and set up the systematic parameterisation that every downstream kinematic and dynamic model depends on.

Module 2 · Forward and Inverse Kinematics

Mapping between joint space and task space — forward kinematics from the DH chain, the manipulator Jacobian and velocity/ singularity analysis, and inverse kinematics by analytical (closed- form) and numerical methods. Students solve forward and inverse kinematics for typical 5- and 6- DOF manipulators and reason about multiple solutions, reachability and singular configurations.

Module 3 · Robot Dynamics and Dynamic Modelling

Modelling the forces and motion of manipulators — rigid-body dynamics, the Euler-Lagrange and Newton-Euler formulations, the manipulator mass/inertia matrix, Coriolis, centrifugal and gravity terms, and actuator/joint torque requirements. Students derive and simulate the dynamic model used for sizing actuators and for model-based control.

Module 4 · Robot Manipulator Design

Mechanical design of the manipulator itself — link and joint design, actuator and transmission (harmonic drive, gearbox) selection, structural stiffness, payload and reach trade- offs, and end- effector/ gripper design. Students carry a manipulator design from requirements through mechanism, actuator and structural sizing.

Module 5 · Robot Motion Planning and Control

Getting the robot from A to B — configuration space, obstacle representation, joint- and task- space trajectory generation, and motion-planning methods (potential fields, sampling- based RRT/ PRM) with an introduction to control. Students plan collision-free trajectories for a manipulator in a real cell layout.

Module 6 · Robot Programming and Simulation

Programming and simulating manipulators — robot programming approaches, and simulation, modelling, analysis and verification/ validation of manipulator behaviour using industry- standard tools (ROS/ MoveIt, Gazebo, CoppeliaSim, RoboDK, MATLAB Robotics Toolbox). Students verify a complete manipulator model and workflow in simulation as an Indian- industry capstone.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Craig J.J.	Introduction to Robotics: Mechanics and Control (Pearson)

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#	Author(s)	Title, Edition & Publisher
2	Spong M.W., Hutchinson S., Vidyasagar M.	Robot Modeling and Control (Wiley)
3	Siciliano B., Sciavicco L., Villani L., Oriolo G.	Robotics: Modelling, Planning and Control (Springer)
4	Niku S.B.	Introduction to Robotics (Wiley)

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26MD5207E Mechanical Vibrations

Acronym: MVIB L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: CMDS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse single- degree- of- freedom vibration covering free undamped and damped, forced harmonic, and base-excited.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer multi- degree- of- freedom and continuous- system vibration covering equations of motion, eigenvalue problem, and modal analysis.	5 · Create	PO1(H), PO2(M), PO3(H), PO5(M), PO6(M)
CO3	Engineer experimental modal analysis and signal processing.	5 · Create	PO1(H), PO2(M), PO3(H), PO5(M), PO6(M)
CO4	Engineer rotor dynamics and balancing covering Jeffcott and Stodola rotors, whirl, and critical speeds.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer vibration control and isolation covering passive isolation, tuned-mass dampers, and viscous.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer NVH, Indian-OEM integration, and complete capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · SDOF Vibration: Free, Forced, Transient

The foundational single-degree-of-freedom mass-spring-damper — free vibration (undamped natural frequency, under/critical/ over-damped response, damped natural frequency, and logarithmic decrement to identify damping from a decay record); forced harmonic response (magnification factor, phase, resonance, and Q- factor/ half- power bandwidth for damping identification); base excitation and displacement/force transmissibility founding vibration isolation; rotating unbalance and its auto/turbo/wind signature; and transient response to impulse, step and arbitrary loading via the Duhamel convolution and response spectra; Indian context — engine and suspension SDOF approximations at Tata Motors/Mahindra, turbo unbalance at Cummins India and BHEL, and wind-rotor unbalance at Suzlon, the daily diagnostic shortcut at every Indian machinery plant.

Module 2 · MDOF + Continuous-System Vibration

Real systems have many modes — MDOF systems (equations via Newton/ Lagrange, the eigenvalue problem yielding natural frequencies and mode shapes, modal orthogonality, modal decoupling and superposition for proportional Rayleigh damping, and non- proportional damping with complex modes in rotor- bearing systems, plus the discrete vibration absorber); continuous systems; and the bridge to FE via Rayleigh-Ritz and Galerkin; Indian context — multi-mode tower, chassis, crankshaft and turbo-blade modal analysis at Tata Motors, Mahindra, BHEL, HAL and Suzlon.

Module 3 · Experimental Modal Analysis & Signal Processing

From sensor data to a modal model — signal processing (sampling, aliasing, Nyquist, windowing and spectral leakage, averaging, the FFT and its limits, STFT and wavelets, and coherence as a quality metric); FRF measurement (driving-point and transfer FRFs via impact-hammer or shaker excitation with accelerometer/ force- cell instrumentation); modal- parameter extraction (peak-pick, circle-fit, the rational-fraction-polynomial workhorse, and time-domain complex-exponential); mode-shape animation and the Modal Assurance Criterion for FE-test correlation and model updating; and operational modal analysis; Indian context — EMA and OMA at Bruel & Kjaer India and LMS Test.Lab across auto/aero/wind machinery, with FE-EMA correlation at Tata Technologies and KPIT.

Module 4 · Rotor Dynamics & Balancing

Where every rotating machine lives or dies — the Jeffcott rotor (a flexible-shaft disc, whirl orbit, critical speed, sub- versus super-critical operation, and damping through criticals); the Stodola rotor and transfer- matrix method; gyroscopic effects (splitting modes into forward and backward whirl, shown on the Campbell diagram with critical- speed crossings); bearing- supported rotors (fluid- film and rolling- bearing stiffness/ damping governing stability, and oil- whirl/ oil- whip instabilities); and balancing; Indian context — turbo, steam, gas and wind-turbine rotor dynamics and balancing at BHEL, Cummins India, Triveni Turbine, Suzlon, HAL and GTRE.

Module 5 · Vibration Control: Isolation, Damping, Active + Torsional

Reducing vibration where it matters — passive isolation (spring and elastomeric mounts, transmissibility, design above the root-2 frequency ratio, for engine mounts and machinery foundations); dynamic absorbers and tuned- mass dampers (Den Hartog optimal tuning, multi-mode and pendulum TMDs); dampers (viscous fluid-orifice, viscoelastic constrained-layer for NVH,

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friction and metallic-yielding, with placement strategy); semi-active MR dampers controlled in real time; an introduction to active control (co-located feedback, LQR, pole- placement, piezo smart- structure actuators, and spillover); and torsional/ driveline vibration; Indian context — auto NVH and driveline at Tata Motors, Mahindra, Bajaj and TVS, and isolation/ TMDs at BHEL and wind-turbine drivetrains.

Module 6 · NVH, Diagnostics & Indian-OEM Capstone

Putting it all together for products — automotive NVH (booming, harshness, squeal/squeak, powertrain orders, tire/road cavity resonance, mode- coupling brake squeal, NVH targets and transfer- path analysis); acoustics (sound pressure level, source identification via intensity probes and beamforming, ISO 362 pass-by noise); machinery vibration severity per ISO 10816/20816 (classifying the machine, measuring RMS velocity against zones) founding vibration- based predictive maintenance; FFT diagnostics; and a capstone: the modern frontier of AI-based and acoustic- AI diagnostics and digital- twin monitoring; Indian deployment — vibration/NVH engineers are a top-five Indian mechanical specialism, in demand across auto, heavy, power, wind and aero.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Rao S.S.	Mechanical Vibrations (Pearson)
2	Inman D.J.	Engineering Vibration (Pearson)
3	Ewins D.J.	Modal Testing: Theory, Practice and Application (Wiley)
4	Childs D.	Turbomachinery Rotordynamics (Wiley)
5	Harris C.M., Piersol A.G.	Shock and Vibration Handbook (McGraw-Hill)

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26IE5201E Research Methodology and Intellectual Property Rights

Acronym: RMIP L-T-P-S: 3-0-0-0 Credits: 2 CH: 3 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Formulate research questions and develop hypotheses using systematic literature review and gap analysis.	3 · Apply	PO1(M), PO2(M), PO3(M), PO4(H)
CO2	Design experiments using quantitative, qualitative and computational methodologies appropriate to engineering research.	3 · Apply	PO1(M), PO2(M), PO3(M), PO4(H)
CO3	Conduct literature search across academic databases and manage references using Zotero/Mendeley with PRISMA discipline.	3 · Apply	PO1(H), PO3(M), PO4(M)
CO4	Write technical papers, theses and research reports in IEEE/ ACM/ Springer formats using LaTeX with proper citation.	3 · Apply	PO2(M), PO3(M), PO4(H)
CO5	Analyse patent landscapes, conduct freedom- to- operate searches and draft patent specifications for engineering inventions.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO6	Evaluate research integrity issues covering plagiarism, AI- disclosure, and replication.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Research Foundations & Question Formulation

Research types — basic, applied, design- based, action research; engineering research versus scientific research and the distinction between problem-solving and knowledge-generation; research questions versus hypotheses — formulating, refining and operationalising them; inductive versus deductive reasoning; research design frameworks (exploratory, descriptive, explanatory); gap analysis from a systematic literature review; theory building and conceptual frameworks in engineering.

Module 2 · Experimental Design & Methodology

Quantitative methods — experimental, quasi-experimental, survey, computational/simulation; qualitative methods — case study, interview, ethnography, grounded theory; mixed- methods designs and triangulation; design of experiments — full- factorial, fractional-factorial, Taguchi orthogonal arrays, response-surface methodology; randomisation, blocking and replication; sample-size determination and power analysis; validity — internal, external, construct, statistical-conclusion; reliability and reproducibility of measurements.

Module 3 · Literature Review & Reference Management

Systematic literature review following PRISMA 2020 — protocol, search strategy, inclusion/ exclusion, screening, synthesis; snowballing by forward and backward citation tracking; databases — Scopus, Web of Science, IEEE Xplore, ACM Digital Library, SpringerLink, ScienceDirect; reference managers (Zotero, Mendeley, JabRef); predatory journals (Beall's list) and journal metrics (impact factor, h-index, CiteScore); open access — green, gold, hybrid, diamond; preprint servers (arXiv, bioRxiv, ChemRxiv).

Module 4 · Scientific Writing & LaTeX

IMRaD structure (introduction, methods, results, discussion); abstract writing — informative versus descriptive; figures and tables — design principles, captioning, self-containment; citation styles — IEEE, ACM, APA, Vancouver; the peer-review process — editorial workflow, reviewer roles, response to reviewers; LaTeX fundamentals — TeX Live, document classes, math mode, BibTeX/ biblatex; journal and conference templates — IEEEtran, ACM, Springer LNCS, Elsevier elsarticle; version control for manuscripts (Git, Overleaf).

Module 5 · IPR & Patent Engineering

Types of intellectual property — patents, copyrights, trademarks, trade secrets, geographical indications, industrial designs; patentability — novelty, non- obviousness (inventive step), industrial applicability, and statutory exclusions (Section 3, Indian Patents Act 1970); patent specification — claims (independent, dependent), description, drawings, abstract; freedom-to-operate analysis; filing routes — provisional, complete, PCT; patent-landscape and prior-art search; software patentability — Section 3(k), Indian guidelines versus the USPTO Alice test.

Module 6 · Research Ethics & Integrity

Plagiarism — text, idea and self-plagiarism, and detection tools; authorship norms — Vancouver, COPE, ICMJE, contributorship and gift/ ghost authorship; conflicts of interest — financial, intellectual, personal; data fabrication and falsification; AI- assisted writing and disclosure norms (Nature, Springer, ACM, IEEE policies); the replication crisis; questionable research practices — p-

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hacking, HARKing, the garden of forking paths; open science — preregistration, open data, open code; ethics review (IRB, animal ethics, IBC).

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Kothari C.R.	Research Methodology: Methods and Techniques (4th ed., New Age, 2024)
2	Deb D. et al.	Engineering Research Methodology (Springer, 2019)
3	Booth W., Colomb G., Williams J.	The Craft of Research (5th ed., Univ Chicago Press, 2024)
4	Pressman D.	Patent It Yourself (22nd ed., Nolo, 2024)
5	Day R., Gastel B.	How to Write and Publish a Scientific Paper (9th ed., Greenwood, 2022)

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Trimester 3

26MD5308E Smart Materials and Adaptive Structures

Acronym: SMAS L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: CMDS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the smart-materials taxonomy and coupled-field theory.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer piezoelectric materials and applications covering PVDF, composites, and sensor design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer shape-memory alloys and magnetostrictive materials.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer MR/ER fluids and electroactive polymers.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer active vibration and shape control.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer energy harvesting, self- sensing, smart composites, and Indian capstone.	5 · Create	PO1(M), PO3(M), PO4(M), PO5(H), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Smart-Materials Taxonomy & Coupled-Field Theory

What 'smart' means and how to model it — the smart- materials family (piezoelectric electric- field/ strain coupling, electrostrictive, temperature/ stress- driven shape- memory alloys, magnetostrictive, large- strain electroactive polymers, field-controlled magnetorheological/ electrorheological fluids, shape- memory polymers, and chromogenic materials); multi- physics coupling (coupled-field constitutive equations linking mechanical and electric/magnetic/thermal fields, with linear and hysteretic regimes); the smart- structure framework (sensors, actuators, controller, structure, collocated versus non- collocated); and the direct sensing versus converse actuating effects; Indian context — Indian smart- structures R&D at HAL aerospace, ISRO satellites, DRDO underwater, CSIR and the IITs/IISc, with emerging piezo, SMA and MR-damper applications.

Module 2 · Piezoelectric Materials & Applications

The workhorse smart material — piezoelectric basics (the direct effect for sensors and energy harvesting versus the converse effect for actuators and transducers); materials (high- coupling brittle PZT ceramic, highest- coupling single- crystal PMN- PT, flexible sensor-favoured PVDF polymer, and macro-fiber composites for curved smart skins) with the d31/d33 coefficients and coupling factor; sensor design (voltage versus charge mode, accelerometers, force and AE sensors); actuator design; energy harvesting; and ultrasonic transducers; Indian context — Indian piezo R&D at CSIR, the IITs/ IISc and Bharat Electronics, with HAL/DRDO sonar, ISRO satellite dampers and auto active mounts.

Module 3 · Shape-Memory Alloys & Magnetostrictive

Phase- transformation and magnetomechanical materials — shape- memory alloys (workhorse Nitinol, with the austenite-martensite transformation giving the shape-memory effect for thermal actuators and stents and the superelastic effect for ~8% recoverable strain in self-centering and biomedical uses, modelled by Brinson/Lagoudas with hysteresis); SMA actuator design (wire, spring, embedded, thermally driven, with slow response but high force- density and transformation fatigue) and applications (stents, variable- geometry aerospace inlets, automotive grille shutters, self- centering seismic isolators, Cryofit couplings); and magnetostrictive materials; Indian context — Indian SMA work at IIT-Madras/Kanpur and IISc (seismic isolators, biomedical stents) and DRDO (underwater, variable-geometry), with magnetostrictive in DRDO sonar/NSTL.

Module 4 · MR/ER Fluids & Electroactive Polymers

Field- controlled rheology and soft actuators — magnetorheological fluids (carbonyl- iron particles forming field- aligned chains that raise apparent viscosity by orders of magnitude into a controllable Bingham-plastic yield-stress fluid, the workhorse semi-active damper material adjustable in milliseconds) and analogous electrorheological fluids; MR damper design (flow, shear and squeeze modes, with yield- stress, damping range and sedimentation, and clipped- optimal/ skyhook semi- active control); applications (Cadillac/Audi MagneRide and Lord MR shocks, emerging Tata-Mahindra adaptive suspensions, seismic structural control, MR prosthetics); and electroactive polymers; Indian context — Indian MR/ER work at IIT-Bombay/Kanpur and IISc with emerging semi-active suspensions, and EAP at IIT-Madras/Kanpur for soft robotics.

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Module 5 · Active Vibration + Shape Control

Closing the loop with smart materials — the control problem (measuring with a piezo/strain sensor, computing a control law in real time, and actuating via a piezo/ SMA/ MR/ EAP actuator to damp vibration, change shape or suppress flutter); actuator/ sensor placement (observability and controllability, modal/Gramian/H-infinity criteria, collocated stability versus non-collocated spillover); control algorithms (LQR, LQG with a Kalman observer, robust H-infinity, adaptive, sliding-mode for SMA/MR, positive position feedback, and neural/ reinforcement- learning controllers); practical issues; and applications; Indian context — Indian active-control work at IIT-Kanpur/Madras/Bombay, IISc, HAL flutter labs, ISRO satellites and auto active-mounts.

Module 6 · Energy Harvesting, Self-Sensing, Smart Composites & Indian Capstone

Powering, sensing and integrating — vibration energy harvesting (converting ambient vibration via a resonance- tuned piezo cantilever, electromagnetic, or emerging triboelectric transduction, with power management yielding microwatts- milliwatts for low-power wireless SHM sensors); self-sensing (using one smart material as both actuator and sensor — piezo voltage or SMA resistance feedback — to cut sensor count); smart composites; 4D printing; a capstone; the modern frontier of AI-controlled and self- healing smart structures; Indian deployment — growing rapidly across HAL, ISRO, DRDO, the IITs/ IISc, auto- OEMs and medical devices, a niche high-prestige specialism.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Smith R.C.	Smart Material Systems: Model Development (SIAM)
2	Leo D.J.	Engineering Analysis of Smart Material Systems (Wiley)
3	Preumont A.	Vibration Control of Active Structures: An Introduction (Springer)
4	Lagoudas D.C.	Shape Memory Alloys: Modeling and Engineering Applications (Springer)
5	Erturk A., Inman D.J.	Piezoelectric Energy Harvesting (Wiley)

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26MD5309E Design of Pressure Vessels and Piping

Acronym: DPVP L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the pressure-vessel design framework covering Section I, IS 2825, and IS 14333.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer shell, head, and nozzle design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer flanges, supports, and heat exchangers.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer design-by-analysis covering elastic stress categorization per Hopper diagram, 3S_m rule, and ratcheting.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer piping and piping- stress analysis covering ASME B31.1, piping flexibility, and thermal-expansion.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer special services and Indian-OEM capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Pressure-Vessel Design Framework, Codes & Materials

The code-driven world of pressure equipment — why codes matter; major codes; Indian regulation (the Indian Boiler Regulations with mandatory inspection, PESO for gas and LPG, and state boiler inspectorates); the design-by-rule versus design-by-analysis philosophy; service categories (pressure, temperature, cyclic fatigue, corrosive, lethal, cryogenic, nuclear); and materials (SA-516 carbon steel, SA-387 Cr-Mo, 304L/316L stainless, clad, 9% Ni cryogenic, Inconel); Indian context — a massive Indian pressure-equipment industry (Reliance Jamnagar, IOC/ HPCL/ BPCL refining, GAIL, Petronet LNG, NTPC/ BHEL boilers, NPCIL nuclear), mostly under IBR jurisdiction.

Module 2 · Shells, Heads & Nozzles (Design-by-Rule)

The Div 1 workhorse — cylindrical shells (membrane and Lame theory, the thin-wall t=PR/(SE-0.6P) formula per UG-27 and thick-wall Lame, with joint efficiency E for full/spot/no radiography); spherical shells (efficient, for heads and LPG bullet ends); conical shells (transition stresses and reinforcement); formed heads (efficient- but- costly hemispherical, common 2:1 ellipsoidal, cheaper torispherical F&D, and heavily- penalised flat heads); and nozzles; Indian context — every Indian refinery/ petrochem vessel uses shells, heads and nozzles per UG-27/32/37, the daily work of L&T Heavy, Godrej Process, Walchandnagar and Anup Engineering.

Module 3 · Flanges, Supports & Heat Exchangers

Closing the vessel, holding it up and heat transfer — flange design (the most-analysed component since flange leaks dominate incidents, via the Taylor- Forge method, ASME Appendix 2 and PCC-1 assembly, computing moment loads, thickness and bolt sizing for weld-neck, slip-on and RTJ flanges, essentially a bolted-joint plus gasket-seating problem); gaskets (soft, spiral-wound, RTJ, Kammprofile, with m and y factors) and bolting (SA-193 B7, PCC-1 tightening); supports; and heat exchangers; Indian context — shell-and-tube exchangers ubiquitous in Indian refining and power, made at GMM Pfaudler, Anup, Godrej Process, L&T Heavy and Tema India.

Module 4 · Design-by-Analysis (FE per Section VIII Div 2 Part 5)

FE-based pressure-vessel design when design-by-rule is too conservative — stress categorisation (interpreting an FE stress field into Section VIII Div 2 Part 5 categories: primary membrane Pm, local primary PL, primary bending Pb, secondary Q and peak F, with limits Pm<=Sm, PL+Pb<=1.5Sm, and the 3Sm rule limiting cyclic ratcheting via the Bree diagram); plastic collapse (elastic-plastic FE demonstrating limit load with a 1.5 factor, the modern alternative to elastic categorisation); buckling; fatigue; and fracture mechanics; Indian context — design-by-analysis increasingly used at L&T Heavy, Reliance, Godrej Process, EIL and Tata Consulting Engineers for cyclic, thick-section and complex vessels.

Module 5 · Piping & Piping-Stress Analysis

The pipe connecting vessels, the larger design problem by linear- foot — the ASME B31 series (B31.1 power piping, the B31.3 process-piping Indian-EPC workhorse, B31.4 liquid and B31.8 gas pipelines); piping flexibility and stress analysis, where systems grow with temperature and are accommodated by route flexibility, expansion joints and spring hangers, with stresses categorised as sustained, occasional and self- limiting thermal per B31.3; pipe- stress software (CAESAR II the Indian- EPC

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standard, AutoPIPE, ROHR2, modelling thermal, pressure, seismic, water- hammer and nozzle loads); supports and flow/ acoustic-induced vibration; Indian context — piping-stress analysis dominates Indian EPC employment at L&T-Hydrocarbon, EIL, Toyo and Technip.

Module 6 · Special Services & Indian-OEM Capstone

Beyond ambient carbon- steel, the daily edge cases — high- temperature creep (the Larson- Miller parameter correlating creep-rupture across time-temperature, creep-limited allowable stress, and creep-fatigue for superheaters and reformer tubes); brittle fracture and low-temperature service (Charpy impact per UCS-66 for LPG, ammonia and cryogenic LNG at -162C using 9% Ni and austenitic steels); cryogenic/LNG; nuclear; welding, NDE and QA; corrosion; Fitness-for-Service; a capstone; the modern frontier of additive pressure parts, AI- assisted DBA, digital- twin RBI and hydrogen- economy equipment; Indian deployment — one of India's largest mechanical specialisms, with L&T Heavy alone employing over 5000 pressure-equipment and piping engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Megyesy E.F.	Pressure Vessel Handbook (Pressure Vessel Publishing)
2	Bednar H.H.	Pressure Vessel Design Handbook (Van Nostrand Reinhold)
3	Moss D.R., Basic M.	Pressure Vessel Design Manual (Butterworth-Heinemann)
4	Becht C.	Process Piping: The Complete Guide to ASME B31.3 (ASME)
5	Singh K.P., Soler A.I.	Mechanical Design of Heat Exchangers (Springer)

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26MD5310E Tribology in Design

Acronym: TRBO L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse contact mechanics and surface topography.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer friction and friction-material design covering Amontons-Coulomb laws and reality, adhesive and ploughing components, and boundary-lubricated.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)
CO3	Engineer wear mechanisms and life prediction.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer lubrication regimes and lubricant design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer tribology of machine elements covering rolling bearings, gears, and cams and tappets.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer surface engineering, condition monitoring, and Indian-tribosystem capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Contact Mechanics & Surface Topography

Where surfaces actually touch — contact mechanics (Hertz sphere/cylinder-flat and general elliptical contact, conformal versus non-conformal, contact pressure, area and subsurface stress with maximum shear at depth ~0.78a as the rolling-contact-fatigue site, and the elastic-plastic transition); surface topography (roughness parameters Ra, Rq, Rsk, Rku and 3D Sa/Sq, spatial wavelength and PSD spectral decomposition); the Greenwood-Williamson model; and roughness's role in friction, wear and lubrication-regime selection; Indian context — surface measurement at Tata Motors, Bharat Forge, Bosch and Sundaram-Clayton (Mahr, Mitutoyo, Hexagon, Taylor Hobson profilometers), where design-for-roughness is a daily decision.

Module 2 · Friction & Friction-Material Design

The tangential contact force — classical Amontons-Coulomb friction (load-independent mu) and its reality (mu depending on load, sliding speed causing stick-slip, temperature causing brake-fade, material pair, finish and lubrication regime, so mu is a tribo-system not a material property); the origin of friction (adhesive component from the weaker material's shear strength, ploughing from asperity plastic deformation, and deformation hysteresis for rubber/polymer); friction across regimes (dry metal-metal prone to galling, boundary-lubricated, mixed, and hydrodynamic/EHL); and friction-material design; Indian context — the Indian brake and clutch industry (Brakes India, Sundaram-Clayton, Anand Group, Rane Brake Lining).

Module 3 · Wear Mechanisms & Life Prediction

Material removed from contact and how much — wear mechanisms (adhesive galling/scuffing from cold welding, two- and three-body abrasive by hardness ratio, rolling-contact and micropitting fatigue in bearings and gears, solid-particle/droplet/cavitation erosion, small-amplitude fretting at clamped contacts producing fretting fatigue, and corrosive/tribochemical oxidation wear); Archard's wear law; Lim-Ashby wear maps; life prediction; and wear testing; Indian context — wear is the number-one downtime driver in Indian mining, construction and agriculture equipment (BEML, L&T, Mahindra, JCB India) and bearing/gear replacement at every OEM.

Module 4 · Lubrication Regimes & Lubricant Design

Reducing friction and wear via fluid films — the Stribeck curve (mu versus the Hersey number in a U-shape from boundary through mixed to full-film hydrodynamic/EHL, usually the design target); hydrodynamic lubrication and the Reynolds equation (from Navier-Stokes for thin viscous films, giving journal-bearing pressure, load capacity, the Sommerfeld number and Raimondi-Boyd charts, plus thermohydrodynamic and thrust bearings); elastohydrodynamic lubrication; boundary EP/anti-wear additives; and lubricant rheology; Indian context — lubricant R&D at IOC, HPCL, Castrol India and Shell India competing globally, with lubricant/grease selection a daily Indian-OEM decision.

Module 5 · Tribology of Machine Elements

Tribology applied to real components — rolling bearings (Hertzian/EHL contact, cage friction, rolling-contact fatigue and ISO 281 L10, failure modes including spalling and EV-motor electric-erosion, and grease-versus-oil lubrication); gears (combined rolling and sliding, EHL/boundary mixed regime, and pitting/scuffing/bending-fatigue failure per ISO/AGMA with EP gear oils); cams

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and tappets (high-pressure reciprocating EHL/boundary contact and valve-train friction as a fuel-economy item); seals (lip and mechanical face seals with dynamic friction, wear and leakage); brakes; tyres; and hydraulics; Indian context — every Indian-OEM engineer designs at least one such tribosystem, with SKF, Schaeffler, Timken and IOC R&D spanning them all.

Module 6 · Surface Engineering, Condition Monitoring & Indian-OEM Capstone

Engineering the surface and watching it live — surface engineering (low- friction hard DLC coatings for valve- trains and EV bearings; nitriding/ carburising case- hardening, HVOF/ plasma thermal spray, PVD TiN/ CrN/ TiAlN tool coatings, laser surface texturing creating EHL micro- reservoirs, cold- spray/ laser- cladding restoration, and shot- peening); condition monitoring of lubricants and tribosystems; a capstone; the modern frontier of AI oil analysis, acoustic- emission tribo- monitoring, nano/ bio-tribology and EV-specific tribology; Indian deployment — tribology demand grows with EVs, wind and smart-factory monitoring, with IOC, HPCL, Castrol and Shell India employing thousands of tribology engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Hutchings I., Shipway P.	Tribology: Friction and Wear of Engineering Materials (Butterworth-Heinemann)
2	Stachowiak G.W., Batchelor A.W.	Engineering Tribology (Butterworth-Heinemann)
3	Bhushan B.	Introduction to Tribology / Modern Tribology Handbook (Wiley)
4	Johnson K.L.	Contact Mechanics (Cambridge)
5	Hamrock B.J., Schmid S.R., Jacobson B.O.	Fundamentals of Machine Elements (McGraw-Hill)

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26UC5302E Placement Training and Professional Readiness

Acronym: PTPR L-T-P-S: 0-0-0-3 Credits: 0 CH: 3 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Solve algorithmic problems at LeetCode Medium- Hard level under interview time pressure with optimal complexity analysis.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO2	Design distributed systems at scale covering capacity estimation, data partitioning, and caching.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M)
CO3	Deliver structured behavioral interview responses using STAR/ SBI/ CAR frameworks with quantified outcomes and learning narratives.	4 · Analyse	PO1(H), PO2(L), PO3(M), PO4(M)
CO4	Negotiate compensation packages using market- data evidence and BATNA analysis.	4 · Analyse	PO1(H), PO2(M), PO3(M), PO4(M)
CO5	Build and execute a placement strategy.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO6	Demonstrate domain- specific interview readiness in their M.Tech specialisation at hiring-bar quality.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(L)

MODULE-WISE SYLLABUS

Module 1 · DSA Refresher & Coding Interview Engineering

Pattern-based data structures and algorithms — sliding window, two pointers, fast-slow, monotonic stack, prefix sums, intervals, BFS/ DFS, topological sort, union- find, segment tree, binary indexed tree, and dynamic- programming patterns (knapsack, LIS, LCS, matrix-chain, partition, state-machine); complexity analysis and edge cases; coding-interview communication — talk before code, clarifying questions, dry-run walkthrough, test before submit.

Module 2 · System Design Interview Engineering

Capacity estimation (back-of-envelope); functional and non-functional requirements; API design and data modelling; scaling — load balancers, caches (Redis, Memcached), CDN, sharding, replication, message queues (Kafka, RabbitMQ); consistency trade-offs (CAP, PACELC); common designs — URL shortener, Twitter, Uber, WhatsApp, Netflix, Dropbox, payment gateway, stock exchange; observability and bottleneck analysis; and communicating design trade-offs clearly under time pressure.

Module 3 · Behavioral Interviews

Frameworks — STAR (situation-task-action-result), SBI (situation-behavior-impact), CAR (context-action-result); a story bank of eight to ten polished stories covering leadership, conflict, failure, learning, ambiguity, deadlines, customers, ethics; company-specific behavioural patterns (Amazon Leadership Principles, Google Googleyness, Meta move-fast, Microsoft growth-mindset); reverse interviews — questions to ask the company; authenticity and reflection; and conveying impact with concrete, quantified outcomes.

Module 4 · Compensation Negotiation

Compensation components — base, RSU/ESOP (vesting cliff and schedule), sign-on, relocation, performance bonus, retention; market- data sources — Levels.fyi, Blind, AmbitionBox, Glassdoor; BATNA and using multiple offers as leverage; the four- step playbook (delay, anchor, justify, mutual gain); recruiter dynamics; counter- offer scripts; common mistakes and how to avoid them; and knowing when to accept, counter or walk away.

Module 5 · Career Strategy & Networking

Company prioritisation — tier mapping, role fit, growth trajectory; application sequencing — the interview-readiness curve, dry-run companies first; recruiter outreach — cold- email templates, LinkedIn DMs, alumni reach- out; networking — informational interviews, hackathons, meetups, open-source contributions for visibility; referrals — how to ask and how to give back; reading the market — labour-market data, Levels trends, hiring slow-downs; long-term career planning.

Module 6 · Domain-Specific Interview Mastery

Specialisation-track interview prep — for CSE/AIDS/CYS: ML system design, RAG/LLM engineering, infrastructure deep-dives; for CTM/ STR: project portfolio, drawings review, BIM/ structural- design walkthrough; for MD/ RA: CAD portfolio, finite- element simulations, hands- on demos; for PEPS/ VLSI/ EMB: circuit walkthrough, simulation results, hardware demos; for BT: lab notebook, SOP defence, scientific reasoning; company- specific deep- dives on what each tier-1 firm actually asks; mock interviews and feedback.

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REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	McDowell G.	Cracking the Coding Interview (6th ed., CareerCup)
2	Xu A.	System Design Interview Vol 1 + Vol 2 (Byte Code LLC)
3	Martin K.	Designing Data-Intensive Applications (O'Reilly, 2017)
4	Bock L.	Work Rules! (Twelve, 2015)
5	Voss C.	Never Split the Difference (Random House, 2016)

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Trimester 4

26MD6112E Reliability and AI Predictive Maintenance

Acronym: RAPM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse reliability fundamentals and maintenance strategy.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer reliability analysis tools covering FMEA/ FMECA per MIL- STD-1629 and SAE J1739 and Markov and Monte Carlo simulation.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO3	Engineer condition monitoring technologies covering vibration analysis, acoustic emission, and oil analysis and wear debris monitoring.	5 · Create	PO1(M), PO2(M), PO4(M), PO5(H), PO6(M)
CO4	Engineer signal processing for fault diagnosis.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer ML/ AI for predictive maintenance covering anomaly detection, classification, and RUL prediction.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer digital twins and Indian capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Reliability Fundamentals & Maintenance Strategy

The maintenance maturity ladder — the bathtub curve (infant- mortality, constant- hazard useful- life, and wear- out regimes); reliability metrics (R(t), failure density, hazard rate, MTBF/ MTTF/ MTTR, and availability); life distributions (memoryless exponential, the universal Weibull whose shape parameter spans all bathtub regions, lognormal, normal) with MLE and censored- data estimation; and maintenance strategies (run- to- failure corrective, time- based preventive, condition- based, ML-driven predictive, the strategic Reliability-Centred Maintenance per SAE JA1011, risk-based, and Japanese TPM); Indian context
— asset-intensive Indian heavy industry (Tata Steel, JSW, Reliance, IOC, BHEL, NTPC, Indian Railways) spends 10-15% of revenue on maintenance, making AI-PdM the highest-ROI digital transformation.

Module 2 · Reliability Analysis Tools (FMEA, FTA, RBD, Monte Carlo)

Quantifying and understanding system reliability — FMEA (systematically ranking failure modes by severity, occurrence and detection into a Risk Priority Number, with design and process variants per the AIAG-VDA handbook, the automotive/aerospace workhorse); FTA (top-down deductive fault trees with AND/OR gates, minimal cut sets, for safety-critical nuclear, aerospace and chemical LOPA); RBD (series, parallel and k-out-of-n reliability block diagrams); Markov chains for multi-state repairable systems; and Monte Carlo simulation; Indian context — FMEA is mandatory in Indian automotive (Bosch India, Tata Motors, Mahindra under IATF 16949), medical-device and aerospace, with FTA at BHEL, NPCIL and ISRO.

Module 3 · Condition Monitoring Technologies

The senses of predictive maintenance — vibration analysis (the dominant technique for rotating equipment via bearing-housing accelerometers, spectrum and orbit); acoustic emission (high- frequency stress- waves for ultra- early crack and spalling detection); oil analysis and wear- debris monitoring (particle counting, ferrography, spectroscopy, deeply linked to tribology); infrared thermography (non-contact hotspot detection in electrical, bearings and motors); airborne ultrasonic (leak and electrical-arc detection); motor-current signature analysis (rotor-bar and eccentricity faults from current alone); and sensor/DAQ architecture; Indian context — Indian heavy industry (Tata Steel, Reliance, IOC, BHEL, NTPC) deploys condition monitoring at scale via SKF, Emerson AMS, Bently Nevada and Bruel & Kjaer.

Module 4 · Signal Processing for Fault Diagnosis

From raw signal to diagnosis — the FFT spectrum (revealing rotation harmonics, bearing- fault frequencies, gear- mesh and resonances); order tracking (resampling by shaft angle for variable- speed wind, auto and railway machines); envelope demodulation (Hilbert- transform extraction of bearing- fault frequencies BPFO/ BPFI/ BSF/ FTF buried in the raw spectrum, the bearing- diagnosis workhorse); STFT spectrograms and wavelets for non- stationary and impulsive events; cepstrum for gear sideband families; and specific fault signatures; Indian context — everyday practice at Tata Steel, Reliance, IOC, BHEL, Indian Railways and Integral Coach Factory condition-monitoring teams.

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Module 5 · ML/AI for Predictive Maintenance

From rules to learning — why ML for PdM (massive multi- channel time- series and complex fault interactions defeat manual rules); the data pipeline (sensor-to-edge-to-cloud collection, preprocessing and feature extraction, labelling, and train/val/test); anomaly detection for unlabelled new assets (One- Class SVM, Isolation Forest, autoencoder reconstruction error); fault classification (Random Forest/XGBoost on features, CNNs on spectrograms, 1D-CNN/LSTM on raw series); remaining-useful-life prediction; transfer learning for data-scarce Indian assets; explainable AI; and MLOps; Indian context — the Indian industrial-AI ecosystem (TCS, Siemens MindSphere India, GE Digital, APM startups) deploys AI-PdM at Tata Steel, Reliance, IOC and Indian Railways at scale.

Module 6 · Digital Twins, APM Platforms & Indian Capstone

From models to integrated maintenance operations — the digital twin (a virtual asset continuously synchronised via IoT, in descriptive, predictive and prescriptive forms); the reference architecture (sensors to edge to cloud ingestion via MQTT/OPC-UA, data lake, physics/ ML models, visualisation, and CMMS work- order creation); digital- twin platforms; CMMS integration and standards; a capstone; the modern frontier of generative- AI maintenance assistants, drone inspection and AR/ VR; Indian deployment — one of India's highest- ROI transformations, massively deployed at Tata Steel, Reliance, IOC, BHEL, NTPC, Tata Power, Indian Railways and L&T Heavy.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Ebeling C.E.	Introduction to Reliability and Maintainability Engineering (Waveland)
2	Smith A.M., Hinchcliffe G.R.	RCM Gateway to World-Class Maintenance (Butterworth-Heinemann)
3	Mobley R.K.	Introduction to Predictive Maintenance (Butterworth-Heinemann)
4	Randall R.B.	Vibration-based Condition Monitoring (Wiley)
5	Lei Y.	Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery (Butterworth-Heinemann)

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26MD6111E Composite Structures Engineering and Manufacturing

Acronym: CSEM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the composite- materials landscape covering fibres and matrices, composite forms, and Indian aerospace.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer micromechanics and Classical Laminate Theory.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer failure criteria and design covering strength, first-ply failure vs last-ply, and progressive damage analysis and design margins.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO4	Engineer composite manufacturing covering hand layup, wet layup, and spray-up.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer joining, bonding, repair, and NDE.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO6	Engineer sandwich/special structures and Indian capstone.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Composite Materials Landscape

What goes into a composite — fibres (high- modulus carbon T700/ T800/ IM7 for aerospace/ auto/ wind from Toray and Hexcel with emerging Indian capacity, cheap E- glass and stronger S- glass for wind/ marine, impact/ ballistic aramid Kevlar, emerging natural jute/bamboo/flax, and high-temperature SiC ceramic; in continuous-tow, woven, non-crimp and chopped forms); matrices (dominant thermoset epoxy at 90% of aerospace, vinyl-ester for wind blades, polyester, high-T BMI, low-moisture cyanate-ester for satellites, and emerging recyclable thermoplastic PEEK/ PPS/ PEI); and composite forms; Indian context — the HAL composite shop (Tejas/ ALH), ISRO VSSC (PSLV/ GSLV fairings and interstages), Tata Advanced Materials (Boeing/ Airbus components) and Suzlon/LM Wind/Vestas blades.

Module 2 · Micromechanics & Classical Laminate Theory (CLT)

The analytical foundation — micromechanics (predicting ply properties from fibre, matrix and volume fraction via the rule of mixtures and Halpin- Tsai, with typical Vf 60% aerospace to 30% auto); the orthotropic lamina (four in- plane constants E1, E2, G12, nu12 with fibre-dominant E1 and matrix- dominated E2/ G12, and the reduced- stiffness Q matrix transformed for off- axis plies); Classical Laminate Theory; laminate design; and hygrothermal residual stress; Indian context — CLT is the everyday tool at HAL, ISRO, Tata Advanced Materials, Boeing/Airbus India and wind-blade design at Suzlon/LM Wind/Vestas.

Module 3 · Failure Criteria & Design

When a composite fails — strength values (fibre- dominated longitudinal tension and compression, weak matrix- dominated transverse tension, transverse compression, and in-plane shear); failure criteria (simple non-interactive Maximum Stress/Strain, quadratic Tsai-Hill and the Tsai-Wu workhorse with tension-compression coupling, the physically-meaningful Hashin separating fibre and matrix modes as the modern aerospace standard, and the most-physical Puck Airbus standard); first-ply versus last-ply/ ultimate failure; design margins (margin of safety, A/ B- basis allowables per MIL- HDBK-17, environmental and impact knockdowns); and progressive damage modelling; Indian context — HAL, ISRO and Boeing/Airbus India teams use Tsai-Wu and Hashin/Puck under AS9100 quality and DGCA/EASA/FAA certification.

Module 4 · Composite Manufacturing

How composites are actually made — hand/wet layup and spray-up (low-cost, large parts, wind and marine); VARTM (dry fabric under vacuum with infused resin, the dominant wind- blade method); RTM (closed- mould injection, automotive); autoclave prepreg; out- of-autoclave prepreg; filament winding; pultrusion; automated tape- laying and fibre- placement; thermoplastic forming; and 3D- printed continuous- fibre composites; with void, porosity and cure quality control; Indian context — HAL, ISRO and Tata use autoclave and emerging ATL/AFP, with giant VARTM wind blades at Suzlon, LM Wind and Vestas, and automotive composites at Mahindra and Tata Motors.

Module 5 · Joining, Bonding, Repair & NDE

Connecting and maintaining composites — mechanical joining (the inevitable bolted interface to metal, with more- severe hole stress concentration, bearing failure, edge- distance and bushing design factors, and titanium Hi- Lok fasteners); adhesive bonding (preferred composite-to-composite via epoxy film adhesives with critical surface preparation, co-cure versus secondary

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bonding); composite repair (scarf repair tapering ply-by-ply to restore 80-95% strength, step repair and bonded patches per the Structural Repair Manual, an MRO industry); NDE; and damage tolerance and certification; Indian context — HAL composite repair and MRO (Tejas, ALH), GMR Aero and Air India MRO, with NDE per ISO 9712 and ASNT.

Module 6 · Sandwich, Special Structures & Indian Capstone

Sandwich and integrated applications — sandwich structures (thin stiff face sheets over a low-density core acting like an I-beam, with Nomex/ aluminium honeycomb, PVC/ PMI/ PUR foam and balsa cores, and failure by face wrinkling/ dimpling, core shear/ crushing and debonding); special applications; a capstone; the modern frontier of AI/ topology- optimised composites, closed-loop AFP, 3D-printed continuous-fibre, recyclable thermoplastic and bio-based composites; Indian deployment — among India's strongest aerospace specialisms at HAL, ISRO, Tata Advanced Materials, Mahindra Aerospace, Boeing/Airbus India, Suzlon/LM Wind and the Indian Navy, growing rapidly under Make in India.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Mallick P.K.	Fiber-Reinforced Composites: Materials, Manufacturing, and Design (CRC Press)
2	Daniel I.M., Ishai O.	Engineering Mechanics of Composite Materials (Oxford)
3	Jones R.M.	Mechanics of Composite Materials (CRC Press)
4	Reddy J.N.	Mechanics of Laminated Composite Plates and Shells (CRC)
5	Strong A.B.	Fundamentals of Composites Manufacturing (SME)

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Trimester 5

26IE6202E Capstone Research / Industry Project – Phase I

Acronym: CAP1 L-T-P-S: 0-0-36-0 Credits: 12 CH: 36 Pre-requisite: RMIP

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Identify and scope a substantial research or industry problem suitable for a 6-month sustained engineering investigation.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(L)
CO2	Conduct comprehensive literature survey or competitive analysis to position the proposed work against current state-of-the-art.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO3	Design system architecture, methodology, and experimental setup with rigorous justification of every design choice.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M)
CO4	Implement a functional baseline that demonstrates feasibility of the approach with measurable preliminary results.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO5	Evaluate baseline against established benchmarks.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO6	Defend Phase-I work to a panel of academic and industry reviewers with a clear roadmap for Phase-II.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Problem Identification & Scoping

Source streams — faculty research labs, industry partnerships (KL corporate MoUs), open- source needs (LangChain/ HuggingFace/ vLLM issues), product gaps and startup ideas; scoping — six- month feasibility, dissertation- worthiness, defensibility, novelty; stakeholder alignment — supervisor, industry mentor, IPR cell; milestone planning — the Phase-I and Phase-II split; framing a clear, answerable research or engineering question.

Module 2 · Literature Survey / Competitive Analysis

For the research track — PRISMA systematic review, citation-graph traversal, identifying seminal versus recent versus adjacent work; for the industry track — competitive analysis of existing products, services and open-source projects, gap analysis, market positioning; identifying the closest three to five prior works the dissertation must outperform; synthesising the state of the art into a defensible baseline.

Module 3 · System Design & Methodology

System architecture — high- level diagram, component breakdown, interface design; methodology — algorithms, training procedures, evaluation protocols; data plan — sources, licensing, ethics; tooling and infrastructure decisions; risk register — what could fail and mitigations; reproducibility plan — commitments to open data, open code and open models; success criteria and evaluation metrics.

Module 4 · Baseline Implementation

Implement the first working version end- to- end — even if simple, it must demonstrate the full pipeline; set up a reproducible training/ inference pipeline; instrument with logging, telemetry and evaluation; establish baseline metrics; code quality — type hints, tests, CI/ CD; containerise for portability; document setup so a reviewer can reproduce results in thirty minutes; version control and experiment tracking.

Module 5 · Baseline Evaluation

Evaluate the baseline against the benchmarks established in the survey; quantitative metrics with statistical-significance testing; qualitative analysis — error categories and failure modes; ablation study — the contribution of each component; a comparative table against prior art; identifying the gaps that Phase II will close; documenting limitations and threats to validity.

Module 6 · Phase-I Defense

A 20- minute presentation to a panel of two to three reviewers (academic supervisor, industry mentor, external faculty); cover problem motivation, literature positioning, methodology, baseline implementation, results and the Phase- II plan; question- and-answer demonstrating depth on every aspect; receiving structured feedback for Phase-II refinement; the decision — pass, pass-with-revisions, or restructure Phase-II; defining clear Phase-II objectives.

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REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Strunk W. & White E.B.	The Elements of Style (4th ed.)
2	Kleppmann M.	Designing Data-Intensive Applications (O'Reilly, 2017)
3	Goodfellow I. et al.	Deep Learning (MIT Press, 2016)
4	Patterson D. & Hennessy J.	Computer Architecture: A Quantitative Approach (6th ed.)
5	Domain-specific dissertation guides per program (e.g., 'Writing for Computer Science'	Zobel, for CSE/AIDS)

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Trimester 6

26IE6303E Capstone Research / Industry Project – Phase II

Acronym: CAP2 L-T-P-S: 0-0-36-0 Credits: 12 CH: 36 Pre-requisite: CAP1

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Implement the full system or methodology beyond Phase- I baseline, incorporating novel contributions that advance the state-of-the-art.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(M)
CO2	Conduct comprehensive evaluation covering benchmark comparisons, ablations, and error analysis.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)
CO3	Produce a dissertation- grade thesis document following IEEE/ ACM/ Springer or institutional format.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO4	Submit a publishable paper to a peer- reviewed venue OR file a patent disclosure OR ship a product feature OR open-source a substantial library.	5 · Create	PO1(L), PO2(H), PO3(M), PO4(M)
CO5	Defend the dissertation to an external-examiner panel demonstrating mastery of every technical and methodological choice.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)
CO6	Translate the dissertation into a placement / PhD- application / startup- pitch artifact suite.	5 · Create	PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Full System Implementation & Novel Contributions

Build beyond the Phase- I baseline; implement the novel contribution — a new algorithm, architecture, analysis, or product feature; integrate components into a polished end- to- end system; performance- tune for production- grade quality; stress- test against edge cases; code quality at staff-engineer level; maintain reproducibility, documentation and version control throughout; and engineering the system for maintainability and extension.

Module 2 · Comprehensive Evaluation

Go beyond Phase-I evaluation; multiple benchmarks — established plus dissertation-specific; ablation studies quantifying every design choice; error analysis — a taxonomy of failure modes; robustness — adversarial inputs, distribution shift, edge cases; fairness analysis where applicable; the cost- performance frontier; reproducibility cross- check by an independent third party; statistical rigour throughout; and reporting results with full honesty about limitations.

Module 3 · Dissertation Writing

The full dissertation document (60-100 pages); structure — abstract, introduction, related work, methodology, implementation, evaluation, discussion, conclusion, future work, references, appendices; the narrative arc telling the story of the work; figures and tables that each earn their place; consistent, correct mathematical notation (LaTeX); citation discipline; plagiarism check; rounds of supervisor review and revision; clarity, rigour and academic style.

Module 4 · External Output — Paper / Patent / Product / OSS

Translate the dissertation into one or more external outputs — a paper submitted to a peer- reviewed venue (workshop, conference, journal); a patent disclosure filed with the IPR cell, optionally via the PCT route; a product feature shipped to production at an industry partner; or an open- source library published with documentation, examples and community engagement; the outcome is real — visible, reviewable and citable.

Module 5 · Final Dissertation Defense

A 30- minute presentation to a panel of supervisor, industry mentor (where applicable), an external examiner from a different institution, and one to two internal faculty; the panel reviews the dissertation, evaluation report and external output before the defence; question-and-answer covering methodology depth, alternative design choices, limitations and future work; the decision
— pass, pass-with-revisions, pass-with-major-revisions, or fail; the external examiner's evaluation is binding.

Module 6 · Translation to Career Artifacts

Translate the dissertation into career-leverage artifacts; for placements — an arXiv preprint, demo video, GitHub repo with stars, and a blog post explaining the work; for PhD applications — a research statement, reference letters, a paper preprint, and a statement of purpose; for startup founding — a pitch deck, business plan, market sizing, technical demo, and IP strategy; the

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dissertation is the launch pad, not the destination.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1		Same Phase-I books continued
2		Domain-specific deep dives selected with supervisor
3		Strunk W., White E.B., The Elements of Style, 4th ed.
4		Patterson D., Hennessy J., domain architecture references
5		Author / first-author papers in the dissertation area (40-60 papers cited in dissertation)

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7 · Professional Electives

Stream A · Vehicle and Mobility Design

Automotive, EV, vehicle dynamics and aerial-vehicle mechanical design.

26MD52A1E Automotive Vehicle Design

Acronym: AVED L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the modern automotive architecture covering BIW and chassis and powertrain integration.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer vehicle packaging, ergonomics, and occupant accommodation.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer crashworthiness and occupant protection covering frontal/side/rear/ rollover.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer aerodynamics and thermal management covering cooling, brake, and battery.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer lightweighting, materials, and manufacturing covering high-strength, UHS steel, and aluminium.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO6	Engineer vehicle-integration capstone covering packaging, crash, and aero.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Automotive Architecture & Development Process

Vehicle architectures — body- on- frame (SUVs and pickups like the Mahindra Thar and Tata Safari), the modern- dominant unibody (Maruti, Hyundai, Tata Nexon), and spaceframe; powertrain layouts (FWD/ RWD/ AWD, ICE, hybrid, BEV skateboard, FCEV); and platform sharing (Tata ALPHA, Maruti Heartect, VW MQB); the development process (a modified V-model stage-gate from concept through packaging, styling freeze, engineering, verification and validation to production, on CAD/ CAE/ PLM via Teamcenter and 3DEXPERIENCE); and development KPIs (weight, cost, performance, safety, emissions, drive quality, NVH); Indian context — 3-5- year Indian OEM cycles at Tata Motors, Mahindra, Maruti, Bajaj, TVS and Ashok Leyland on Indian platforms.

Module 2 · Vehicle Packaging, Ergonomics & Occupant Accommodation

Packaging fits everyone and everything in the smallest envelope while meeting comfort and regulation — the H-point occupant reference (per SAE J1100 and ECE R17) defining layout, with ingress/egress and fore-aft/vertical/lateral zones; anthropometry (5th-percentile female to 95th-percentile male, Reichert manikins); visibility (A-pillar obscuration and mirror vision per ECE R46, blind spots and sensor placement); reach and controls; approach/ departure/ breakover angles; and HVAC thermal comfort; Indian context — Indian- population anthropometry (IIT/ CRRI databases), high ground- clearance demand, and rear- seat/ chauffeur comfort emphasis at Maruti, Mahindra and Tata, with RAMSIS at Tata, Mahindra and Bosch India.

Module 3 · Crashworthiness & Occupant Protection

Saving lives via controlled energy management — crash modes (frontal full and 25% small- overlap, oblique, side pole, rear, rollover, and pedestrian); the energy-management strategy (front rails and crumple zones, a rigid passenger cell, boron-steel B-pillars and door beams, rollover roof); restraints (three-point belts with pretensioners and load limiters, front/side/curtain/knee airbags, ISOFIX); injury criteria (HIC below 1000, chest deflection, Nij neck, via Hybrid III and WorldSID dummies); explicit-FEM CAE; and regulations; Indian context — Bharat NCAP (launched 2023) rapidly elevating standards, with 5- star Tata Nexon EV, Punch and Mahindra XUV300, tested at ARAI and iCAT.

Module 4 · Aerodynamics & Thermal Management

Moving and cooling a vehicle efficiently — aerodynamics (drag coefficient targets of 0.25-0.30 with EVs pushing below 0.22 for range, via RANS/DES CFD in STAR-CCM+, Fluent and OpenFOAM with wind-tunnel validation, underbody smoothing, diffusers, active grille shutters, and lift/crosswind stability); and thermal management; with aero and thermal interacting at the front-end

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aperture; Indian context — severe Indian- climate thermal loads (high ambient, monsoon humidity, dust) driving over- specified cooling at Tata, Mahindra, Maruti and EV makers, with ARAI/CRRI wind tunnels.

Module 5 · Lightweighting, Materials & Manufacturing

Lighter means better range, economy and performance — materials (the mild-steel to HSLA to advanced-high-strength AHSS to boron- steel hot- stamping progression, aluminium sheet and extrusion for premium bodies, magnesium, carbon- fibre composites, and plastic- composite hybrids); material selection per part (strength, stiffness, cost, formability, joinability, recyclability, Indian localisation); joining; tailor-welded and hot- stamped blanks; CAE- driven topology, size and shape optimisation for load paths; and manufacturing constraints; Indian context — Indian mills (Tata Steel, JSW, AMNS) supplying AHSS, with aggressive lightweighting under BS-VI, Bharat NCAP and CAFE-II, and emerging Hindalco aluminium sheet.

Module 6 · Vehicle Integration Capstone & Indian Regulatory

Putting it together — integration (simultaneous packaging, crash, aero, lightweighting, NVH, dynamics, powertrain, ADAS and manufacturing via CAE-led multidisciplinary optimisation); NVH (engine, road and wind noise and body/mount vibration via FE/ BEM in Nastran and Actran); manufacturing readiness and tolerance stack- up; the Indian regulatory landscape (AIS standards via ARAI/iCAT homologation, BS-VI and RDE emissions, Bharat NCAP, AIS-140 tracking, ABS/ESC/airbag mandates, CAFE-II, and EV- specific AIS-038/156 battery safety and CCS2 charging); the software- defined- vehicle frontier; and a capstone; Indian deployment — heavy investment in next-gen EVs, ADAS and connected vehicles at Tata, Mahindra, Maruti, Bajaj and TVS, with very high demand for integration engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Heisler H.	Advanced Vehicle Technology (Butterworth-Heinemann)
2	Genta G., Morello L.	The Automotive Chassis (Springer)
3	Davies G.	Materials for Automobile Bodies (Butterworth-Heinemann)
4	Hucho W.-H.	Aerodynamics of Road Vehicles (SAE)
5	Du Bois P.A. et al.	Crashworthiness Engineering (CRC)

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26MD53A2E Powertrain Engineering for EVs and Hybrids

Acronym: PTEV L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the EV/hybrid powertrain covering BEV and HEV and PHEV, FCEV, and range-extended.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer electric machines for traction covering PMSM and axial-flux.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer power electronics and drives covering 3- phase inverter, DC- DC converter, and on-board charger.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer Li-ion battery and pack design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer BMS, thermal management, and charging.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer e-axle integration and Indian capstone.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · EV & Hybrid Powertrain Architectures

Why electric — energy economics, emissions, grid evolution, and an 80%+ battery- cost decline; architectures (dominant full-battery BEVs like the Tata Nexon EV; parallel, series and power- split hybrids classified P0- P4 by motor placement, as in the Toyota Prius and Honda i-MMD; plug-in PHEVs; range-extended REEVs; and hydrogen FCEVs); the system architecture; and 400V versus 800V architecture; Indian context — the Indian EV revolution under FAME-II, PLI-Auto and PLI-ACC, AIS-156 safety and the Hydrogen Mission, with Tata leading and Mahindra, Ola, Ather, Bajaj and TVS scaling.

Module 2 · Electric Machines for Traction

Converting electricity to torque — PMSM (the dominant 95-97%- efficient traction motor in Tata Nexon EV, Ola and Tesla 3/ Y, using embedded rare-earth NdFeB magnets and hairpin windings, with an Indian rare-earth dependency); induction motors (rare-earth-free and robust, as in Tesla S/X); switched-reluctance motors (rare-earth-free and cheap but high torque-ripple and noise); emerging high- torque- density axial-flux and unsprung- mass hub motors; cooling (air versus liquid/ oil- spray/ immersion); materials (low-loss silicon electrical steel, hairpin copper, and heavy-rare-earth-reduced magnets); and design; Indian context — Indian EV-OEM motor design at Tata, Mahindra (Valeo), Ola and Ather, with machine R&D at IIT-Madras/Bombay and IISc.

Module 3 · Power Electronics & Motor Control

Converting and controlling — the traction inverter (a three-phase bridge turning DC to AC, using mature cheap Si-IGBTs versus faster lower-loss SiC MOSFETs for premium 800V EVs and emerging GaN for OBC/DC-DC, in 2-level or 3-level topologies, sized by DC-link voltage, peak current and junction-temperature cooling via liquid cold plates); the DC-DC converter and bidirectional on-board charger (with emerging V2G/V2L); and motor control; Indian context — Bosch, Continental, ZF and Mahle India inverter design, Indian startups and in-house Tata/Mahindra, with power-electronics R&D at the IITs.

Module 4 · Li-ion Battery & Pack Design

The heart of the EV — cell chemistries (energy-dense NMC/NCA in most EVs, cheaper safer longer-life LFP dominant in mass-market and favoured by Indian PLI- ACC, emerging LMFP and sodium- ion, and future solid- state); cell formats (cylindrical 18650/21700/4680, prismatic BYD blade, and pouch); cell-to-pack and cell-to-chassis designs eliminating modules for 15-25% density gain (BYD blade, Tesla 4680 structural pack); pack design (series/ parallel arrangement, busbars, liquid/ immersion cooling, and safety via fuses, pyro- disconnect and thermal- propagation barriers); and AIS-156; Indian context — battery localisation under the 18,100-crore PLI-ACC (Tata BatteryWorks, Reliance New Energy, Ola Cell, Amara Raja, Exide) amid lithium/ rare-earth dependency.

Module 5 · BMS, Thermal Management & Charging

Smart battery operation — the BMS (the pack's brain monitoring cell voltages, temperatures and currents; estimating State of Charge via coulomb- counting/ OCV/ Kalman, State of Health and State of Power; cell balancing; safety monitoring; and CAN communication, in distributed or centralised architecture under ISO 26262 ASIL- C/ D); battery thermal management (keeping cells at 20-40C via air for two-wheelers, dominant liquid cold- plate, emerging immersion, and refrigerant/ heat- pump systems that also heat the cabin and save range); and DC fast- charging; Indian context — rapid charging- infrastructure growth (Tata

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Power EZ, Statiq, ChargeZone), Indian V2G pilots, and battery-localisation-driven BMS R&D.

Module 6 · E-Axle Integration & Indian EV Capstone

Putting it together — the e- axle (integrated motor, co- packaged inverter, single- or multi- speed reducer, differential and half-shafts, from Bosch, ZF, Schaeffler and Magna, reducing weight and cost); single- versus multi- speed transmissions (single sufficient for most EVs, multi-speed for high- performance and heavy trucks); hybrid architectures and control (Toyota power-split, series REEV, parallel and 48V mild-hybrid, with rule-based, ECMS, DP and ML energy management); vehicle integration; the Indian EV regulatory ecosystem; and a capstone: Indian deployment — Tata leading with 70%+ share, alongside Mahindra BE 6e/9e, Maruti eVX, Ola, Ather, Bajaj and TVS.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Larminie J., Lowry J.	Electric Vehicle Technology Explained (Wiley)
2	Husain I.	Electric and Hybrid Vehicles: Design Fundamentals (CRC)
3	Plett G.	Battery Management Systems (Vol 1 & 2, Artech)
4	Krishnan R.	Electric Motor Drives (Prentice Hall)
5	Mohan N., Undeland T., Robbins W.	Power Electronics (Wiley)

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26MD61A3E Vehicle Dynamics and Suspension Design

Acronym: VDSD L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, MVIB

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse vehicle dynamics fundamentals covering tire- road interface as primary force generator, ride, and handling.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer tire mechanics covering slip angle, slip ratio, and tire force generation.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer suspension and ride dynamics covering McPherson, double-wishbone, and multi-link.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer handling dynamics and stability covering bicycle and 4- wheel handling model, understeer/oversteer and slip-angle, and roll and lateral load transfer.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer brake and steering systems covering brake hydraulics, regenerative blending, and brake-by-wire.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO6	Engineer chassis-tuning capstone covering virtual and physical tuning using CarMaker, ADAMS Car, and VI-Grade.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Vehicle Dynamics Fundamentals

The 6-DOF view — vehicle-body degrees of freedom (longitudinal, lateral and vertical translations plus roll, pitch and yaw) across coupled ride, handling and longitudinal subsystems; coordinate systems (ISO and SAE conventions); the tire as the primary force generator through four hand-sized contact patches; and the integrated body-chassis-suspension-steering-brake-tire system with its mass, inertia, CG and roll axis; Indian-road context — variable and often poor surfaces, monsoon potholes as the suspension-dimensioning load case, and speed- breakers driving Indian- tuned dynamics at Tata, Mahindra and Maruti; and how EVs shift dynamics (heavier low-CG battery floors, instant torque, regen, low NVH) demanding EV-specific tuning.

Module 2 · Tire Mechanics & Pacejka Magic Formula

The tire is the foundation — construction (radial versus bias, tread, sidewall, steel- belt and carcass, the size code, and rolling versus dynamic radius); slip (longitudinal slip ratio and lateral slip angle); force generation (longitudinal, lateral and self-aligning moment saturating at moderate slip, and the combined-slip friction circle critical for ABS/ESC); the industry-standard Pacejka Magic Formula (MF-Tyre with B/C/D/E parameters per load, camber and inflation); the tire-model hierarchy; and flat-track and drum testing; Indian context — a world-class Indian tire industry (MRF, Apollo, JK, CEAT with significant R&D), where tire-vehicle matching is a critical Indian-tuning skill.

Module 3 · Suspension Types & Ride Dynamics

Isolating the body from the road — suspension types (common McPherson strut, double- wishbone, modern multi- link, cheap torsion-beam, off-road 5-link rigid axle, commercial leaf spring, air-spring, and semi-active/active dampers); geometry (camber, caster, toe, kingpin, roll-center height, anti- dive and anti- squat, the last critical for EV regen); springs and dampers (coil/ leaf/ torsion/air, twin-tube versus monotube, and low/high-speed valving); ride models (the canonical 2-DOF quarter-car, half-car and 7- DOF full- car under ISO 8608 road inputs); metrics; and sky- hook semi- active damper tuning; Indian context — pothole and speed- breaker robustness and tropical durability making ride- tuning a differentiator, with Tenneco India and Tata/ Mahindra/ Maruti chassis teams.

Module 4 · Handling Dynamics & Stability

How the vehicle corners — the canonical 2- DOF bicycle model (front/ rear slip angles, cornering stiffness and CG distribution giving the understeer gradient, with characteristic and critical speeds); the 4-wheel model adding load transfer, roll and nonlinear tires; cornering performance (steady- state lateral- acceleration diagrams and transient sine- with- dwell yaw response); roll dynamics (roll stiffness, lateral load transfer and anti-roll-bar tuning controlling understeer balance); brake-handling interaction; and electronic controls; with rollover mitigation for SUVs; Indian context — variable- surface handling and Bharat NCAP 5- star demanding ESC, supplied by Bosch and Continental India, with evolving Indian-OEM chassis tuning.

Module 5 · Brake & Steering Systems

Stopping and steering — brake systems (front discs and rear discs/ drums, master cylinder and vacuum/ electric booster, ABS modulator, and floating/fixed calipers); brake-force distribution (electronic EBD); EV regenerative-braking blending (motor regen

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for 60-80% of energy with cooperative ABS and brake- by- wire via Bosch IPB and Continental MK C2); brake- fade cooling and monsoon recovery; steering systems; and advanced steering; Indian context — Bosch, Continental, ZF and Brembo India braking and JTEKT/Mando/ZF steering, with a transition to EPS and by-wire in Indian premium vehicles.

Module 6 · Chassis Tuning, Simulation & Indian Capstone

Putting it all together — virtual prototyping (full- vehicle multibody in the dominant IPG CarMaker and ADAMS Car, VI- Grade driving simulators and dSPACE HIL, running skid- pad, slalom and sine- with- dwell scenarios correlated to test); K&C rig characterisation for parameter ID; proving- ground testing (NATRiP, iCAT, ARAI, Mahindra MRV, Tata ERC); the chassis- tuning workflow; ADAS-dynamics integration; Indian off-road strength (Mahindra Thar, Tata Safari, Maruti Jimny); the software-defined-vehicle frontier; and a capstone (a complete Indian- OEM chassis- tuning study with virtual, physical and ADAS- aware tuning); Indian context — Indian chassis tuning a growing differentiator at Tata, Mahindra and Maruti.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Milliken W., Milliken D.	Race Car Vehicle Dynamics (SAE)
2	Gillespie T.	Fundamentals of Vehicle Dynamics (SAE)
3	Pacejka H.	Tire and Vehicle Dynamics (Butterworth-Heinemann)
4	Reimpell J., Stoll H.	Automotive Chassis: Engineering Principles
5	Wong J.Y.	Theory of Ground Vehicles (Wiley)

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26MD61A4E Drone and UAV Mechanical Design

Acronym: DUMD L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse UAV configurations and Indian ecosystem.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer UAV aerodynamics and flight mechanics.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer airframe structural design covering composite, 3D- printed, and injection-molded polymer.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO4	Engineer propulsion and power covering BLDC out- runner motor, propellers, and Li-Po and Li-ion battery.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer payload integration and mission-specific design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO6	Engineer Indian drone capstone covering Drone Shakti, PM Drone Didi, and KISAN.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · UAV Configurations & Indian Drone Ecosystem

The configuration zoo — multirotors (dominant quad/ hexa/ octocopters, fully electric with excellent hover but limited 30-60-minute endurance, at 5-20kg MTOW); fixed- wing UAVs (miniature aircraft like DRDO Tapas- BH with far greater range and endurance but needing a runway and unable to hover); VTOL hybrids (tilt- rotor, tail- sitter, and the emerging- dominant lift- plus-cruise); and flapping-wing and airship variants; across mission classes (military ISR and strike, photography, delivery, agriculture, inspection, Smart City, and eVTOL passenger air mobility); Indian ecosystem — liberalised Drone Rules 2021 with Digital Sky zones, a Drone PLI, Drone Shakti proliferation, and the ideaForge/Garuda/ePlane industry making India the world's third-largest projected drone market.

Module 2 · UAV Aerodynamics & Flight Mechanics

Lift, propel and control — multirotor aerodynamics (momentum theory and Blade Element Theory for thrust and torque, figure-of-merit, ground effect, and rotor- wash interaction); fixed- wing aerodynamics (low- Reynolds- number Selig/ Eppler airfoils, lift and drag versus angle of attack and stall, wing planform and aspect ratio, and finite- wing induced drag and Oswald efficiency); stability and control (longitudinal pitch stability and tail volume, lateral dihedral effect, directional yaw, and phugoid/ short-period/Dutch-roll dynamic modes); tools (the XFOIL low-Re gold standard, AVL vortex-lattice, XFLR5, and OpenFOAM/Fluent for rotors); and performance; Indian context — foundational aero for Indian UAV design at DRDO, NAL and drone startups.

Module 3 · Airframe Structural Design

Lightweight and strong — materials (workhorse carbon- fibre composite for performance UAVs, cheaper glass- fibre, impact-resistant Kevlar for defence, aluminium 6061- T6, 3D- printed nylon/ carbon- filled for prototypes and light production, crash-tolerant foam, and injection-moulded consumer bodies); airframe types (frame-based multirotor, monocoque, composite shell); structural sizing (flight, maneuver, gust and hard-landing loads, payload mounting and vibration isolation, and crash/bird-strike); CAD (Solidworks, Fusion 360, CATIA); FEA (Abaqus, ANSYS, nTopology for static, modal, impact and buckling); topology optimisation; and component design; Indian context — carbon-composite airframes at ideaForge and premium Indian makers, with 3D-printing increasingly used by drone startups.

Module 4 · Propulsion & Power

Thrust and endurance — the BLDC out-runner motor (direct-drive with a Kv rating sized to thrust, propeller, voltage and current at 85-93% efficiency); the ESC (a three- phase inverter with PWM/ DShot protocols and BLHeli32/ AM32 firmware); propellers (diameter and pitch, 2- versus 3- blade trading endurance against thrust, carbon/ plastic materials, and critical balancing); batteries (high-power-density LiPo versus higher-energy Li-ion NMC for endurance, cell configuration, C-rate, and 30-50% of UAV mass with monitoring and thermal safety); fixed-wing/hybrid options; and propulsion sizing; Indian context — Li-ion heavy-lift at ideaForge and Garuda, with DRDO/IISc hydrogen-UAV and NAL solar-HALE programs.

Module 5 · Payload Integration & Mission-Specific Design

Mission-driven payloads — cameras (4K-8K RGB, thermal IR, 5-band multispectral for crop NDVI, and hyperspectral); LiDAR (DJI Zenmuse and Indian systems rapidly replacing photogrammetry for survey- grade 3D mapping); sprayers (10-30L agri- drone

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tanks with pumps, nozzles, application- rate and drift control, for the Garuda/ DJI Agras fleet under PM Drone Didi and KISAN drone); cargo delivery (quick-release drop mechanisms for medical and e-commerce, via Zomato, Garuda and ePlane); gimbals; retractable landing gear; CG management and quick-change modular payloads; and defence payloads; Indian context — mission-specific integration across the Indian agri, inspection, delivery and defence drone markets.

Module 6 · Indian Drone Capstone + DGCA + Drone Shakti

Indian regulation and manufacturing — DGCA Drone Rules 2021 (UIN registration, the Nano- to- Large weight categories, No-Permission-No- Take- off via Digital Sky, green/ amber/ red geofencing, the Remote Pilot Certificate, insurance, and BVLOS approval); type certification for medium/ large drones; the Drone PLI incentivising 30+ Indian OEMs; Drone Shakti proliferation; PM Drone Didi (15,000 women-led agri-drone enterprises with subsidy) and the KISAN drone and SVAMITVA mapping schemes; counter- drone systems (jamming, nets, interceptors at DRDO and the Army); the eVTOL/ UAM frontier (ePlane) and hydrogen/ solar UAVs; and a capstone; Indian context — a fast-growing liberalised ecosystem under Drone Shakti and PLI.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Austin R.	Unmanned Aircraft Systems: UAVS Design, Development and Deployment (Wiley)
2	Valavanis K., Vachtsevanos G.	Handbook of Unmanned Aerial Vehicles (Springer)
3	Anderson J.D.	Fundamentals of Aerodynamics (McGraw-Hill)
4	Etkin B., Reid L.D.	Dynamics of Flight (Wiley)
5	Leishman J.G.	Principles of Helicopter Aerodynamics (Cambridge)

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Stream B · Manufacturing and Industrial Engineering

Additive manufacturing, smart factory, generative design and precision engineering.

26MD52B1E Additive Manufacturing and Design for AM

Acronym: ADAM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, DEPL

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse AM process families and Indian ecosystem.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer Design for AM covering topology optimization, lattice and cellular structures, and part consolidation and assembly elimination.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer metal AM processes covering DMLS/ SLM, WAAM, and Binder Jetting.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer polymer and ceramic AM covering Material Jetting.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer AM materials, post-processing, and quality.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer Indian AM capstone and qualification.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · AM Process Families & Indian Ecosystem

AM builds a part layer-by-layer from a 3D model, in seven ASTM F2792 process families — material extrusion (low-cost FDM/FFF via Stratasys, Markforged and Indian bureaus), vat photopolymerisation (high- resolution SLA/ DLP for dental and jewelry), powder-bed fusion (polymer SLS and MJF, and the dominant metal DMLS/SLM via EOS, GE and Renishaw, plus EBM), material jetting (multi- colour PolyJet), binder jetting, sheet lamination, and directed- energy deposition; plus ceramic and concrete AM: Indian context — a strong ecosystem led by Wipro 3D (India's largest bureau, supplying HAL/ISRO), Intech DMLS, Imaginarium, in-house HAL/ISRO/DRDO/GTRE AM, and the CSIR-AMTC Hyderabad hub under Make in India.

Module 2 · Design for AM (DfAM)

DfAM unlocks AM's power — topology optimisation (Altair OptiStruct, nTopology and Ansys removing material within a design space, exemplified by GE's 855-parts-to-1 fuel nozzle); lattice and cellular structures (gyroid TPMS, octet-truss, Voronoi via nTop and Materialise Magics, for lightweighting, cooling and impact absorption); part consolidation (replacing assemblies with a single part); internal channels (conformal cooling, heat exchangers, manifolds impossible subtractively); multi- functional integration; build- orientation and support-structure design; and thermal- distortion- aware predistortion simulation; with AM design rules (45- degree self- supporting overhangs, minimum feature size, wall thickness); Indian context — emerging DfAM strength at the IITs/IISc, Wipro 3D, 3D Future and Intech DMLS engineering teams.

Module 3 · Metal AM Processes

The flagship of AM — DMLS/ SLM (a fiber laser melting powder under inert atmosphere at 20-60um layers, the dominant production metal AM via EOS, GE, Renishaw, SLM Solutions and support-free Velo3D, with process parameters governed by melt-pool physics and volumetric energy density controlling lack-of-fusion versus keyhole porosity); EBM; WAAM; DED; metal binder jetting; and cold spray; with process selection by feature size, throughput and criticality; Indian context — Wipro 3D operates over 30 SLM/DMLS/EBM machines, ISRO LPSC makes Vikas and CE-20 engine components via SLM, and HAL/DRDO/GTRE increase adoption.

Module 4 · Polymer + Ceramic + Composite AM

AM beyond metal — FDM/FFF (extruded thermoplastic via Stratasys and Markforged's continuous-fibre composites, from PLA/ ABS to high-T PEEK/PEKK/PEI); SLA/DLP/LCD (high-resolution UV-cured photopolymer for dental, jewelry and medical models via Formlabs and Carbon's fast CLIP); SLS (CO2- laser- sintered nylon PA12 via EOS, production- grade); HP Multi- Jet Fusion (faster nylon production); PolyJet material jetting (multi- material full- colour); continuous- fibre composite AM (Markforged, Anisoprint at near- metal strength); high-T thermoplastics for aerospace and implants; ceramic AM (Lithoz alumina/ zirconia); and bio- printing; Indian context — Markforged, Stratasys, 3D Systems, HP MJF and EOS via Wipro 3D, 3D Future, Imaginarium

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and academic AM at the IITs/IISc.

Module 5 · Materials, Post-Processing & Quality

Materials physics and finishing — metal alloys (canonical Ti-6Al-4V for aerospace and implants, lightweight AlSi10Mg, high- T Inconel 625/718 for turbines, 316L, tool steels for conformal- cooled moulds, CoCr implants, copper, refractories); polymer materials (SLS PA12, PEEK, TPU); powder properties (particle- size distribution, sphericity, flowability, recyclability, and Ti/ Al pyrophoric safety); AM microstructure with columnar grains treatable by heat treatment and HIP; post- processing (HIP eliminating porosity, stress- relief, support removal, machining, surface finishing); inspection (CMM, X- ray CT as the gold standard for internal defects); and standards; Indian context — Wipro 3D AS9100, ISRO/ HAL qualifications, and medical AM under ISO 13485 and CDSCO.

Module 6 · Indian AM Capstone + Qualification

Production- grade Indian deployment — aerospace qualification (AS9100, DGCA AC 20-184, OEM AMS specs, HAL/ ISRO protocols); medical qualification (ISO 13485, USFDA 510(k), CDSCO, ISO 10993 biocompatibility) and patient-specific implants; production economics (AM winning for complex, low-volume, customised, repair and spares, subtractive for high-volume); repair AM (DED, cold- spray, WAAM for engines, turbine blades and dies); emerging multi- material, AM- electronics, in- space and construction AM, multi- laser throughput and AI- driven AM; a capstone; Indian context — India is among the world's fastest-growing AM markets, with opportunity under AM-PLI, Make in India, Atal Mission and ISRO cryogenic engines.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Gibson I., Rosen D., Stucker B.	Additive Manufacturing Technologies (Springer)
2	Yang S., Zhao Y.F.	Additive Manufacturing-Enabled Design Theory and Methodology
3	Yan L.	Selective Laser Melting Additive Manufacturing
4	Milewski J.O.	Additive Manufacturing of Metals (Springer)
5	Wohlers T.	Wohlers Report (annual industry survey)

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26MD53B2E Mechatronics and IoT Smart Systems

Acronym: MISS L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: DEPL, MISS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the mechatronics and IoT framework.	4 · Analyse	PO1(H), PO2(M), PO4(M), PO5(L), PO6(M)
CO2	Analyze sensors, signal conditioning, and actuators.	4 · Analyse	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Design microcontroller and embedded systems covering Arduino, STM32, and ESP32.	6 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO4	Apply industrial automation and motion control.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Apply IoT communications, cloud, and edge.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Develop Industry 4.0, digital twin, and smart-product capstone.	6 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Mechatronics & IoT Framework

What mechatronics and IoT mean today — the synergistic integration of mechanical, electrical, electronic, control and software/ IoT elements into smart systems. Students frame the four pillars (mechanical kinematics/ dynamics, electrical motors/ drives, electronic sensing, control/ computation), the sense- decide- actuate loop, and the IoT layers (device, connectivity, edge, cloud, application) that turn a machine into a connected smart product.

Module 2 · Sensors, Signal Conditioning & Actuators

The front end of any smart system — sensors (position, velocity, force, temperature, vision, IMU), their characteristics and selection, signal conditioning (amplification, filtering, ADC), and actuators (DC/ BLDC/ stepper/ servo motors, pneumatics, hydraulics) with their drives. Students specify a complete sensing-and-actuation chain and condition real signals.

Module 3 · Microcontrollers & Embedded Systems

The compute core — microcontroller and embedded-system design across Arduino, STM32 and ESP32, GPIO/timers/interrupts/ PWM/ADC, communication peripherals (UART, I2C, SPI), and real-time embedded programming. Students design and program an embedded controller for a mechatronic subsystem.

Module 4 · Industrial Automation: PLC + SCADA + Motion Control

Automation at the factory scale — industrial automation with PLCs and SCADA, ladder/structured-text programming, HMI, and motion control (servo drives, motion profiles, CNC concepts). Students implement a PLC + SCADA + motion-control routine for an automation task.

Module 5 · IoT Communications, Cloud & Edge

Connecting the smart system — IoT communication protocols (MQTT, CoAP, HTTP), wired and wireless links, edge computing and gateways, and cloud platforms (ThingsBoard, AWS IoT, Azure IoT) for data ingestion, dashboards and analytics. Students build a device-to-cloud IoT pipeline with an edge layer.

Module 6 · Industry 4.0, Digital Twins & Indian Capstone

The integrated end- state — Industry 4.0 (cyber- physical systems, IoT, AI, cloud and analytics), digital twins, predictive maintenance, and smart products, delivered as an Indian-context capstone. Students integrate sensing, control, IoT and a digital twin into a working smart-product demonstrator aligned to Indian smart-manufacturing practice.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bolton W.	Mechatronics (Pearson)
2	Alciatore D.G., Histand M.B.	Introduction to Mechatronics and Measurement Systems (McGraw-Hill)
3	Bishop R.H.	The Mechatronics Handbook (CRC)

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#	Author(s)	Title, Edition & Publisher
4		Gaonkar / relevant Embedded + IoT texts (STM32 + ESP32)

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26MD61B3E Generative Design and Topology Optimisation

Acronym: GDTO L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: NFEM, AIOE

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the design- optimization landscape covering 3 levels, SIMP density-based, and level-set.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer topology optimization covering formulation, SIMP penalization, and adjoint sensitivity.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO3	Engineer lattice and cellular structures covering TPMS, octet truss, and Kelvin.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer generative design covering Autodesk Generative Design, Solidworks Generative, and Altair Inspire.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer manufacturing- aware optimization covering DfAM, casting, and injection molding.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO6	Engineer AI-driven design and Indian capstone.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Design Optimization Landscape

From sizing to topology to AI-generative — the three levels of structural optimisation (sizing of fixed-topology parameters, shape morphing of boundaries, and topology radically redistributing material for the biggest gains); topology methods (the dominant density- based SIMP with penalisation in Altair OptiStruct and Ansys/ Tosca, the smoother level- set, evolutionary ESO/ BESO, phase-field, and homogenisation); and applications, enabled by additive manufacturing for organic geometry; Indian context — increasing adoption at HAL, ISRO, DRDO, Tata Advanced Systems, Tata Motors and Mahindra, with world- class academic strength at the IITs/IISc and Altair/Autodesk/Ansys India.

Module 2 · Topology Optimization Theory & Practice

The math and workflow — the SIMP formulation (minimising compliance subject to equilibrium and a volume constraint, with element densities penalised toward 0/1 via E=rho^p*E0); sensitivity analysis via the efficient adjoint method (one extra solve regardless of variable count); solvers (Svanberg's Method of Moving Asymptotes and Optimality Criteria); filters preventing checkerboarding and mesh-dependence (density, sensitivity, Helmholtz-PDE, Heaviside projection); constraints and extensions; and tools; Indian context — adoption in HAL brackets and airframes, ISRO LPSC cryogenic-engine and payload structures, DRDO, Tata Advanced Systems and Tata/Mahindra/Bosch India CAE teams.

Module 3 · Lattice + Cellular Structures

Engineered porosity — why lattices (lightweighting, impact, thermal, acoustic and bone- like implants, enabled by AM); lattice classes (periodic octet- truss, Kelvin, BCC/ FCC and diamond; smooth isotropic TPMS gyroid and Schwarz P/ D; stochastic Voronoi for bone-like implants; and functionally-graded via nTopology implicit modelling); mechanical behaviour (stiff stretching-dominated octet-truss with linear density scaling versus energy-absorbing bending-dominated foams with quadratic scaling, per Gibson-Ashby and Maxwell stability); multi-physics; and AM-aware design via nTopology, Materialise Magics and Ansys Lattice; Indian context — lattice/AM at Wipro 3D, HAL, ISRO LPSC, DRDO and Indian medical implants (Nupar) under AM-PLI.

Module 4 · Generative Design

AI explores the design space for you — generative design (software exploring thousands of alternatives from loads, constraints, materials, process and goals, presenting mass/ stiffness/ cost/ manufacturability trade- off curves for the designer to select); tools (cloud-AI Autodesk Generative Design pioneering massive parallelism, Solidworks Generative, Altair Inspire, premium AM-focused nTopology, real- time Ansys Discovery, Siemens NX and Creo Generative); multi- objective Pareto frontiers; manufacturing-process awareness; cloud-parallel exploration cutting turnaround from weeks to hours; the designer-in-the-loop as augmentation not replacement; and ML- learned design priors; Indian context — Indian OEMs and bureaus adopting (HAL, ISRO, Tata Advanced Systems, Wipro 3D, Tata Motors, Mahindra, Bosch India).

Module 5 · Manufacturing-Aware Optimization

Optimise for what you can build — DfAM (topology, lattice, consolidation, support-minimisation, build-orientation, and thermal-distortion predistortion, with overhang, feature-size and powder-evacuation constraints and integrated Ansys/Simufact thermal simulation); DfM for subtractive (CNC tool-access, clamping and corner-radius constraints); casting (draft, parting line, uniform

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sections, gigacasting); injection moulding (draft, uniform walls, conformal cooling); sheet metal (bend radii, spring- back); composites (fibre orientation, ply scheduling, tow-steered AFP); and multi-physics/multi-material optimisation; Indian context — Indian- OEM optimisation at HAL (Tejas/ AMCA components), ISRO LPSC, Tata and Mahindra (cast, machined, AM, composite EV), and Indian medical AM.

Module 6 · AI-Driven Design + Indian Capstone

The next frontier — ML/ AI in structural design (deep generative GANs, diffusion models and VAEs generating alternatives in seconds, trained on design/ simulation libraries); reinforcement learning framing design as a game; generative- AI design copilots; neural/Kriging surrogates replacing FEA for rapid optimisation; inverse design from desired performance via diffusion/ RL; bio- inspired design; and the digital- twin feedback loop from operational data; a capstone; Indian context — rapid adoption under AM-PLI and Make in India with world-class academic strength and emerging industrial capability.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bendsoe M.P., Sigmund O.	Topology Optimization: Theory, Methods and Applications (Springer)
2	Christensen P.W., Klarbring A.	An Introduction to Structural Optimization (Springer)
3	Gibson L.J., Ashby M.F.	Cellular Solids: Structure and Properties (Cambridge)
4	Sigmund O.	A 99 line topology optimization code (Structural and Multidisciplinary Optimization journal)
5	Liu J., Du Q.	Design for Additive Manufacturing (Elsevier)

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26MD61B4E Precision Engineering and Metrology

Acronym: PREM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse precision engineering and metrology fundamentals.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer Geometric Dimensioning and Tolerancing covering ASME Y14.5, ISO 1101, and 8015.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Engineer measurement uncertainty, ISO 17025, and NABL.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer Coordinate Measuring Machines and optical metrology.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer laser interferometry, nanometrology, and surface metrology.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer in-line, Industry 4.0 metrology, and Indian semiconductor capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Precision Engineering & Metrology Fundamentals

Foundations — accuracy, precision, uncertainty and trueness (per ISO 5725 and the VIM); the traceability hierarchy (the 2019 SI redefinition via fundamental constants, primary national standards at the National Metrology Institute — India's CSIR- NPL — through secondary and working standards to industrial measurements, documented back to SI); NABL accrediting Indian calibration labs to ISO 17025; the measurement system and its error sources (operator, 20C- standard temperature, humidity, vibration, thermal expansion); and the precision-engineering scale; Indian context — the Indian Semiconductor Mission (Tata Electronics Dholera 28nm fab, Micron Sanand) demands world-class metrology, alongside HAL/ ISRO/ DRDO aerospace and Indian medical-implant precision.

Module 2 · Geometric Dimensioning & Tolerancing (GD&T)

The language of mechanical design and manufacturing — why GD&T (defining functional intent via geometric controls referenced to datums, where plus-minus tolerances under-constrain fit); the standards (ASME Y14.5-2018 and the ISO GPS 1101 series); the fourteen controls in five categories (datum- free form and versatile profile, and datum- referenced orientation, workhorse position/location and rotating-part runout); modifiers (Maximum and Least Material Condition with bonus tolerance, Regardless of Feature Size, projected zones); the datum reference frame; tolerance stack- up; and functional gauging; Indian context — GD&T is mandatory in Indian aerospace (HAL, Boeing/ Airbus per AS9100), automotive (IATF 16949), medical (ISO 13485) and semiconductor.

Module 3 · Measurement Uncertainty + ISO 17025 + NABL

Putting numbers to the doubt — every measurement reporting a value and its uncertainty; the GUM framework; the uncertainty budget tabulating all error sources; worked examples; Monte Carlo per JCGM 101 when linear GUM assumptions fail; ISO 17025 laboratory competence; and Indian NABL accreditation under QCI, with certificates traceable to NPL and globally recognised via ILAC; Indian context — the Indian metrology ecosystem (CSIR-NPL as NMI, 1000+ NABL labs) growing under the Semiconductor Mission and increasing aerospace/medical/automotive demand.

Module 4 · CMM + Optical Metrology

The workhorse measurement systems — CMMs (bridge, cantilever, horizontal- arm, portable Faro/ Hexagon arms, and 5- axis Renishaw Revo, with touch- trigger, scanning, laser and vision/ multi- sensor probes, driven by PC- DMIS, Calypso and MODUS software via off- line CAD programming, subject to ISO 10360 acceptance and thermal error); and optical metrology; Indian context — CMM and optical installations at HAL, ISRO, Tata Electronics, Bharat Forge, Tata Motors, Mahindra, Maruti and Indian medical AM, with Zeiss, Hexagon, Mitutoyo and Renishaw India leading the market.

Module 5 · Laser Interferometry + Nanometrology + Surface Metrology

Nanometer-scale and below — laser interferometry (split-and-recombined coherent light resolving sub-wavelength displacement, the length-traceability gold standard, for machine- tool calibration via Renishaw XL-80 and Zygo per ISO 230); AFM (a sharp-tipped cantilever scanning surface forces at sub-nm Z-resolution in contact/tapping modes, via Bruker and Park); STM atomic imaging and SEM (electron-beam sub-nm imaging with EDX/EBSD, including semiconductor CD-SEM); surface metrology; Indian

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context — Indian nanometrology at the IITs/ IISc, CSIR- NPL, CMERI and CSIO, with emerging semiconductor metrology at Tata Electronics and SCL under the Semiconductor Mission.

Module 6 · In-Line + Industry 4.0 Metrology + Indian Capstone

From lab to line — in-line metrology (measurement integrated into manufacturing for SPC, closed-loop control and zero-defect Industry 4.0); machine- tool integration (Renishaw on- machine probing and the gauge- by- comparison Equator); optical/ vision inline with AI defect detection; semiconductor metrology (CD-SEM, ASML/KLA overlay, wafer flatness, ellipsometry thin-film, and defect inspection, ramping under the Indian Semiconductor Mission); medical metrology (implant dimensional, surface and porosity verification per ISO 13485 and CDSCO); aerospace metrology; and Industry-4.0 digital- twin and MES/ ERP metrology integration; a capstone; Indian context — India becoming a precision- metrology powerhouse under the 1.26- lakh- crore Semiconductor Mission and Make in India.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bell S.	A Beginner's Guide to Uncertainty of Measurement (NPL Good Practice Guide)
2	Krulikowski A.	Fundamentals of Geometric Dimensioning and Tolerancing (Cengage)
3	Hocken R., Pereira P.	Coordinate Measuring Machines and Systems (CRC)
4	Whitehouse D.	Handbook of Surface and Nanometrology (CRC)
5	Smith G.T.	Industrial Metrology: Surfaces and Roundness (Springer)

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26MD5206E Robot Modelling, Design and Analysis

Acronym: RMDA L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Apply homogeneous transformations and Denavit Hartenberg parameters for robot manipulators.	3 · Apply	PO1(H), PO2(M), PO4(M), PO5(L), PO6(M)
CO2	Apply forward and inverse kinematics to robot manipulators.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Apply rigid body dynamics and dynamic modelling to robot manipulators.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Design mechanical systems for robot manipulators.	6 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Apply configuration space and motion planning for robotic systems.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Apply robot programming and simulation tools for manipulator analysis.	5 · Evaluate	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Introduction to Robotics and Robot Kinematics

The foundations of robot geometry — spatial descriptions, rotation matrices, homogeneous transformations, and the Denavit-Hartenberg (DH) convention for assigning frames to a serial manipulator. Students build the link- transformation chain for real manipulators, understand joint types and workspace, and set up the systematic parameterisation that every downstream kinematic and dynamic model depends on.

Module 2 · Forward and Inverse Kinematics

Mapping between joint space and task space — forward kinematics from the DH chain, the manipulator Jacobian and velocity/ singularity analysis, and inverse kinematics by analytical (closed- form) and numerical methods. Students solve forward and inverse kinematics for typical 5- and 6- DOF manipulators and reason about multiple solutions, reachability and singular configurations.

Module 3 · Robot Dynamics and Dynamic Modelling

Modelling the forces and motion of manipulators — rigid-body dynamics, the Euler-Lagrange and Newton-Euler formulations, the manipulator mass/inertia matrix, Coriolis, centrifugal and gravity terms, and actuator/joint torque requirements. Students derive and simulate the dynamic model used for sizing actuators and for model-based control.

Module 4 · Robot Manipulator Design

Mechanical design of the manipulator itself — link and joint design, actuator and transmission (harmonic drive, gearbox) selection, structural stiffness, payload and reach trade- offs, and end- effector/ gripper design. Students carry a manipulator design from requirements through mechanism, actuator and structural sizing.

Module 5 · Robot Motion Planning and Control

Getting the robot from A to B — configuration space, obstacle representation, joint- and task- space trajectory generation, and motion-planning methods (potential fields, sampling- based RRT/ PRM) with an introduction to control. Students plan collision-free trajectories for a manipulator in a real cell layout.

Module 6 · Robot Programming and Simulation

Programming and simulating manipulators — robot programming approaches, and simulation, modelling, analysis and verification/ validation of manipulator behaviour using industry- standard tools (ROS/ MoveIt, Gazebo, CoppeliaSim, RoboDK, MATLAB Robotics Toolbox). Students verify a complete manipulator model and workflow in simulation as an Indian- industry capstone.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Craig J.J.	Introduction to Robotics: Mechanics and Control (Pearson)

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#	Author(s)	Title, Edition & Publisher
2	Spong M.W., Hutchinson S., Vidyasagar M.	Robot Modeling and Control (Wiley)
3	Siciliano B., Sciavicco L., Villani L., Oriolo G.	Robotics: Modelling, Planning and Control (Springer)
4	Niku S.B.	Introduction to Robotics (Wiley)

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26MD5207E Mechanical Vibrations

Acronym: MVIB L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: CMDS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse single- degree- of- freedom vibration covering free undamped and damped, forced harmonic, and base-excited.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer multi- degree- of- freedom and continuous- system vibration covering equations of motion, eigenvalue problem, and modal analysis.	5 · Create	PO1(H), PO2(M), PO3(H), PO5(M), PO6(M)
CO3	Engineer experimental modal analysis and signal processing.	5 · Create	PO1(H), PO2(M), PO3(H), PO5(M), PO6(M)
CO4	Engineer rotor dynamics and balancing covering Jeffcott and Stodola rotors, whirl, and critical speeds.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer vibration control and isolation covering passive isolation, tuned-mass dampers, and viscous.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer NVH, Indian-OEM integration, and complete capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · SDOF Vibration: Free, Forced, Transient

The foundational single-degree-of-freedom mass-spring-damper — free vibration (undamped natural frequency, under/critical/ over-damped response, damped natural frequency, and logarithmic decrement to identify damping from a decay record); forced harmonic response (magnification factor, phase, resonance, and Q- factor/ half- power bandwidth for damping identification); base excitation and displacement/force transmissibility founding vibration isolation; rotating unbalance and its auto/turbo/wind signature; and transient response to impulse, step and arbitrary loading via the Duhamel convolution and response spectra; Indian context — engine and suspension SDOF approximations at Tata Motors/Mahindra, turbo unbalance at Cummins India and BHEL, and wind-rotor unbalance at Suzlon, the daily diagnostic shortcut at every Indian machinery plant.

Module 2 · MDOF + Continuous-System Vibration

Real systems have many modes — MDOF systems (equations via Newton/ Lagrange, the eigenvalue problem yielding natural frequencies and mode shapes, modal orthogonality, modal decoupling and superposition for proportional Rayleigh damping, and non- proportional damping with complex modes in rotor- bearing systems, plus the discrete vibration absorber); continuous systems; and the bridge to FE via Rayleigh-Ritz and Galerkin; Indian context — multi-mode tower, chassis, crankshaft and turbo-blade modal analysis at Tata Motors, Mahindra, BHEL, HAL and Suzlon.

Module 3 · Experimental Modal Analysis & Signal Processing

From sensor data to a modal model — signal processing (sampling, aliasing, Nyquist, windowing and spectral leakage, averaging, the FFT and its limits, STFT and wavelets, and coherence as a quality metric); FRF measurement (driving-point and transfer FRFs via impact-hammer or shaker excitation with accelerometer/ force- cell instrumentation); modal- parameter extraction (peak-pick, circle-fit, the rational-fraction-polynomial workhorse, and time-domain complex-exponential); mode-shape animation and the Modal Assurance Criterion for FE-test correlation and model updating; and operational modal analysis; Indian context — EMA and OMA at Bruel & Kjaer India and LMS Test.Lab across auto/aero/wind machinery, with FE-EMA correlation at Tata Technologies and KPIT.

Module 4 · Rotor Dynamics & Balancing

Where every rotating machine lives or dies — the Jeffcott rotor (a flexible-shaft disc, whirl orbit, critical speed, sub- versus super-critical operation, and damping through criticals); the Stodola rotor and transfer- matrix method; gyroscopic effects (splitting modes into forward and backward whirl, shown on the Campbell diagram with critical- speed crossings); bearing- supported rotors (fluid- film and rolling- bearing stiffness/ damping governing stability, and oil- whirl/ oil- whip instabilities); and balancing; Indian context — turbo, steam, gas and wind-turbine rotor dynamics and balancing at BHEL, Cummins India, Triveni Turbine, Suzlon, HAL and GTRE.

Module 5 · Vibration Control: Isolation, Damping, Active + Torsional

Reducing vibration where it matters — passive isolation (spring and elastomeric mounts, transmissibility, design above the root-2 frequency ratio, for engine mounts and machinery foundations); dynamic absorbers and tuned- mass dampers (Den Hartog optimal tuning, multi-mode and pendulum TMDs); dampers (viscous fluid-orifice, viscoelastic constrained-layer for NVH,

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friction and metallic-yielding, with placement strategy); semi-active MR dampers controlled in real time; an introduction to active control (co-located feedback, LQR, pole- placement, piezo smart- structure actuators, and spillover); and torsional/ driveline vibration; Indian context — auto NVH and driveline at Tata Motors, Mahindra, Bajaj and TVS, and isolation/ TMDs at BHEL and wind-turbine drivetrains.

Module 6 · NVH, Diagnostics & Indian-OEM Capstone

Putting it all together for products — automotive NVH (booming, harshness, squeal/squeak, powertrain orders, tire/road cavity resonance, mode- coupling brake squeal, NVH targets and transfer- path analysis); acoustics (sound pressure level, source identification via intensity probes and beamforming, ISO 362 pass-by noise); machinery vibration severity per ISO 10816/20816 (classifying the machine, measuring RMS velocity against zones) founding vibration- based predictive maintenance; FFT diagnostics; and a capstone; the modern frontier of AI-based and acoustic- AI diagnostics and digital- twin monitoring; Indian deployment — vibration/NVH engineers are a top-five Indian mechanical specialism, in demand across auto, heavy, power, wind and aero.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Rao S.S.	Mechanical Vibrations (Pearson)
2	Inman D.J.	Engineering Vibration (Pearson)
3	Ewins D.J.	Modal Testing: Theory, Practice and Application (Wiley)
4	Childs D.	Turbomachinery Rotordynamics (Wiley)
5	Harris C.M., Piersol A.G.	Shock and Vibration Handbook (McGraw-Hill)

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26IE5201E Research Methodology and Intellectual Property Rights

Acronym: RMIP L-T-P-S: 3-0-0-0 Credits: 2 CH: 3 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Formulate research questions and develop hypotheses using systematic literature review and gap analysis.	3 · Apply	PO1(M), PO2(M), PO3(M), PO4(H)
CO2	Design experiments using quantitative, qualitative and computational methodologies appropriate to engineering research.	3 · Apply	PO1(M), PO2(M), PO3(M), PO4(H)
CO3	Conduct literature search across academic databases and manage references using Zotero/Mendeley with PRISMA discipline.	3 · Apply	PO1(H), PO3(M), PO4(M)
CO4	Write technical papers, theses and research reports in IEEE/ ACM/ Springer formats using LaTeX with proper citation.	3 · Apply	PO2(M), PO3(M), PO4(H)
CO5	Analyse patent landscapes, conduct freedom- to- operate searches and draft patent specifications for engineering inventions.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO6	Evaluate research integrity issues covering plagiarism, AI- disclosure, and replication.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Research Foundations & Question Formulation

Research types — basic, applied, design- based, action research; engineering research versus scientific research and the distinction between problem-solving and knowledge-generation; research questions versus hypotheses — formulating, refining and operationalising them; inductive versus deductive reasoning; research design frameworks (exploratory, descriptive, explanatory); gap analysis from a systematic literature review; theory building and conceptual frameworks in engineering.

Module 2 · Experimental Design & Methodology

Quantitative methods — experimental, quasi-experimental, survey, computational/simulation; qualitative methods — case study, interview, ethnography, grounded theory; mixed- methods designs and triangulation; design of experiments — full- factorial, fractional-factorial, Taguchi orthogonal arrays, response-surface methodology; randomisation, blocking and replication; sample-size determination and power analysis; validity — internal, external, construct, statistical-conclusion; reliability and reproducibility of measurements.

Module 3 · Literature Review & Reference Management

Systematic literature review following PRISMA 2020 — protocol, search strategy, inclusion/ exclusion, screening, synthesis; snowballing by forward and backward citation tracking; databases — Scopus, Web of Science, IEEE Xplore, ACM Digital Library, SpringerLink, ScienceDirect; reference managers (Zotero, Mendeley, JabRef); predatory journals (Beall's list) and journal metrics (impact factor, h-index, CiteScore); open access — green, gold, hybrid, diamond; preprint servers (arXiv, bioRxiv, ChemRxiv).

Module 4 · Scientific Writing & LaTeX

IMRaD structure (introduction, methods, results, discussion); abstract writing — informative versus descriptive; figures and tables — design principles, captioning, self-containment; citation styles — IEEE, ACM, APA, Vancouver; the peer-review process — editorial workflow, reviewer roles, response to reviewers; LaTeX fundamentals — TeX Live, document classes, math mode, BibTeX/ biblatex; journal and conference templates — IEEEtran, ACM, Springer LNCS, Elsevier elsarticle; version control for manuscripts (Git, Overleaf).

Module 5 · IPR & Patent Engineering

Types of intellectual property — patents, copyrights, trademarks, trade secrets, geographical indications, industrial designs; patentability — novelty, non- obviousness (inventive step), industrial applicability, and statutory exclusions (Section 3, Indian Patents Act 1970); patent specification — claims (independent, dependent), description, drawings, abstract; freedom-to-operate analysis; filing routes — provisional, complete, PCT; patent-landscape and prior-art search; software patentability — Section 3(k), Indian guidelines versus the USPTO Alice test.

Module 6 · Research Ethics & Integrity

Plagiarism — text, idea and self-plagiarism, and detection tools; authorship norms — Vancouver, COPE, ICMJE, contributorship and gift/ ghost authorship; conflicts of interest — financial, intellectual, personal; data fabrication and falsification; AI- assisted writing and disclosure norms (Nature, Springer, ACM, IEEE policies); the replication crisis; questionable research practices — p-

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hacking, HARKing, the garden of forking paths; open science — preregistration, open data, open code; ethics review (IRB, animal ethics, IBC).

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Kothari C.R.	Research Methodology: Methods and Techniques (4th ed., New Age, 2024)
2	Deb D. et al.	Engineering Research Methodology (Springer, 2019)
3	Booth W., Colomb G., Williams J.	The Craft of Research (5th ed., Univ Chicago Press, 2024)
4	Pressman D.	Patent It Yourself (22nd ed., Nolo, 2024)
5	Day R., Gastel B.	How to Write and Publish a Scientific Paper (9th ed., Greenwood, 2022)

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Trimester 3

26MD5308E Smart Materials and Adaptive Structures

Acronym: SMAS L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: CMDS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the smart-materials taxonomy and coupled-field theory.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer piezoelectric materials and applications covering PVDF, composites, and sensor design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer shape-memory alloys and magnetostrictive materials.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer MR/ER fluids and electroactive polymers.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer active vibration and shape control.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer energy harvesting, self- sensing, smart composites, and Indian capstone.	5 · Create	PO1(M), PO3(M), PO4(M), PO5(H), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Smart-Materials Taxonomy & Coupled-Field Theory

What 'smart' means and how to model it — the smart- materials family (piezoelectric electric- field/ strain coupling, electrostrictive, temperature/ stress- driven shape- memory alloys, magnetostrictive, large- strain electroactive polymers, field-controlled magnetorheological/ electrorheological fluids, shape- memory polymers, and chromogenic materials); multi- physics coupling (coupled-field constitutive equations linking mechanical and electric/magnetic/thermal fields, with linear and hysteretic regimes); the smart- structure framework (sensors, actuators, controller, structure, collocated versus non- collocated); and the direct sensing versus converse actuating effects; Indian context — Indian smart- structures R&D at HAL aerospace, ISRO satellites, DRDO underwater, CSIR and the IITs/IISc, with emerging piezo, SMA and MR-damper applications.

Module 2 · Piezoelectric Materials & Applications

The workhorse smart material — piezoelectric basics (the direct effect for sensors and energy harvesting versus the converse effect for actuators and transducers); materials (high- coupling brittle PZT ceramic, highest- coupling single- crystal PMN- PT, flexible sensor-favoured PVDF polymer, and macro-fiber composites for curved smart skins) with the d31/d33 coefficients and coupling factor; sensor design (voltage versus charge mode, accelerometers, force and AE sensors); actuator design; energy harvesting; and ultrasonic transducers; Indian context — Indian piezo R&D at CSIR, the IITs/ IISc and Bharat Electronics, with HAL/DRDO sonar, ISRO satellite dampers and auto active mounts.

Module 3 · Shape-Memory Alloys & Magnetostrictive

Phase- transformation and magnetomechanical materials — shape- memory alloys (workhorse Nitinol, with the austenite-martensite transformation giving the shape-memory effect for thermal actuators and stents and the superelastic effect for ~8% recoverable strain in self-centering and biomedical uses, modelled by Brinson/Lagoudas with hysteresis); SMA actuator design (wire, spring, embedded, thermally driven, with slow response but high force- density and transformation fatigue) and applications (stents, variable- geometry aerospace inlets, automotive grille shutters, self- centering seismic isolators, Cryofit couplings); and magnetostrictive materials; Indian context — Indian SMA work at IIT-Madras/Kanpur and IISc (seismic isolators, biomedical stents) and DRDO (underwater, variable-geometry), with magnetostrictive in DRDO sonar/NSTL.

Module 4 · MR/ER Fluids & Electroactive Polymers

Field- controlled rheology and soft actuators — magnetorheological fluids (carbonyl- iron particles forming field- aligned chains that raise apparent viscosity by orders of magnitude into a controllable Bingham-plastic yield-stress fluid, the workhorse semi-active damper material adjustable in milliseconds) and analogous electrorheological fluids; MR damper design (flow, shear and squeeze modes, with yield- stress, damping range and sedimentation, and clipped- optimal/ skyhook semi- active control); applications (Cadillac/Audi MagneRide and Lord MR shocks, emerging Tata-Mahindra adaptive suspensions, seismic structural control, MR prosthetics); and electroactive polymers; Indian context —Indian MR/ER work at IIT-Bombay/Kanpur and IISc with emerging semi-active suspensions, and EAP at IIT-Madras/Kanpur for soft robotics.

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Module 5 · Active Vibration + Shape Control

Closing the loop with smart materials — the control problem (measuring with a piezo/strain sensor, computing a control law in real time, and actuating via a piezo/ SMA/ MR/ EAP actuator to damp vibration, change shape or suppress flutter); actuator/ sensor placement (observability and controllability, modal/Gramian/H-infinity criteria, collocated stability versus non-collocated spillover); control algorithms (LQR, LQG with a Kalman observer, robust H-infinity, adaptive, sliding-mode for SMA/MR, positive position feedback, and neural/ reinforcement- learning controllers); practical issues; and applications; Indian context — Indian active-control work at IIT-Kanpur/Madras/Bombay, IISc, HAL flutter labs, ISRO satellites and auto active-mounts.

Module 6 · Energy Harvesting, Self-Sensing, Smart Composites & Indian Capstone

Powering, sensing and integrating — vibration energy harvesting (converting ambient vibration via a resonance- tuned piezo cantilever, electromagnetic, or emerging triboelectric transduction, with power management yielding microwatts- milliwatts for low-power wireless SHM sensors); self-sensing (using one smart material as both actuator and sensor — piezo voltage or SMA resistance feedback — to cut sensor count); smart composites; 4D printing; a capstone; the modern frontier of AI-controlled and self- healing smart structures; Indian deployment — growing rapidly across HAL, ISRO, DRDO, the IITs/ IISc, auto- OEMs and medical devices, a niche high-prestige specialism.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Smith R.C.	Smart Material Systems: Model Development (SIAM)
2	Leo D.J.	Engineering Analysis of Smart Material Systems (Wiley)
3	Preumont A.	Vibration Control of Active Structures: An Introduction (Springer)
4	Lagoudas D.C.	Shape Memory Alloys: Modeling and Engineering Applications (Springer)
5	Erturk A., Inman D.J.	Piezoelectric Energy Harvesting (Wiley)

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26MD5309E Design of Pressure Vessels and Piping

Acronym: DPVP L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the pressure-vessel design framework covering Section I, IS 2825, and IS 14333.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer shell, head, and nozzle design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer flanges, supports, and heat exchangers.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer design-by-analysis covering elastic stress categorization per Hopper diagram, 3S_m rule, and ratcheting.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer piping and piping- stress analysis covering ASME B31.1, piping flexibility, and thermal-expansion.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer special services and Indian-OEM capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Pressure-Vessel Design Framework, Codes & Materials

The code-driven world of pressure equipment — why codes matter; major codes; Indian regulation (the Indian Boiler Regulations with mandatory inspection, PESO for gas and LPG, and state boiler inspectorates); the design-by-rule versus design-by-analysis philosophy; service categories (pressure, temperature, cyclic fatigue, corrosive, lethal, cryogenic, nuclear); and materials (SA-516 carbon steel, SA-387 Cr-Mo, 304L/316L stainless, clad, 9% Ni cryogenic, Inconel); Indian context — a massive Indian pressure-equipment industry (Reliance Jamnagar, IOC/ HPCL/ BPCL refining, GAIL, Petronet LNG, NTPC/ BHEL boilers, NPCIL nuclear), mostly under IBR jurisdiction.

Module 2 · Shells, Heads & Nozzles (Design-by-Rule)

The Div 1 workhorse — cylindrical shells (membrane and Lame theory, the thin-wall t=PR/(SE-0.6P) formula per UG-27 and thick-wall Lame, with joint efficiency E for full/spot/no radiography); spherical shells (efficient, for heads and LPG bullet ends); conical shells (transition stresses and reinforcement); formed heads (efficient- but- costly hemispherical, common 2:1 ellipsoidal, cheaper torispherical F&D, and heavily- penalised flat heads); and nozzles; Indian context — every Indian refinery/ petrochem vessel uses shells, heads and nozzles per UG-27/32/37, the daily work of L&T Heavy, Godrej Process, Walchandnagar and Anup Engineering.

Module 3 · Flanges, Supports & Heat Exchangers

Closing the vessel, holding it up and heat transfer — flange design (the most-analysed component since flange leaks dominate incidents, via the Taylor- Forge method, ASME Appendix 2 and PCC-1 assembly, computing moment loads, thickness and bolt sizing for weld-neck, slip-on and RTJ flanges, essentially a bolted-joint plus gasket-seating problem); gaskets (soft, spiral-wound, RTJ, Kammprofile, with m and y factors) and bolting (SA-193 B7, PCC-1 tightening); supports; and heat exchangers; Indian context — shell-and-tube exchangers ubiquitous in Indian refining and power, made at GMM Pfaudler, Anup, Godrej Process, L&T Heavy and Tema India.

Module 4 · Design-by-Analysis (FE per Section VIII Div 2 Part 5)

FE-based pressure-vessel design when design-by-rule is too conservative — stress categorisation (interpreting an FE stress field into Section VIII Div 2 Part 5 categories: primary membrane Pm, local primary PL, primary bending Pb, secondary Q and peak F, with limits Pm<=Sm, PL+Pb<=1.5Sm, and the 3Sm rule limiting cyclic ratcheting via the Bree diagram); plastic collapse (elastic-plastic FE demonstrating limit load with a 1.5 factor, the modern alternative to elastic categorisation); buckling; fatigue; and fracture mechanics; Indian context — design-by-analysis increasingly used at L&T Heavy, Reliance, Godrej Process, EIL and Tata Consulting Engineers for cyclic, thick-section and complex vessels.

Module 5 · Piping & Piping-Stress Analysis

The pipe connecting vessels, the larger design problem by linear- foot — the ASME B31 series (B31.1 power piping, the B31.3 process-piping Indian-EPC workhorse, B31.4 liquid and B31.8 gas pipelines); piping flexibility and stress analysis, where systems grow with temperature and are accommodated by route flexibility, expansion joints and spring hangers, with stresses categorised as sustained, occasional and self- limiting thermal per B31.3; pipe- stress software (CAESAR II the Indian- EPC

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standard, AutoPIPE, ROHR2, modelling thermal, pressure, seismic, water- hammer and nozzle loads); supports and flow/ acoustic-induced vibration; Indian context — piping-stress analysis dominates Indian EPC employment at L&T-Hydrocarbon, EIL, Toyo and Technip.

Module 6 · Special Services & Indian-OEM Capstone

Beyond ambient carbon- steel, the daily edge cases — high- temperature creep (the Larson- Miller parameter correlating creep-rupture across time-temperature, creep-limited allowable stress, and creep-fatigue for superheaters and reformer tubes); brittle fracture and low-temperature service (Charpy impact per UCS-66 for LPG, ammonia and cryogenic LNG at -162C using 9% Ni and austenitic steels); cryogenic/LNG; nuclear; welding, NDE and QA; corrosion; Fitness-for-Service; a capstone; the modern frontier of additive pressure parts, AI- assisted DBA, digital- twin RBI and hydrogen- economy equipment; Indian deployment — one of India's largest mechanical specialisms, with L&T Heavy alone employing over 5000 pressure-equipment and piping engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Megyesy E.F.	Pressure Vessel Handbook (Pressure Vessel Publishing)
2	Bednar H.H.	Pressure Vessel Design Handbook (Van Nostrand Reinhold)
3	Moss D.R., Basic M.	Pressure Vessel Design Manual (Butterworth-Heinemann)
4	Becht C.	Process Piping: The Complete Guide to ASME B31.3 (ASME)
5	Singh K.P., Soler A.I.	Mechanical Design of Heat Exchangers (Springer)

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26MD5310E Tribology in Design

Acronym: TRBO L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse contact mechanics and surface topography.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer friction and friction- material design covering Amontons- Coulomb laws and reality, adhesive and ploughing components, and boundary-lubricated.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO5(H)
CO3	Engineer wear mechanisms and life prediction.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer lubrication regimes and lubricant design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer tribology of machine elements covering rolling bearings, gears, and cams and tappets.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer surface engineering, condition monitoring, and Indian- tribosystem capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Contact Mechanics & Surface Topography

Where surfaces actually touch — contact mechanics (Hertz sphere/cylinder-flat and general elliptical contact, conformal versus non-conformal, contact pressure, area and subsurface stress with maximum shear at depth ~0.78a as the rolling- contact-fatigue site, and the elastic-plastic transition); surface topography (roughness parameters Ra, Rq, Rsk, Rku and 3D Sa/Sq, spatial wavelength and PSD spectral decomposition); the Greenwood- Williamson model; and roughness's role in friction, wear and lubrication-regime selection; Indian context — surface measurement at Tata Motors, Bharat Forge, Bosch and Sundaram-Clayton (Mahr, Mitutoyo, Hexagon, Taylor Hobson profilometers), where design-for-roughness is a daily decision.

Module 2 · Friction & Friction-Material Design

The tangential contact force — classical Amontons- Coulomb friction (load- independent mu) and its reality (mu depending on load, sliding speed causing stick- slip, temperature causing brake- fade, material pair, finish and lubrication regime, so mu is a tribo- system not a material property); the origin of friction (adhesive component from the weaker material's shear strength, ploughing from asperity plastic deformation, and deformation hysteresis for rubber/polymer); friction across regimes (dry metal-metal prone to galling, boundary-lubricated, mixed, and hydrodynamic/EHL); and friction-material design; Indian context — the Indian brake and clutch industry (Brakes India, Sundaram-Clayton, Anand Group, Rane Brake Lining).

Module 3 · Wear Mechanisms & Life Prediction

Material removed from contact and how much — wear mechanisms (adhesive galling/ scuffing from cold welding, two- and three- body abrasive by hardness ratio, rolling- contact and micropitting fatigue in bearings and gears, solid- particle/ droplet/ cavitation erosion, small-amplitude fretting at clamped contacts producing fretting fatigue, and corrosive/ tribochemical oxidation wear); Archard's wear law; Lim-Ashby wear maps; life prediction; and wear testing; Indian context — wear is the number- one downtime driver in Indian mining, construction and agriculture equipment (BEML, L&T, Mahindra, JCB India) and bearing/gear replacement at every OEM.

Module 4 · Lubrication Regimes & Lubricant Design

Reducing friction and wear via fluid films — the Stribeck curve (mu versus the Hersey number in a U- shape from boundary through mixed to full- film hydrodynamic/ EHL, usually the design target); hydrodynamic lubrication and the Reynolds equation (from Navier-Stokes for thin viscous films, giving journal-bearing pressure, load capacity, the Sommerfeld number and Raimondi-Boyd charts, plus thermohydrodynamic and thrust bearings); elastohydrodynamic lubrication; boundary EP/anti-wear additives; and lubricant rheology; Indian context — lubricant R&D at IOC, HPCL, Castrol India and Shell India competing globally, with lubricant/grease selection a daily Indian-OEM decision.

Module 5 · Tribology of Machine Elements

Tribology applied to real components — rolling bearings (Hertzian/EHL contact, cage friction, rolling-contact fatigue and ISO 281 L10, failure modes including spalling and EV-motor electric-erosion, and grease-versus-oil lubrication); gears (combined rolling and sliding, EHL/ boundary mixed regime, and pitting/ scuffing/ bending- fatigue failure per ISO/ AGMA with EP gear oils); cams

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and tappets (high-pressure reciprocating EHL/boundary contact and valve-train friction as a fuel-economy item); seals (lip and mechanical face seals with dynamic friction, wear and leakage); brakes; tyres; and hydraulics; Indian context — every Indian-OEM engineer designs at least one such tribosystem, with SKF, Schaeffler, Timken and IOC R&D spanning them all.

Module 6 · Surface Engineering, Condition Monitoring & Indian-OEM Capstone

Engineering the surface and watching it live — surface engineering (low- friction hard DLC coatings for valve- trains and EV bearings, nitriding/ carburising case- hardening, HVOF/ plasma thermal spray, PVD TiN/ CrN/ TiAlN tool coatings, laser surface texturing creating EHL micro- reservoirs, cold- spray/ laser- cladding restoration, and shot- peening); condition monitoring of lubricants and tribosystems; a capstone; the modern frontier of AI oil analysis, acoustic- emission tribo- monitoring, nano/ bio-tribology and EV-specific tribology; Indian deployment — tribology demand grows with EVs, wind and smart-factory monitoring, with IOC, HPCL, Castrol and Shell India employing thousands of tribology engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Hutchings I., Shipway P.	Tribology: Friction and Wear of Engineering Materials (Butterworth-Heinemann)
2	Stachowiak G.W., Batchelor A.W.	Engineering Tribology (Butterworth-Heinemann)
3	Bhushan B.	Introduction to Tribology / Modern Tribology Handbook (Wiley)
4	Johnson K.L.	Contact Mechanics (Cambridge)
5	Hamrock B.J., Schmid S.R., Jacobson B.O.	Fundamentals of Machine Elements (McGraw-Hill)

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26UC5302E Placement Training and Professional Readiness

Acronym: PTPR L-T-P-S: 0-0-0-3 Credits: 0 CH: 3 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Solve algorithmic problems at LeetCode Medium-Hard level under interview time pressure with optimal complexity analysis.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO2	Design distributed systems at scale covering capacity estimation, data partitioning, and caching.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M)
CO3	Deliver structured behavioral interview responses using STAR/ SBI/ CAR frameworks with quantified outcomes and learning narratives.	4 · Analyse	PO1(H), PO2(L), PO3(M), PO4(M)
CO4	Negotiate compensation packages using market-data evidence and BATNA analysis.	4 · Analyse	PO1(H), PO2(M), PO3(M), PO4(M)
CO5	Build and execute a placement strategy.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO6	Demonstrate domain-specific interview readiness in their M.Tech specialisation at hiring-bar quality.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(L)

MODULE-WISE SYLLABUS

Module 1 · DSA Refresher & Coding Interview Engineering

Pattern-based data structures and algorithms — sliding window, two pointers, fast-slow, monotonic stack, prefix sums, intervals, BFS/ DFS, topological sort, union-find, segment tree, binary indexed tree, and dynamic-programming patterns (knapsack, LIS, LCS, matrix-chain, partition, state-machine); complexity analysis and edge cases; coding-interview communication — talk before code, clarifying questions, dry-run walkthrough, test before submit.

Module 2 · System Design Interview Engineering

Capacity estimation (back-of-envelope); functional and non-functional requirements; API design and data modelling; scaling — load balancers, caches (Redis, Memcached), CDN, sharding, replication, message queues (Kafka, RabbitMQ); consistency trade-offs (CAP, PACELC); common designs — URL shortener, Twitter, Uber, WhatsApp, Netflix, Dropbox, payment gateway, stock exchange; observability and bottleneck analysis; and communicating design trade-offs clearly under time pressure.

Module 3 · Behavioral Interviews

Frameworks — STAR (situation-task-action-result), SBI (situation-behavior-impact), CAR (context-action-result); a story bank of eight to ten polished stories covering leadership, conflict, failure, learning, ambiguity, deadlines, customers, ethics; company-specific behavioural patterns (Amazon Leadership Principles, Google Googleyness, Meta move-fast, Microsoft growth-mindset); reverse interviews — questions to ask the company; authenticity and reflection; and conveying impact with concrete, quantified outcomes.

Module 4 · Compensation Negotiation

Compensation components — base, RSU/ESOP (vesting cliff and schedule), sign-on, relocation, performance bonus, retention; market-data sources — Levels.fyi, Blind, AmbitionBox, Glassdoor; BATNA and using multiple offers as leverage; the four-step playbook (delay, anchor, justify, mutual gain); recruiter dynamics; counter-offer scripts; common mistakes and how to avoid them; and knowing when to accept, counter or walk away.

Module 5 · Career Strategy & Networking

Company prioritisation — tier mapping, role fit, growth trajectory; application sequencing — the interview-readiness curve, dry-run companies first; recruiter outreach — cold-email templates, LinkedIn DMs, alumni reach-out; networking — informational interviews, hackathons, meetups, open-source contributions for visibility; referrals — how to ask and how to give back; reading the market — labour-market data, Levels trends, hiring slow-downs; long-term career planning.

Module 6 · Domain-Specific Interview Mastery

Specialisation-track interview prep — for CSE/AIDS/CYS: ML system design, RAG/LLM engineering, infrastructure deep-dives; for CTM/ STR: project portfolio, drawings review, BIM/ structural-design walkthrough; for MD/ RA: CAD portfolio, finite-element simulations, hands-on demos; for PEPS/ VLSI/ EMB: circuit walkthrough, simulation results, hardware demos; for BT: lab notebook, SOP defence, scientific reasoning; company-specific deep-dives on what each tier-1 firm actually asks; mock interviews and feedback.

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REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	McDowell G.	Cracking the Coding Interview (6th ed., CareerCup)
2	Xu A.	System Design Interview Vol 1 + Vol 2 (Byte Code LLC)
3	Martin K.	Designing Data-Intensive Applications (O'Reilly, 2017)
4	Bock L.	Work Rules! (Twelve, 2015)
5	Voss C.	Never Split the Difference (Random House, 2016)

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Trimester 4

26MD6112E Reliability and AI Predictive Maintenance

Acronym: RAPM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse reliability fundamentals and maintenance strategy.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer reliability analysis tools covering FMEA/ FMECA per MIL- STD-1629 and SAE J1739 and Markov and Monte Carlo simulation.	5 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO3	Engineer condition monitoring technologies covering vibration analysis, acoustic emission, and oil analysis and wear debris monitoring.	5 · Create	PO1(M), PO2(M), PO4(M), PO5(H), PO6(M)
CO4	Engineer signal processing for fault diagnosis.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer ML/ AI for predictive maintenance covering anomaly detection, classification, and RUL prediction.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer digital twins and Indian capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Reliability Fundamentals & Maintenance Strategy

The maintenance maturity ladder — the bathtub curve (infant- mortality, constant- hazard useful- life, and wear- out regimes); reliability metrics (R(t), failure density, hazard rate, MTBF/ MTTF/ MTTR, and availability); life distributions (memoryless exponential, the universal Weibull whose shape parameter spans all bathtub regions, lognormal, normal) with MLE and censored- data estimation; and maintenance strategies (run- to- failure corrective, time- based preventive, condition- based, ML-driven predictive, the strategic Reliability-Centred Maintenance per SAE JA1011, risk-based, and Japanese TPM); Indian context
— asset-intensive Indian heavy industry (Tata Steel, JSW, Reliance, IOC, BHEL, NTPC, Indian Railways) spends 10-15% of revenue on maintenance, making AI-PdM the highest-ROI digital transformation.

Module 2 · Reliability Analysis Tools (FMEA, FTA, RBD, Monte Carlo)

Quantifying and understanding system reliability — FMEA (systematically ranking failure modes by severity, occurrence and detection into a Risk Priority Number, with design and process variants per the AIAG-VDA handbook, the automotive/aerospace workhorse); FTA (top-down deductive fault trees with AND/OR gates, minimal cut sets, for safety-critical nuclear, aerospace and chemical LOPA); RBD (series, parallel and k-out-of-n reliability block diagrams); Markov chains for multi-state repairable systems; and Monte Carlo simulation; Indian context — FMEA is mandatory in Indian automotive (Bosch India, Tata Motors, Mahindra under IATF 16949), medical-device and aerospace, with FTA at BHEL, NPCIL and ISRO.

Module 3 · Condition Monitoring Technologies

The senses of predictive maintenance — vibration analysis (the dominant technique for rotating equipment via bearing-housing accelerometers, spectrum and orbit); acoustic emission (high- frequency stress- waves for ultra- early crack and spalling detection); oil analysis and wear- debris monitoring (particle counting, ferrography, spectroscopy, deeply linked to tribology); infrared thermography (non-contact hotspot detection in electrical, bearings and motors); airborne ultrasonic (leak and electrical-arc detection); motor-current signature analysis (rotor-bar and eccentricity faults from current alone); and sensor/DAQ architecture; Indian context — Indian heavy industry (Tata Steel, Reliance, IOC, BHEL, NTPC) deploys condition monitoring at scale via SKF, Emerson AMS, Bently Nevada and Bruel & Kjaer.

Module 4 · Signal Processing for Fault Diagnosis

From raw signal to diagnosis — the FFT spectrum (revealing rotation harmonics, bearing- fault frequencies, gear- mesh and resonances); order tracking (resampling by shaft angle for variable- speed wind, auto and railway machines); envelope demodulation (Hilbert- transform) extraction of bearing- fault frequencies BPFO/ BPFI/ BSF/ FTF buried in the raw spectrum, the bearing- diagnosis workhorse); STFT spectrograms and wavelets for non- stationary and impulsive events; cepstrum for gear sideband families; and specific fault signatures; Indian context — everyday practice at Tata Steel, Reliance, IOC, BHEL, Indian Railways and Integral Coach Factory condition-monitoring teams.

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Module 5 · ML/AI for Predictive Maintenance

From rules to learning — why ML for PdM (massive multi- channel time- series and complex fault interactions defeat manual rules); the data pipeline (sensor-to-edge-to-cloud collection, preprocessing and feature extraction, labelling, and train/val/test); anomaly detection for unlabelled new assets (One- Class SVM, Isolation Forest, autoencoder reconstruction error); fault classification (Random Forest/XGBoost on features, CNNs on spectrograms, 1D-CNN/LSTM on raw series); remaining-useful-life prediction; transfer learning for data-scarce Indian assets; explainable AI; and MLOps; Indian context — the Indian industrial-AI ecosystem (TCS, Siemens MindSphere India, GE Digital, APM startups) deploys AI-PdM at Tata Steel, Reliance, IOC and Indian Railways at scale.

Module 6 · Digital Twins, APM Platforms & Indian Capstone

From models to integrated maintenance operations — the digital twin (a virtual asset continuously synchronised via IoT, in descriptive, predictive and prescriptive forms); the reference architecture (sensors to edge to cloud ingestion via MQTT/OPC-UA, data lake, physics/ ML models, visualisation, and CMMS work- order creation); digital- twin platforms; CMMS integration and standards; a capstone; the modern frontier of generative- AI maintenance assistants, drone inspection and AR/ VR; Indian deployment — one of India's highest- ROI transformations, massively deployed at Tata Steel, Reliance, IOC, BHEL, NTPC, Tata Power, Indian Railways and L&T Heavy.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Ebeling C.E.	Introduction to Reliability and Maintainability Engineering (Waveland)
2	Smith A.M., Hinchcliffe G.R.	RCM Gateway to World-Class Maintenance (Butterworth-Heinemann)
3	Mobley R.K.	Introduction to Predictive Maintenance (Butterworth-Heinemann)
4	Randall R.B.	Vibration-based Condition Monitoring (Wiley)
5	Lei Y.	Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery (Butterworth-Heinemann)

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26MD6111E Composite Structures Engineering and Manufacturing

Acronym: CSEM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: None

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the composite- materials landscape covering fibres and matrices, composite forms, and Indian aerospace.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer micromechanics and Classical Laminate Theory.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer failure criteria and design covering strength, first-ply failure vs last-ply, and progressive damage analysis and design margins.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO4	Engineer composite manufacturing covering hand layup, wet layup, and spray-up.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer joining, bonding, repair, and NDE.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO6	Engineer sandwich/special structures and Indian capstone.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Composite Materials Landscape

What goes into a composite — fibres (high- modulus carbon T700/ T800/ IM7 for aerospace/ auto/ wind from Toray and Hexcel with emerging Indian capacity, cheap E- glass and stronger S- glass for wind/ marine, impact/ ballistic aramid Kevlar, emerging natural jute/bamboo/flax, and high-temperature SiC ceramic; in continuous-tow, woven, non-crimp and chopped forms); matrices (dominant thermoset epoxy at 90% of aerospace, vinyl-ester for wind blades, polyester, high-T BMI, low-moisture cyanate-ester for satellites, and emerging recyclable thermoplastic PEEK/ PPS/ PEI); and composite forms; Indian context — the HAL composite shop (Tejas/ ALH), ISRO VSSC (PSLV/ GSLV fairings and interstages), Tata Advanced Materials (Boeing/ Airbus components) and Suzlon/LM Wind/Vestas blades.

Module 2 · Micromechanics & Classical Laminate Theory (CLT)

The analytical foundation — micromechanics (predicting ply properties from fibre, matrix and volume fraction via the rule of mixtures and Halpin- Tsai, with typical Vf 60% aerospace to 30% auto); the orthotropic lamina (four in- plane constants E1, E2, G12, nu12 with fibre-dominant E1 and matrix- dominated E2/ G12, and the reduced- stiffness Q matrix transformed for off- axis plies); Classical Laminate Theory; laminate design; and hygrothermal residual stress; Indian context — CLT is the everyday tool at HAL, ISRO, Tata Advanced Materials, Boeing/Airbus India and wind-blade design at Suzlon/LM Wind/Vestas.

Module 3 · Failure Criteria & Design

When a composite fails — strength values (fibre- dominated longitudinal tension and compression, weak matrix- dominated transverse tension, transverse compression, and in-plane shear); failure criteria (simple non-interactive Maximum Stress/Strain, quadratic Tsai-Hill and the Tsai-Wu workhorse with tension-compression coupling, the physically-meaningful Hashin separating fibre and matrix modes as the modern aerospace standard, and the most-physical Puck Airbus standard); first-ply versus last-ply/ ultimate failure; design margins (margin of safety, A/ B- basis allowables per MIL- HDBK-17, environmental and impact knockdowns); and progressive damage modelling; Indian context — HAL, ISRO and Boeing/Airbus India teams use Tsai-Wu and Hashin/Puck under AS9100 quality and DGCA/EASA/FAA certification.

Module 4 · Composite Manufacturing

How composites are actually made — hand/wet layup and spray-up (low-cost, large parts, wind and marine); VARTM (dry fabric under vacuum with infused resin, the dominant wind- blade method); RTM (closed- mould injection, automotive); autoclave prepreg; out- of-autoclave prepreg; filament winding; pultrusion; automated tape- laying and fibre- placement; thermoplastic forming; and 3D- printed continuous- fibre composites; with void, porosity and cure quality control; Indian context — HAL, ISRO and Tata use autoclave and emerging ATL/AFP, with giant VARTM wind blades at Suzlon, LM Wind and Vestas, and automotive composites at Mahindra and Tata Motors.

Module 5 · Joining, Bonding, Repair & NDE

Connecting and maintaining composites — mechanical joining (the inevitable bolted interface to metal, with more- severe hole stress concentration, bearing failure, edge- distance and bushing design factors, and titanium Hi- Lok fasteners); adhesive bonding (preferred composite-to-composite via epoxy film adhesives with critical surface preparation, co-cure versus secondary

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bonding); composite repair (scarf repair tapering ply-by-ply to restore 80-95% strength, step repair and bonded patches per the Structural Repair Manual, an MRO industry); NDE; and damage tolerance and certification; Indian context — HAL composite repair and MRO (Tejas, ALH), GMR Aero and Air India MRO, with NDE per ISO 9712 and ASNT.

Module 6 · Sandwich, Special Structures & Indian Capstone

Sandwich and integrated applications — sandwich structures (thin stiff face sheets over a low-density core acting like an I-beam, with Nomex/ aluminium honeycomb, PVC/ PMI/ PUR foam and balsa cores, and failure by face wrinkling/ dimpling, core shear/ crushing and debonding); special applications; a capstone; the modern frontier of AI/ topology- optimised composites, closed-loop AFP, 3D-printed continuous-fibre, recyclable thermoplastic and bio-based composites; Indian deployment — among India's strongest aerospace specialisms at HAL, ISRO, Tata Advanced Materials, Mahindra Aerospace, Boeing/Airbus India, Suzlon/LM Wind and the Indian Navy, growing rapidly under Make in India.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Mallick P.K.	Fiber-Reinforced Composites: Materials, Manufacturing, and Design (CRC Press)
2	Daniel I.M., Ishai O.	Engineering Mechanics of Composite Materials (Oxford)
3	Jones R.M.	Mechanics of Composite Materials (CRC Press)
4	Reddy J.N.	Mechanics of Laminated Composite Plates and Shells (CRC)
5	Strong A.B.	Fundamentals of Composites Manufacturing (SME)

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Trimester 5

26IE6202E Capstone Research / Industry Project – Phase I

Acronym: CAP1 L-T-P-S: 0-0-36-0 Credits: 12 CH: 36 Pre-requisite: RMIP

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Identify and scope a substantial research or industry problem suitable for a 6-month sustained engineering investigation.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(L)
CO2	Conduct comprehensive literature survey or competitive analysis to position the proposed work against current state-of-the-art.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO3	Design system architecture, methodology, and experimental setup with rigorous justification of every design choice.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M)
CO4	Implement a functional baseline that demonstrates feasibility of the approach with measurable preliminary results.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO5	Evaluate baseline against established benchmarks.	4 · Analyse	PO1(M), PO2(H), PO3(M), PO4(L)
CO6	Defend Phase-I work to a panel of academic and industry reviewers with a clear roadmap for Phase-II.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Problem Identification & Scoping

Source streams — faculty research labs, industry partnerships (KL corporate MoUs), open- source needs (LangChain/ HuggingFace/ vLLM issues), product gaps and startup ideas; scoping — six- month feasibility, dissertation- worthiness, defensibility, novelty; stakeholder alignment — supervisor, industry mentor, IPR cell; milestone planning — the Phase-I and Phase-II split; framing a clear, answerable research or engineering question.

Module 2 · Literature Survey / Competitive Analysis

For the research track — PRISMA systematic review, citation-graph traversal, identifying seminal versus recent versus adjacent work; for the industry track — competitive analysis of existing products, services and open-source projects, gap analysis, market positioning; identifying the closest three to five prior works the dissertation must outperform; synthesising the state of the art into a defensible baseline.

Module 3 · System Design & Methodology

System architecture — high- level diagram, component breakdown, interface design; methodology — algorithms, training procedures, evaluation protocols; data plan — sources, licensing, ethics; tooling and infrastructure decisions; risk register — what could fail and mitigations; reproducibility plan — commitments to open data, open code and open models; success criteria and evaluation metrics.

Module 4 · Baseline Implementation

Implement the first working version end- to- end — even if simple, it must demonstrate the full pipeline; set up a reproducible training/ inference pipeline; instrument with logging, telemetry and evaluation; establish baseline metrics; code quality — type hints, tests, CI/ CD; containerise for portability; document setup so a reviewer can reproduce results in thirty minutes; version control and experiment tracking.

Module 5 · Baseline Evaluation

Evaluate the baseline against the benchmarks established in the survey; quantitative metrics with statistical-significance testing; qualitative analysis — error categories and failure modes; ablation study — the contribution of each component; a comparative table against prior art; identifying the gaps that Phase II will close; documenting limitations and threats to validity.

Module 6 · Phase-I Defense

A 20- minute presentation to a panel of two to three reviewers (academic supervisor, industry mentor, external faculty); cover problem motivation, literature positioning, methodology, baseline implementation, results and the Phase- II plan; question- and-answer demonstrating depth on every aspect; receiving structured feedback for Phase-II refinement; the decision — pass, pass-with-revisions, or restructure Phase-II; defining clear Phase-II objectives.

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REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Strunk W. & White E.B.	The Elements of Style (4th ed.)
2	Kleppmann M.	Designing Data-Intensive Applications (O'Reilly, 2017)
3	Goodfellow I. et al.	Deep Learning (MIT Press, 2016)
4	Patterson D. & Hennessy J.	Computer Architecture: A Quantitative Approach (6th ed.)
5	Domain-specific dissertation guides per program (e.g., 'Writing for Computer Science'	Zobel, for CSE/AIDS)

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Trimester 6

26IE6303E Capstone Research / Industry Project – Phase II

Acronym: CAP2 L-T-P-S: 0-0-36-0 Credits: 12 CH: 36 Pre-requisite: CAP1

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Implement the full system or methodology beyond Phase- I baseline, incorporating novel contributions that advance the state-of-the-art.	5 · Create	PO1(M), PO2(H), PO3(M), PO4(M)
CO2	Conduct comprehensive evaluation covering benchmark comparisons, ablations, and error analysis.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)
CO3	Produce a dissertation-grade thesis document following IEEE/ ACM/ Springer or institutional format.	5 · Create	PO1(M), PO2(M), PO3(M), PO4(H)
CO4	Submit a publishable paper to a peer- reviewed venue OR file a patent disclosure OR ship a product feature OR open-source a substantial library.	5 · Create	PO1(L), PO2(H), PO3(M), PO4(M)
CO5	Defend the dissertation to an external-examiner panel demonstrating mastery of every technical and methodological choice.	5 · Evaluate	PO1(L), PO2(H), PO3(M), PO4(M)
CO6	Translate the dissertation into a placement / PhD- application / startup- pitch artifact suite.	5 · Create	PO2(H), PO3(M), PO4(M)

MODULE-WISE SYLLABUS

Module 1 · Full System Implementation & Novel Contributions

Build beyond the Phase- I baseline; implement the novel contribution — a new algorithm, architecture, analysis, or product feature; integrate components into a polished end- to- end system; performance- tune for production- grade quality; stress- test against edge cases; code quality at staff-engineer level; maintain reproducibility, documentation and version control throughout; and engineering the system for maintainability and extension.

Module 2 · Comprehensive Evaluation

Go beyond Phase-I evaluation; multiple benchmarks — established plus dissertation-specific; ablation studies quantifying every design choice; error analysis — a taxonomy of failure modes; robustness — adversarial inputs, distribution shift, edge cases; fairness analysis where applicable; the cost- performance frontier; reproducibility cross- check by an independent third party; statistical rigour throughout; and reporting results with full honesty about limitations.

Module 3 · Dissertation Writing

The full dissertation document (60-100 pages); structure — abstract, introduction, related work, methodology, implementation, evaluation, discussion, conclusion, future work, references, appendices; the narrative arc telling the story of the work; figures and tables that each earn their place; consistent, correct mathematical notation (LaTeX); citation discipline; plagiarism check; rounds of supervisor review and revision; clarity, rigour and academic style.

Module 4 · External Output — Paper / Patent / Product / OSS

Translate the dissertation into one or more external outputs — a paper submitted to a peer- reviewed venue (workshop, conference, journal); a patent disclosure filed with the IPR cell, optionally via the PCT route; a product feature shipped to production at an industry partner; or an open- source library published with documentation, examples and community engagement; the outcome is real — visible, reviewable and citable.

Module 5 · Final Dissertation Defense

A 30- minute presentation to a panel of supervisor, industry mentor (where applicable), an external examiner from a different institution, and one to two internal faculty; the panel reviews the dissertation, evaluation report and external output before the defence; question-and-answer covering methodology depth, alternative design choices, limitations and future work; the decision
— pass, pass-with-revisions, pass-with-major-revisions, or fail; the external examiner's evaluation is binding.

Module 6 · Translation to Career Artifacts

Translate the dissertation into career-leverage artifacts; for placements — an arXiv preprint, demo video, GitHub repo with stars, and a blog post explaining the work; for PhD applications — a research statement, reference letters, a paper preprint, and a statement of purpose; for startup founding — a pitch deck, business plan, market sizing, technical demo, and IP strategy; the

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dissertation is the launch pad, not the destination.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1		Same Phase-I books continued
2		Domain-specific deep dives selected with supervisor
3		Strunk W., White E.B., The Elements of Style, 4th ed.
4		Patterson D., Hennessy J., domain architecture references
5		Author / first-author papers in the dissertation area (40-60 papers cited in dissertation)

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7 · Professional Electives

Stream A · Vehicle and Mobility Design

Automotive, EV, vehicle dynamics and aerial-vehicle mechanical design.

26MD52A1E Automotive Vehicle Design

Acronym: AVED L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the modern automotive architecture covering BIW and chassis and powertrain integration.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer vehicle packaging, ergonomics, and occupant accommodation.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer crashworthiness and occupant protection covering frontal/side/rear/ rollover.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer aerodynamics and thermal management covering cooling, brake, and battery.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer lightweighting, materials, and manufacturing covering high-strength, UHS steel, and aluminium.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO6	Engineer vehicle-integration capstone covering packaging, crash, and aero.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Automotive Architecture & Development Process

Vehicle architectures — body- on- frame (SUVs and pickups like the Mahindra Thar and Tata Safari), the modern- dominant unibody (Maruti, Hyundai, Tata Nexon), and spaceframe; powertrain layouts (FWD/ RWD/ AWD, ICE, hybrid, BEV skateboard, FCEV); and platform sharing (Tata ALPHA, Maruti Heartect, VW MQB); the development process (a modified V-model stage-gate from concept through packaging, styling freeze, engineering, verification and validation to production, on CAD/ CAE/ PLM via Teamcenter and 3DEXPERIENCE); and development KPIs (weight, cost, performance, safety, emissions, drive quality, NVH); Indian context — 3-5- year Indian OEM cycles at Tata Motors, Mahindra, Maruti, Bajaj, TVS and Ashok Leyland on Indian platforms.

Module 2 · Vehicle Packaging, Ergonomics & Occupant Accommodation

Packaging fits everyone and everything in the smallest envelope while meeting comfort and regulation — the H-point occupant reference (per SAE J1100 and ECE R17) defining layout, with ingress/egress and fore-aft/vertical/lateral zones; anthropometry (5th-percentile female to 95th-percentile male, Reichert manikins); visibility (A-pillar obscuration and mirror vision per ECE R46, blind spots and sensor placement); reach and controls; approach/ departure/ breakover angles; and HVAC thermal comfort; Indian context — Indian- population anthropometry (IIT/ CRRI databases), high ground- clearance demand, and rear- seat/ chauffeur comfort emphasis at Maruti, Mahindra and Tata, with RAMSIS at Tata, Mahindra and Bosch India.

Module 3 · Crashworthiness & Occupant Protection

Saving lives via controlled energy management — crash modes (frontal full and 25% small- overlap, oblique, side pole, rear, rollover, and pedestrian); the energy-management strategy (front rails and crumple zones, a rigid passenger cell, boron-steel B-pillars and door beams, rollover roof); restraints (three-point belts with pretensioners and load limiters, front/side/curtain/knee airbags, ISOFIX); injury criteria (HIC below 1000, chest deflection, Nij neck, via Hybrid III and WorldSID dummies); explicit-FEM CAE; and regulations; Indian context — Bharat NCAP (launched 2023) rapidly elevating standards, with 5- star Tata Nexon EV, Punch and Mahindra XUV300, tested at ARAI and iCAT.

Module 4 · Aerodynamics & Thermal Management

Moving and cooling a vehicle efficiently — aerodynamics (drag coefficient targets of 0.25-0.30 with EVs pushing below 0.22 for range, via RANS/DES CFD in STAR-CCM+, Fluent and OpenFOAM with wind-tunnel validation, underbody smoothing, diffusers, active grille shutters, and lift/crosswind stability); and thermal management; with aero and thermal interacting at the front-end

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aperture; Indian context — severe Indian- climate thermal loads (high ambient, monsoon humidity, dust) driving over- specified cooling at Tata, Mahindra, Maruti and EV makers, with ARAI/CRRI wind tunnels.

Module 5 · Lightweighting, Materials & Manufacturing

Lighter means better range, economy and performance — materials (the mild-steel to HSLA to advanced-high-strength AHSS to boron- steel hot- stamping progression, aluminium sheet and extrusion for premium bodies, magnesium, carbon- fibre composites, and plastic- composite hybrids); material selection per part (strength, stiffness, cost, formability, joinability, recyclability, Indian localisation); joining; tailor-welded and hot- stamped blanks; CAE- driven topology, size and shape optimisation for load paths; and manufacturing constraints; Indian context — Indian mills (Tata Steel, JSW, AMNS) supplying AHSS, with aggressive lightweighting under BS-VI, Bharat NCAP and CAFE-II, and emerging Hindalco aluminium sheet.

Module 6 · Vehicle Integration Capstone & Indian Regulatory

Putting it together — integration (simultaneous packaging, crash, aero, lightweighting, NVH, dynamics, powertrain, ADAS and manufacturing via CAE-led multidisciplinary optimisation); NVH (engine, road and wind noise and body/mount vibration via FE/ BEM in Nastran and Actran); manufacturing readiness and tolerance stack- up; the Indian regulatory landscape (AIS standards via ARAI/iCAT homologation, BS-VI and RDE emissions, Bharat NCAP, AIS-140 tracking, ABS/ESC/airbag mandates, CAFE-II, and EV- specific AIS-038/156 battery safety and CCS2 charging); the software- defined- vehicle frontier; and a capstone; Indian deployment — heavy investment in next-gen EVs, ADAS and connected vehicles at Tata, Mahindra, Maruti, Bajaj and TVS, with very high demand for integration engineers.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Heisler H.	Advanced Vehicle Technology (Butterworth-Heinemann)
2	Genta G., Morello L.	The Automotive Chassis (Springer)
3	Davies G.	Materials for Automobile Bodies (Butterworth-Heinemann)
4	Hucho W.-H.	Aerodynamics of Road Vehicles (SAE)
5	Du Bois P.A. et al.	Crashworthiness Engineering (CRC)

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26MD53A2E Powertrain Engineering for EVs and Hybrids

Acronym: PTEV L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the EV/hybrid powertrain covering BEV and HEV and PHEV, FCEV, and range-extended.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer electric machines for traction covering PMSM and axial-flux.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer power electronics and drives covering 3- phase inverter, DC- DC converter, and on-board charger.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer Li-ion battery and pack design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer BMS, thermal management, and charging.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer e-axle integration and Indian capstone.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · EV & Hybrid Powertrain Architectures

Why electric — energy economics, emissions, grid evolution, and an 80%+ battery- cost decline; architectures (dominant full-battery BEVs like the Tata Nexon EV; parallel, series and power- split hybrids classified P0- P4 by motor placement, as in the Toyota Prius and Honda i-MMD; plug-in PHEVs; range-extended REEVs; and hydrogen FCEVs); the system architecture; and 400V versus 800V architecture; Indian context — the Indian EV revolution under FAME-II, PLI-Auto and PLI-ACC, AIS-156 safety and the Hydrogen Mission, with Tata leading and Mahindra, Ola, Ather, Bajaj and TVS scaling.

Module 2 · Electric Machines for Traction

Converting electricity to torque — PMSM (the dominant 95-97%- efficient traction motor in Tata Nexon EV, Ola and Tesla 3/ Y, using embedded rare-earth NdFeB magnets and hairpin windings, with an Indian rare-earth dependency); induction motors (rare-earth-free and robust, as in Tesla S/X); switched-reluctance motors (rare-earth-free and cheap but high torque-ripple and noise); emerging high- torque- density axial-flux and unsprung- mass hub motors; cooling (air versus liquid/ oil- spray/ immersion); materials (low-loss silicon electrical steel, hairpin copper, and heavy-rare-earth-reduced magnets); and design; Indian context — Indian EV-OEM motor design at Tata, Mahindra (Valeo), Ola and Ather, with machine R&D at IIT-Madras/Bombay and IISc.

Module 3 · Power Electronics & Motor Control

Converting and controlling — the traction inverter (a three-phase bridge turning DC to AC, using mature cheap Si-IGBTs versus faster lower-loss SiC MOSFETs for premium 800V EVs and emerging GaN for OBC/DC-DC, in 2-level or 3-level topologies, sized by DC-link voltage, peak current and junction-temperature cooling via liquid cold plates); the DC-DC converter and bidirectional on-board charger (with emerging V2G/V2L); and motor control; Indian context — Bosch, Continental, ZF and Mahle India inverter design, Indian startups and in-house Tata/Mahindra, with power-electronics R&D at the IITs.

Module 4 · Li-ion Battery & Pack Design

The heart of the EV — cell chemistries (energy-dense NMC/NCA in most EVs, cheaper safer longer-life LFP dominant in mass-market and favoured by Indian PLI- ACC, emerging LMFP and sodium- ion, and future solid- state); cell formats (cylindrical 18650/21700/4680, prismatic BYD blade, and pouch); cell-to-pack and cell-to-chassis designs eliminating modules for 15-25% density gain (BYD blade, Tesla 4680 structural pack); pack design (series/ parallel arrangement, busbars, liquid/ immersion cooling, and safety via fuses, pyro- disconnect and thermal- propagation barriers); and AIS-156; Indian context — battery localisation under the 18,100-crore PLI-ACC (Tata BatteryWorks, Reliance New Energy, Ola Cell, Amara Raja, Exide) amid lithium/ rare-earth dependency.

Module 5 · BMS, Thermal Management & Charging

Smart battery operation — the BMS (the pack's brain monitoring cell voltages, temperatures and currents; estimating State of Charge via coulomb- counting/ OCV/ Kalman, State of Health and State of Power; cell balancing; safety monitoring; and CAN communication, in distributed or centralised architecture under ISO 26262 ASIL- C/ D); battery thermal management (keeping cells at 20-40C via air for two-wheelers, dominant liquid cold- plate, emerging immersion, and refrigerant/ heat- pump systems that also heat the cabin and save range); and DC fast- charging; Indian context — rapid charging- infrastructure growth (Tata

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Power EZ, Statiq, ChargeZone), Indian V2G pilots, and battery-localisation-driven BMS R&D.

Module 6 · E-Axle Integration & Indian EV Capstone

Putting it together — the e- axle (integrated motor, co- packaged inverter, single- or multi- speed reducer, differential and half-shafts, from Bosch, ZF, Schaeffler and Magna, reducing weight and cost); single- versus multi- speed transmissions (single sufficient for most EVs, multi-speed for high- performance and heavy trucks); hybrid architectures and control (Toyota power-split, series REEV, parallel and 48V mild-hybrid, with rule-based, ECMS, DP and ML energy management); vehicle integration; the Indian EV regulatory ecosystem; and a capstone: Indian deployment — Tata leading with 70%+ share, alongside Mahindra BE 6e/9e, Maruti eVX, Ola, Ather, Bajaj and TVS.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Larminie J., Lowry J.	Electric Vehicle Technology Explained (Wiley)
2	Husain I.	Electric and Hybrid Vehicles: Design Fundamentals (CRC)
3	Plett G.	Battery Management Systems (Vol 1 & 2, Artech)
4	Krishnan R.	Electric Motor Drives (Prentice Hall)
5	Mohan N., Undeland T., Robbins W.	Power Electronics (Wiley)

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26MD61A3E Vehicle Dynamics and Suspension Design

Acronym: VDSD L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, MVIB

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse vehicle dynamics fundamentals covering tire- road interface as primary force generator, ride, and handling.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer tire mechanics covering slip angle, slip ratio, and tire force generation.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer suspension and ride dynamics covering McPherson, double-wishbone, and multi-link.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO4	Engineer handling dynamics and stability covering bicycle and 4- wheel handling model, understeer/oversteer and slip-angle, and roll and lateral load transfer.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer brake and steering systems covering brake hydraulics, regenerative blending, and brake-by-wire.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO6	Engineer chassis-tuning capstone covering virtual and physical tuning using CarMaker, ADAMS Car, and VI-Grade.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · Vehicle Dynamics Fundamentals

The 6-DOF view — vehicle-body degrees of freedom (longitudinal, lateral and vertical translations plus roll, pitch and yaw) across coupled ride, handling and longitudinal subsystems; coordinate systems (ISO and SAE conventions); the tire as the primary force generator through four hand-sized contact patches; and the integrated body-chassis-suspension-steering-brake-tire system with its mass, inertia, CG and roll axis; Indian-road context — variable and often poor surfaces, monsoon potholes as the suspension-dimensioning load case, and speed- breakers driving Indian- tuned dynamics at Tata, Mahindra and Maruti; and how EVs shift dynamics (heavier low-CG battery floors, instant torque, regen, low NVH) demanding EV-specific tuning.

Module 2 · Tire Mechanics & Pacejka Magic Formula

The tire is the foundation — construction (radial versus bias, tread, sidewall, steel- belt and carcass, the size code, and rolling versus dynamic radius); slip (longitudinal slip ratio and lateral slip angle); force generation (longitudinal, lateral and self-aligning moment saturating at moderate slip, and the combined-slip friction circle critical for ABS/ESC); the industry-standard Pacejka Magic Formula (MF-Tyre with B/C/D/E parameters per load, camber and inflation); the tire-model hierarchy; and flat-track and drum testing; Indian context — a world-class Indian tire industry (MRF, Apollo, JK, CEAT with significant R&D), where tire-vehicle matching is a critical Indian-tuning skill.

Module 3 · Suspension Types & Ride Dynamics

Isolating the body from the road — suspension types (common McPherson strut, double- wishbone, modern multi- link, cheap torsion-beam, off-road 5-link rigid axle, commercial leaf spring, air-spring, and semi-active/active dampers); geometry (camber, caster, toe, kingpin, roll-center height, anti- dive and anti- squat, the last critical for EV regen); springs and dampers (coil/ leaf/ torsion/air, twin-tube versus monotube, and low/high-speed valving); ride models (the canonical 2-DOF quarter-car, half-car and 7- DOF full- car under ISO 8608 road inputs); metrics; and sky- hook semi- active damper tuning; Indian context — pothole and speed- breaker robustness and tropical durability making ride- tuning a differentiator, with Tenneco India and Tata/ Mahindra/ Maruti chassis teams.

Module 4 · Handling Dynamics & Stability

How the vehicle corners — the canonical 2- DOF bicycle model (front/ rear slip angles, cornering stiffness and CG distribution giving the understeer gradient, with characteristic and critical speeds); the 4-wheel model adding load transfer, roll and nonlinear tires; cornering performance (steady- state lateral- acceleration diagrams and transient sine- with- dwell yaw response); roll dynamics (roll stiffness, lateral load transfer and anti-roll-bar tuning controlling understeer balance); brake-handling interaction; and electronic controls; with rollover mitigation for SUVs; Indian context — variable- surface handling and Bharat NCAP 5- star demanding ESC, supplied by Bosch and Continental India, with evolving Indian-OEM chassis tuning.

Module 5 · Brake & Steering Systems

Stopping and steering — brake systems (front discs and rear discs/ drums, master cylinder and vacuum/ electric booster, ABS modulator, and floating/fixed calipers); brake-force distribution (electronic EBD); EV regenerative-braking blending (motor regen

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for 60-80% of energy with cooperative ABS and brake- by- wire via Bosch IPB and Continental MK C2); brake- fade cooling and monsoon recovery; steering systems; and advanced steering; Indian context — Bosch, Continental, ZF and Brembo India braking and JTEKT/Mando/ZF steering, with a transition to EPS and by-wire in Indian premium vehicles.

Module 6 · Chassis Tuning, Simulation & Indian Capstone

Putting it all together — virtual prototyping (full- vehicle multibody in the dominant IPG CarMaker and ADAMS Car, VI- Grade driving simulators and dSPACE HIL, running skid- pad, slalom and sine- with- dwell scenarios correlated to test); K&C rig characterisation for parameter ID; proving- ground testing (NATRiP, iCAT, ARAI, Mahindra MRV, Tata ERC); the chassis- tuning workflow; ADAS-dynamics integration; Indian off-road strength (Mahindra Thar, Tata Safari, Maruti Jimny); the software-defined-vehicle frontier; and a capstone (a complete Indian- OEM chassis- tuning study with virtual, physical and ADAS- aware tuning); Indian context — Indian chassis tuning a growing differentiator at Tata, Mahindra and Maruti.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Milliken W., Milliken D.	Race Car Vehicle Dynamics (SAE)
2	Gillespie T.	Fundamentals of Vehicle Dynamics (SAE)
3	Pacejka H.	Tire and Vehicle Dynamics (Butterworth-Heinemann)
4	Reimpell J., Stoll H.	Automotive Chassis: Engineering Principles
5	Wong J.Y.	Theory of Ground Vehicles (Wiley)

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26MD61A4E Drone and UAV Mechanical Design

Acronym: DUMD L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, NFEM

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse UAV configurations and Indian ecosystem.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer UAV aerodynamics and flight mechanics.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO3	Engineer airframe structural design covering composite, 3D- printed, and injection-molded polymer.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO4	Engineer propulsion and power covering BLDC out- runner motor, propellers, and Li-Po and Li-ion battery.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)
CO5	Engineer payload integration and mission-specific design.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO6	Engineer Indian drone capstone covering Drone Shakti, PM Drone Didi, and KISAN.	5 · Create	PO1(H), PO2(H), PO3(M), PO4(M), PO5(M)

MODULE-WISE SYLLABUS

Module 1 · UAV Configurations & Indian Drone Ecosystem

The configuration zoo — multirotors (dominant quad/ hexa/ octocopters, fully electric with excellent hover but limited 30-60-minute endurance, at 5-20kg MTOW); fixed- wing UAVs (miniature aircraft like DRDO Tapas- BH with far greater range and endurance but needing a runway and unable to hover); VTOL hybrids (tilt- rotor, tail- sitter, and the emerging- dominant lift- plus-cruise); and flapping-wing and airship variants; across mission classes (military ISR and strike, photography, delivery, agriculture, inspection, Smart City, and eVTOL passenger air mobility); Indian ecosystem — liberalised Drone Rules 2021 with Digital Sky zones, a Drone PLI, Drone Shakti proliferation, and the ideaForge/Garuda/ePlane industry making India the world's third-largest projected drone market.

Module 2 · UAV Aerodynamics & Flight Mechanics

Lift, propel and control — multirotor aerodynamics (momentum theory and Blade Element Theory for thrust and torque, figure-of-merit, ground effect, and rotor- wash interaction); fixed- wing aerodynamics (low- Reynolds- number Selig/ Eppler airfoils, lift and drag versus angle of attack and stall, wing planform and aspect ratio, and finite- wing induced drag and Oswald efficiency); stability and control (longitudinal pitch stability and tail volume, lateral dihedral effect, directional yaw, and phugoid/ short-period/Dutch-roll dynamic modes); tools (the XFOIL low-Re gold standard, AVL vortex-lattice, XFLR5, and OpenFOAM/Fluent for rotors); and performance; Indian context — foundational aero for Indian UAV design at DRDO, NAL and drone startups.

Module 3 · Airframe Structural Design

Lightweight and strong — materials (workhorse carbon- fibre composite for performance UAVs, cheaper glass- fibre, impact-resistant Kevlar for defence, aluminium 6061- T6, 3D- printed nylon/ carbon- filled for prototypes and light production, crash-tolerant foam, and injection-moulded consumer bodies); airframe types (frame-based multirotor, monocoque, composite shell); structural sizing (flight, maneuver, gust and hard-landing loads, payload mounting and vibration isolation, and crash/bird-strike); CAD (Solidworks, Fusion 360, CATIA); FEA (Abaqus, ANSYS, nTopology for static, modal, impact and buckling); topology optimisation; and component design; Indian context — carbon-composite airframes at ideaForge and premium Indian makers, with 3D-printing increasingly used by drone startups.

Module 4 · Propulsion & Power

Thrust and endurance — the BLDC out-runner motor (direct-drive with a Kv rating sized to thrust, propeller, voltage and current at 85-93% efficiency); the ESC (a three- phase inverter with PWM/ DShot protocols and BLHeli32/ AM32 firmware); propellers (diameter and pitch, 2- versus 3- blade trading endurance against thrust, carbon/ plastic materials, and critical balancing); batteries (high-power-density LiPo versus higher-energy Li-ion NMC for endurance, cell configuration, C-rate, and 30-50% of UAV mass with monitoring and thermal safety); fixed-wing/hybrid options; and propulsion sizing; Indian context — Li-ion heavy-lift at ideaForge and Garuda, with DRDO/IISc hydrogen-UAV and NAL solar-HALE programs.

Module 5 · Payload Integration & Mission-Specific Design

Mission-driven payloads — cameras (4K-8K RGB, thermal IR, 5-band multispectral for crop NDVI, and hyperspectral); LiDAR (DJI Zenmuse and Indian systems rapidly replacing photogrammetry for survey- grade 3D mapping); sprayers (10-30L agri- drone

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tanks with pumps, nozzles, application- rate and drift control, for the Garuda/ DJI Agras fleet under PM Drone Didi and KISAN drone); cargo delivery (quick-release drop mechanisms for medical and e-commerce, via Zomato, Garuda and ePlane); gimbals; retractable landing gear; CG management and quick-change modular payloads; and defence payloads; Indian context — mission-specific integration across the Indian agri, inspection, delivery and defence drone markets.

Module 6 · Indian Drone Capstone + DGCA + Drone Shakti

Indian regulation and manufacturing — DGCA Drone Rules 2021 (UIN registration, the Nano- to- Large weight categories, No-Permission-No- Take- off via Digital Sky, green/ amber/ red geofencing, the Remote Pilot Certificate, insurance, and BVLOS approval); type certification for medium/ large drones; the Drone PLI incentivising 30+ Indian OEMs; Drone Shakti proliferation; PM Drone Didi (15,000 women-led agri-drone enterprises with subsidy) and the KISAN drone and SVAMITVA mapping schemes; counter- drone systems (jamming, nets, interceptors at DRDO and the Army); the eVTOL/ UAM frontier (ePlane) and hydrogen/ solar UAVs; and a capstone: Indian context — a fast-growing liberalised ecosystem under Drone Shakti and PLI.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Austin R.	Unmanned Aircraft Systems: UAVS Design, Development and Deployment (Wiley)
2	Valavanis K., Vachtsevanos G.	Handbook of Unmanned Aerial Vehicles (Springer)
3	Anderson J.D.	Fundamentals of Aerodynamics (McGraw-Hill)
4	Etkin B., Reid L.D.	Dynamics of Flight (Wiley)
5	Leishman J.G.	Principles of Helicopter Aerodynamics (Cambridge)

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Stream B · Manufacturing and Industrial Engineering

Additive manufacturing, smart factory, generative design and precision engineering.

26MD52B1E Additive Manufacturing and Design for AM

Acronym: ADAM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO, DEPL

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse AM process families and Indian ecosystem.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer Design for AM covering topology optimization, lattice and cellular structures, and part consolidation and assembly elimination.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO3	Engineer metal AM processes covering DMLS/ SLM, WAAM, and Binder Jetting.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer polymer and ceramic AM covering Material Jetting.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer AM materials, post-processing, and quality.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer Indian AM capstone and qualification.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · AM Process Families & Indian Ecosystem

AM builds a part layer-by-layer from a 3D model, in seven ASTM F2792 process families — material extrusion (low-cost FDM/FFF via Stratasys, Markforged and Indian bureaus), vat photopolymerisation (high- resolution SLA/ DLP for dental and jewelry), powder-bed fusion (polymer SLS and MJF, and the dominant metal DMLS/SLM via EOS, GE and Renishaw, plus EBM), material jetting (multi- colour PolyJet), binder jetting, sheet lamination, and directed- energy deposition; plus ceramic and concrete AM; Indian context — a strong ecosystem led by Wipro 3D (India's largest bureau, supplying HAL/ISRO), Intech DMLS, Imaginarium, in-house HAL/ISRO/DRDO/GTRE AM, and the CSIR-AMTC Hyderabad hub under Make in India.

Module 2 · Design for AM (DfAM)

DfAM unlocks AM's power — topology optimisation (Altair OptiStruct, nTopology and Ansys removing material within a design space, exemplified by GE's 855-parts-to-1 fuel nozzle); lattice and cellular structures (gyroid TPMS, octet-truss, Voronoi via nTop and Materialise Magics, for lightweighting, cooling and impact absorption); part consolidation (replacing assemblies with a single part); internal channels (conformal cooling, heat exchangers, manifolds impossible subtractively); multi- functional integration; build- orientation and support-structure design; and thermal- distortion- aware predistortion simulation; with AM design rules (45- degree self- supporting overhangs, minimum feature size, wall thickness); Indian context — emerging DfAM strength at the IITs/IISc, Wipro 3D, 3D Future and Intech DMLS engineering teams.

Module 3 · Metal AM Processes

The flagship of AM — DMLS/ SLM (a fiber laser melting powder under inert atmosphere at 20-60um layers, the dominant production metal AM via EOS, GE, Renishaw, SLM Solutions and support-free Velo3D, with process parameters governed by melt-pool physics and volumetric energy density controlling lack-of-fusion versus keyhole porosity); EBM; WAAM; DED; metal binder jetting; and cold spray; with process selection by feature size, throughput and criticality; Indian context — Wipro 3D operates over 30 SLM/DMLS/EBM machines, ISRO LPSC makes Vikas and CE-20 engine components via SLM, and HAL/DRDO/GTRE increase adoption.

Module 4 · Polymer + Ceramic + Composite AM

AM beyond metal — FDM/FFF (extruded thermoplastic via Stratasys and Markforged's continuous-fibre composites, from PLA/ ABS to high-T PEEK/PEKK/PEI); SLA/DLP/LCD (high-resolution UV-cured photopolymer for dental, jewelry and medical models via Formlabs and Carbon's fast CLIP); SLS (CO2- laser- sintered nylon PA12 via EOS, production- grade); HP Multi- Jet Fusion (faster nylon production); PolyJet material jetting (multi- material full- colour); continuous- fibre composite AM (Markforged, Anisoprint at near- metal strength); high-T thermoplastics for aerospace and implants; ceramic AM (Lithoz alumina/ zirconia); and bio- printing; Indian context — Markforged, Stratasys, 3D Systems, HP MJF and EOS via Wipro 3D, 3D Future, Imaginarium

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and academic AM at the IITs/IISc.

Module 5 · Materials, Post-Processing & Quality

Materials physics and finishing — metal alloys (canonical Ti-6Al-4V for aerospace and implants, lightweight AlSi10Mg, high- T Inconel 625/718 for turbines, 316L, tool steels for conformal- cooled moulds, CoCr implants, copper, refractories); polymer materials (SLS PA12, PEEK, TPU); powder properties (particle- size distribution, sphericity, flowability, recyclability, and Ti/ Al pyrophoric safety); AM microstructure with columnar grains treatable by heat treatment and HIP; post- processing (HIP eliminating porosity, stress- relief, support removal, machining, surface finishing); inspection (CMM, X- ray CT as the gold standard for internal defects); and standards; Indian context — Wipro 3D AS9100, ISRO/ HAL qualifications, and medical AM under ISO 13485 and CDSCO.

Module 6 · Indian AM Capstone + Qualification

Production- grade Indian deployment — aerospace qualification (AS9100, DGCA AC 20-184, OEM AMS specs, HAL/ ISRO protocols); medical qualification (ISO 13485, USFDA 510(k), CDSCO, ISO 10993 biocompatibility) and patient-specific implants; production economics (AM winning for complex, low-volume, customised, repair and spares, subtractive for high-volume); repair AM (DED, cold- spray, WAAM for engines, turbine blades and dies); emerging multi- material, AM- electronics, in- space and construction AM, multi- laser throughput and AI- driven AM; a capstone; Indian context — India is among the world's fastest-growing AM markets, with opportunity under AM-PLI, Make in India, Atal Mission and ISRO cryogenic engines.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Gibson I., Rosen D., Stucker B.	Additive Manufacturing Technologies (Springer)
2	Yang S., Zhao Y.F.	Additive Manufacturing-Enabled Design Theory and Methodology
3	Yan L.	Selective Laser Melting Additive Manufacturing
4	Milewski J.O.	Additive Manufacturing of Metals (Springer)
5	Wohlers T.	Wohlers Report (annual industry survey)

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26MD53B2E Mechatronics and IoT Smart Systems

Acronym: MISS L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: DEPL, MISS

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the mechatronics and IoT framework.	4 · Analyse	PO1(H), PO2(M), PO4(M), PO5(L), PO6(M)
CO2	Analyze sensors, signal conditioning, and actuators.	4 · Analyse	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Design microcontroller and embedded systems covering Arduino, STM32, and ESP32.	6 · Create	PO1(H), PO2(M), PO4(M), PO5(M), PO6(M)
CO4	Apply industrial automation and motion control.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Apply IoT communications, cloud, and edge.	3 · Apply	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Develop Industry 4.0, digital twin, and smart-product capstone.	6 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Mechatronics & IoT Framework

What mechatronics and IoT mean today — the synergistic integration of mechanical, electrical, electronic, control and software/ IoT elements into smart systems. Students frame the four pillars (mechanical kinematics/ dynamics, electrical motors/ drives, electronic sensing, control/ computation), the sense- decide- actuate loop, and the IoT layers (device, connectivity, edge, cloud, application) that turn a machine into a connected smart product.

Module 2 · Sensors, Signal Conditioning & Actuators

The front end of any smart system — sensors (position, velocity, force, temperature, vision, IMU), their characteristics and selection, signal conditioning (amplification, filtering, ADC), and actuators (DC/ BLDC/ stepper/ servo motors, pneumatics, hydraulics) with their drives. Students specify a complete sensing-and-actuation chain and condition real signals.

Module 3 · Microcontrollers & Embedded Systems

The compute core — microcontroller and embedded-system design across Arduino, STM32 and ESP32, GPIO/timers/interrupts/ PWM/ADC, communication peripherals (UART, I2C, SPI), and real-time embedded programming. Students design and program an embedded controller for a mechatronic subsystem.

Module 4 · Industrial Automation: PLC + SCADA + Motion Control

Automation at the factory scale — industrial automation with PLCs and SCADA, ladder/structured-text programming, HMI, and motion control (servo drives, motion profiles, CNC concepts). Students implement a PLC + SCADA + motion-control routine for an automation task.

Module 5 · IoT Communications, Cloud & Edge

Connecting the smart system — IoT communication protocols (MQTT, CoAP, HTTP), wired and wireless links, edge computing and gateways, and cloud platforms (ThingsBoard, AWS IoT, Azure IoT) for data ingestion, dashboards and analytics. Students build a device-to-cloud IoT pipeline with an edge layer.

Module 6 · Industry 4.0, Digital Twins & Indian Capstone

The integrated end- state — Industry 4.0 (cyber- physical systems, IoT, AI, cloud and analytics), digital twins, predictive maintenance, and smart products, delivered as an Indian-context capstone. Students integrate sensing, control, IoT and a digital twin into a working smart-product demonstrator aligned to Indian smart-manufacturing practice.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bolton W.	Mechatronics (Pearson)
2	Alciatore D.G., Histand M.B.	Introduction to Mechatronics and Measurement Systems (McGraw-Hill)
3	Bishop R.H.	The Mechatronics Handbook (CRC)

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#	Author(s)	Title, Edition & Publisher
4		Gaonkar / relevant Embedded + IoT texts (STM32 + ESP32)

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26MD61B3E Generative Design and Topology Optimisation

Acronym: GDTO L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: NFEM, AIOE

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse the design- optimization landscape covering 3 levels, SIMP density-based, and level-set.	4 · Analyse	PO1(H), PO2(M), PO3(L), PO4(M), PO6(M)
CO2	Engineer topology optimization covering formulation, SIMP penalization, and adjoint sensitivity.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO3	Engineer lattice and cellular structures covering TPMS, octet truss, and Kelvin.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer generative design covering Autodesk Generative Design, Solidworks Generative, and Altair Inspire.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)
CO5	Engineer manufacturing- aware optimization covering DfAM, casting, and injection molding.	5 · Create	PO1(H), PO2(M), PO3(H), PO4(M), PO5(M)
CO6	Engineer AI-driven design and Indian capstone.	5 · Create	PO1(H), PO2(M), PO3(M), PO4(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Design Optimization Landscape

From sizing to topology to AI-generative — the three levels of structural optimisation (sizing of fixed-topology parameters, shape morphing of boundaries, and topology radically redistributing material for the biggest gains); topology methods (the dominant density- based SIMP with penalisation in Altair OptiStruct and Ansys/ Tosca, the smoother level- set, evolutionary ESO/ BESO, phase-field, and homogenisation); and applications, enabled by additive manufacturing for organic geometry; Indian context — increasing adoption at HAL, ISRO, DRDO, Tata Advanced Systems, Tata Motors and Mahindra, with world- class academic strength at the IITs/IISc and Altair/Autodesk/Ansys India.

Module 2 · Topology Optimization Theory & Practice

The math and workflow — the SIMP formulation (minimising compliance subject to equilibrium and a volume constraint, with element densities penalised toward 0/1 via E=rho^p*E0); sensitivity analysis via the efficient adjoint method (one extra solve regardless of variable count); solvers (Svanberg's Method of Moving Asymptotes and Optimality Criteria); filters preventing checkerboarding and mesh-dependence (density, sensitivity, Helmholtz-PDE, Heaviside projection); constraints and extensions; and tools; Indian context — adoption in HAL brackets and airframes, ISRO LPSC cryogenic-engine and payload structures, DRDO, Tata Advanced Systems and Tata/Mahindra/Bosch India CAE teams.

Module 3 · Lattice + Cellular Structures

Engineered porosity — why lattices (lightweighting, impact, thermal, acoustic and bone- like implants, enabled by AM); lattice classes (periodic octet- truss, Kelvin, BCC/ FCC and diamond; smooth isotropic TPMS gyroid and Schwarz P/ D; stochastic Voronoi for bone-like implants; and functionally-graded via nTopology implicit modelling); mechanical behaviour (stiff stretching-dominated octet-truss with linear density scaling versus energy-absorbing bending-dominated foams with quadratic scaling, per Gibson-Ashby and Maxwell stability); multi-physics; and AM-aware design via nTopology, Materialise Magics and Ansys Lattice; Indian context — lattice/AM at Wipro 3D, HAL, ISRO LPSC, DRDO and Indian medical implants (Nupar) under AM-PLI.

Module 4 · Generative Design

AI explores the design space for you — generative design (software exploring thousands of alternatives from loads, constraints, materials, process and goals, presenting mass/ stiffness/ cost/ manufacturability trade- off curves for the designer to select); tools (cloud-AI Autodesk Generative Design pioneering massive parallelism, Solidworks Generative, Altair Inspire, premium AM-focused nTopology, real- time Ansys Discovery, Siemens NX and Creo Generative); multi- objective Pareto frontiers; manufacturing-process awareness; cloud-parallel exploration cutting turnaround from weeks to hours; the designer-in-the-loop as augmentation not replacement; and ML- learned design priors; Indian context — Indian OEMs and bureaus adopting (HAL, ISRO, Tata Advanced Systems, Wipro 3D, Tata Motors, Mahindra, Bosch India).

Module 5 · Manufacturing-Aware Optimization

Optimise for what you can build — DfAM (topology, lattice, consolidation, support-minimisation, build-orientation, and thermal-distortion predistortion, with overhang, feature-size and powder-evacuation constraints and integrated Ansys/Simufact thermal simulation); DfM for subtractive (CNC tool-access, clamping and corner-radius constraints); casting (draft, parting line, uniform

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sections, gigacasting); injection moulding (draft, uniform walls, conformal cooling); sheet metal (bend radii, spring- back); composites (fibre orientation, ply scheduling, tow-steered AFP); and multi-physics/multi-material optimisation; Indian context — Indian- OEM optimisation at HAL (Tejas/ AMCA components), ISRO LPSC, Tata and Mahindra (cast, machined, AM, composite EV), and Indian medical AM.

Module 6 · AI-Driven Design + Indian Capstone

The next frontier — ML/ AI in structural design (deep generative GANs, diffusion models and VAEs generating alternatives in seconds, trained on design/ simulation libraries); reinforcement learning framing design as a game; generative- AI design copilots; neural/Kriging surrogates replacing FEA for rapid optimisation; inverse design from desired performance via diffusion/ RL; bio- inspired design; and the digital- twin feedback loop from operational data; a capstone; Indian context — rapid adoption under AM-PLI and Make in India with world-class academic strength and emerging industrial capability.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bendsoe M.P., Sigmund O.	Topology Optimization: Theory, Methods and Applications (Springer)
2	Christensen P.W., Klarbring A.	An Introduction to Structural Optimization (Springer)
3	Gibson L.J., Ashby M.F.	Cellular Solids: Structure and Properties (Cambridge)
4	Sigmund O.	A 99 line topology optimization code (Structural and Multidisciplinary Optimization journal)
5	Liu J., Du Q.	Design for Additive Manufacturing (Elsevier)

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26MD61B4E Precision Engineering and Metrology

Acronym: PREM L-T-P-S: 3-1-3-0 Credits: 3.5 CH: 7 Pre-requisite: MEDO

COURSE OUTCOMES

CO	Course Outcome Statement	BTL	PO Mapping (L/M/H)
CO1	Analyse precision engineering and metrology fundamentals.	4 · Analyse	PO1(H), PO2(L), PO4(M), PO5(M), PO6(M)
CO2	Engineer Geometric Dimensioning and Tolerancing covering ASME Y14.5, ISO 1101, and 8015.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO3	Engineer measurement uncertainty, ISO 17025, and NABL.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO4	Engineer Coordinate Measuring Machines and optical metrology.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO5	Engineer laser interferometry, nanometrology, and surface metrology.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)
CO6	Engineer in-line, Industry 4.0 metrology, and Indian semiconductor capstone.	5 · Create	PO1(H), PO3(M), PO4(M), PO5(M), PO6(M)

MODULE-WISE SYLLABUS

Module 1 · Precision Engineering & Metrology Fundamentals

Foundations — accuracy, precision, uncertainty and trueness (per ISO 5725 and the VIM); the traceability hierarchy (the 2019 SI redefinition via fundamental constants, primary national standards at the National Metrology Institute — India's CSIR- NPL — through secondary and working standards to industrial measurements, documented back to SI); NABL accrediting Indian calibration labs to ISO 17025; the measurement system and its error sources (operator, 20C- standard temperature, humidity, vibration, thermal expansion); and the precision-engineering scale; Indian context — the Indian Semiconductor Mission (Tata Electronics Dholera 28nm fab, Micron Sanand) demands world-class metrology, alongside HAL/ ISRO/ DRDO aerospace and Indian medical-implant precision.

Module 2 · Geometric Dimensioning & Tolerancing (GD&T)

The language of mechanical design and manufacturing — why GD&T (defining functional intent via geometric controls referenced to datums, where plus-minus tolerances under-constrain fit); the standards (ASME Y14.5-2018 and the ISO GPS 1101 series); the fourteen controls in five categories (datum- free form and versatile profile, and datum- referenced orientation, workhorse position/location and rotating-part runout); modifiers (Maximum and Least Material Condition with bonus tolerance, Regardless of Feature Size, projected zones); the datum reference frame; tolerance stack- up; and functional gauging; Indian context — GD&T is mandatory in Indian aerospace (HAL, Boeing/ Airbus per AS9100), automotive (IATF 16949), medical (ISO 13485) and semiconductor.

Module 3 · Measurement Uncertainty + ISO 17025 + NABL

Putting numbers to the doubt — every measurement reporting a value and its uncertainty; the GUM framework; the uncertainty budget tabulating all error sources; worked examples; Monte Carlo per JCGM 101 when linear GUM assumptions fail; ISO 17025 laboratory competence; and Indian NABL accreditation under QCI, with certificates traceable to NPL and globally recognised via ILAC; Indian context — the Indian metrology ecosystem (CSIR-NPL as NMI, 1000+ NABL labs) growing under the Semiconductor Mission and increasing aerospace/medical/automotive demand.

Module 4 · CMM + Optical Metrology

The workhorse measurement systems — CMMs (bridge, cantilever, horizontal- arm, portable Faro/ Hexagon arms, and 5- axis Renishaw Revo, with touch- trigger, scanning, laser and vision/ multi- sensor probes, driven by PC- DMIS, Calypso and MODUS software via off- line CAD programming, subject to ISO 10360 acceptance and thermal error); and optical metrology; Indian context — CMM and optical installations at HAL, ISRO, Tata Electronics, Bharat Forge, Tata Motors, Mahindra, Maruti and Indian medical AM, with Zeiss, Hexagon, Mitutoyo and Renishaw India leading the market.

Module 5 · Laser Interferometry + Nanometrology + Surface Metrology

Nanometer-scale and below — laser interferometry (split-and-recombined coherent light resolving sub-wavelength displacement, the length-traceability gold standard, for machine- tool calibration via Renishaw XL-80 and Zygo per ISO 230); AFM (a sharp-tipped cantilever scanning surface forces at sub-nm Z-resolution in contact/tapping modes, via Bruker and Park); STM atomic imaging and SEM (electron-beam sub-nm imaging with EDX/EBSD, including semiconductor CD-SEM); surface metrology; Indian

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context — Indian nanometrology at the IITs/ IISc, CSIR- NPL, CMERI and CSIO, with emerging semiconductor metrology at Tata Electronics and SCL under the Semiconductor Mission.

Module 6 · In-Line + Industry 4.0 Metrology + Indian Capstone

From lab to line — in-line metrology (measurement integrated into manufacturing for SPC, closed-loop control and zero-defect Industry 4.0); machine- tool integration (Renishaw on- machine probing and the gauge- by- comparison Equator); optical/ vision inline with AI defect detection; semiconductor metrology (CD-SEM, ASML/KLA overlay, wafer flatness, ellipsometry thin-film, and defect inspection, ramping under the Indian Semiconductor Mission); medical metrology (implant dimensional, surface and porosity verification per ISO 13485 and CDSCO); aerospace metrology; and Industry-4.0 digital- twin and MES/ ERP metrology integration; a capstone; Indian context — India becoming a precision- metrology powerhouse under the 1.26- lakh- crore Semiconductor Mission and Make in India.

REFERENCE BOOKS

#	Author(s)	Title, Edition & Publisher
1	Bell S.	A Beginner's Guide to Uncertainty of Measurement (NPL Good Practice Guide)
2	Krulikowski A.	Fundamentals of Geometric Dimensioning and Tolerancing (Cengage)
3	Hocken R., Pereira P.	Coordinate Measuring Machines and Systems (CRC)
4	Whitehouse D.	Handbook of Surface and Nanometrology (CRC)
5	Smith G.T.	Industrial Metrology: Surfaces and Roundness (Springer)

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LIST OF VALUE ADDED COURSES TO BE OFFERED TO Y25 & Y26 B.TECH MECHANICAL STUDENTS

S.No.	Level/Stage	Course Title	Domain
1	S1	AutoCAD User Certification (Foundation)	CAD
2	S2	Auto desk Fusion 360 basics	
3	S3	Solid works/ Inventor Professional	
4	S4	CSWE or CATIA V5	
5	S1	Leetcode 100 Problems	Computational Thinking
6	S2	Python Institute PCEP	
7	S3	MATLAB Associate	
8	S1	GitHub Copilot	AICoding & Design Tools
9	S2	Claude Code	
10	S3	Autodesk Generative Design exposure	
11	L0	Autodesk certified User:AutoCAD	Smart Manufacturing
12	L1	Autodesk certified User:Inventor	
13	L2	Siemens MindSphere Foundation (Industrial IOT Theory)	
14	L3	AWS IoT Foundation Speciality (Industrial track)	
15	L0	Aurdino Certified-Maker	Mechatronics
16	L1	NI LabVIEW Certified Assiciate Developer(CLAD)	
17	L2	ABB RoboStudis Associate	
18	L3	ABB RoboStudis Associate	
19	L0	Autodesk certified user: AutoCAD	Mechanicl Design
20	L1	ASME Y14.5 GD&T Fundamentals	
21	L2	ANSYS Mechanical Associate	
22	L3	Solidworks Certified Associate (CSWA)	
23	L0	BEE Certified Energy Auditor	Thermal & Energy
24	L1	COMSOL Multiphysics Specialist	
25	L2	CTI Thermal Performance Engineer cert	
26	L3	EV Battery Thermal Management Specialist	
27	L0	Python Institute PCEP	AI For Engineering
28	L1	Google Cloud Generatice AI Leader	
29	L2	Google Cloud Professional ML Engineer	
30	L3	Google Cloud Professional ML Engineer	
31	L0	ANSYS Mechanical Associate	Simulation / CAE
32	L1	ANSYS Mechanical Associate	
33	L2	COMSOL Multiphysics Specialist	
34	L3	COMSOL Multiphysics Specialist	

11/8/26

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List of Open Electives & Management Electives Offered to Y25 & Y26 B.Tech Mechanical Admitted Batch			
S.No.	**OEC #**	**Course Title**	**Stream**
1	OEC1	Foundations of AI Driven Product Thinking	AI Driven Product Management
2	OEC2	Product Strategy & Roadmapping in AI markets	
3	OEC3	AI Product Metrics, Experimentation & Growth Analytics	
4	MGEL	AI Business Models, Pricing Strategy & Monetisation	
5	OEC1	Creative Economy & the Digital Arts Industry	Computational Arts & Digital Creative Media
6	OEC2	Media Production Business, Content Strtegy & Createoe Economy	
7	OEC3	Gaming Industry: Business Models, Market Intelligence & Immersive Commerce	
8	MGEL	Creative Entrepreneurship & Digital Media Venture Strategy	
9	OEC1	Platform Economics & Business Model Design	Digital Economics & Platform Market Intelligence
10	OEC2	Market Intelligence, Competitive Analytics & Strategic Decision Science	
11	OEC3	Digital Consumer Economics, Behavioural Insights & Growth Strategy	
12	MGEL	Innovation Economics, Venture Strategy & Disruptive Market Development	
13	OEC1	Healthcare Systems & Digital Health Ecosystem	Digital Health & Healthcare Informatics
14	OEC2	Healthcare data Analytics and Popilation health Intelligence	
15	OEC3	Hospital Operations, Healthcare Finance & Revenue Management	
16	MGEL	Health policy, Ethics & Global health Care Innovation	
17	OEC1	Financial Ecosystem & Digital Business Models	Fintech & Digital Financial Services
18	OEC2	Digital payments & Transaction Economics	
19	OEC3	Digital lending, Credit Analytics & Risk Markets	
20	MGEL	InsurTech, Embedded Finance & Open Banking	
21	OEC1	Agri-Business Strategy & Food Value Chain Management	Precision Agriculture & AgriTech
22	OEC2	Precision Agiculture & Data Driven Farm Management	
23	OEC3	AgriTech Entrpreneurship, Rural Finance & innovation Ecosystems	
24	MGEL	Global Food Systems, Agricultural Policy & Food Security	
25	OEC1	Global Supply Chain Strategy & Network Design	Supply Chain Logistics Intelligence
26	OEC2	Procurement Intelligence & Supplier Ecosystem Management	
27	OEC3	Logistics Operations & last-Mile Intelligence	
28	MGEL	AI, Blockchain & Autonomous Systems in Future Supply Chains	

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OEME0007-FUNDAMENTALS OF AUTOMOBILES

L-T-P-S:3-0-0-0 CR:3 CH:3 PRE-REQUISITE:NIL

CO-PO MAPPING

CO#	CO DESCRIPTION	PO/PSO MAPPING	BTL
CO1	Identify the major automobile components and layouts	PO1(L2)	2
CO2	Apply the concepts of thermodynamics to understand the working principles of IC, EV and Hybrid Vehicles	PO1(L3)	3
CO3	Apply the concepts of mechanics to understand the transmission systems in automobiles	PO1(L3)	3
CO4	Analyse Suspension, Steering, braking and Emission characteristics of automobiles with an emphasis on performance and environment impact	PO2(L3)	4

Syllabus:

Introduction & Structure of Automobiles: Evolution and classification of automobiles, Vehicle architecture and layouts (FR, FF, RR, EV skateboard), Chassis: Ladder frame, monocoque, Body types and materials, Basic automotive terminology

Power Systems: Engine classification; SI and CI Engines, Four Stroke and Two Stoke Engines, Combustion chambers, Cooling and Lubrication systems, EV and Hybrid Vehicles working principles.

Transmission Systems: Clutch and gearbox (manual & automatic basics), Differential and final drive, Transmission layouts in IC vehicles, Hybrid transmission concepts.

Suspension: Types, Independent, rigid axle, Springs: Coil, leaf, air, Shock absorbers, Steering: Steering geometry basics, Mechanical and power steering, Electric power steering, Intro to steer-by-wire, Braking Systems: Drum and disc brakes, ABS and EBD , Safety considerations. Vehicle Emissions

Text books:

1. Automotive Technology: A Systems Approach, Jack Erjavec, Rob Thompson, 6th Edition, 2014, Cengage Learning
2. Basic Automobile Engineering, C. P. Nakra, 2019 Edition , 2019 (Reprint 2021) , Dhanpat Rai Publications
3. *Automobile Engineering,* S. L. Gavhale, N. R. Choudhary, 4th Edition, 2023, Nirali Prakashan
4. Textbook of Automobile Engineering, S. K. Gupta, 2017 , Tech India Publications
5. Automobile Engineering by Dr. Kirpal Singh. Standard Publishers and Distributors.

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