K L E F

DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech in Robotics & Mechatronics -2018

2018-19 Admitted batch Course Structure

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Contact Hours	Credits
			L	T	P		
1	18 ME 5101	Fundamentals of Mechatronics	3	1	0	4	4
2	18 ME 5102	Advanced Engineering Mathematics	3	1	0	4	4
3	18 ME 5103	Sensors and Actuators	3	1	0	4	4
4	18 ME 5104	Modeling and Simulation of Mechatronic Systems	3	0	2	4	4
5		Elective – 1	3	0	0	3	3
6		Elective – 2	3	0	0	3	3
7	18 IE 5149	Seminar	0	0	4	4	2
		Total	**18**	**3**	**6**	**26**	**24**

First Year (Second Semester):

S. No.	Course Code	Course Title	Periods			Contact Hours	Credits
			L	T	P		
1	18 ME 5205	Robotics: Advanced Concepts and Analysis	3	1	0	4	4
2	18 ME 5206	Control of Mechatronic Systems	3	1	0	4	4
3	18 ME 5207	Mechatronics Product Design	3	1	0	4	4
4	18 ME 5208	Precision Engineering	3	1	0	4	4
5		Elective – 3	3	0	0	3	3
6		Elective – 4	3	0	0	3	3
7	18 IE 5250	Term Paper	0	0	4	4	2
		Total	**18**	**4**	**4**	**26**	**24**

Second Year (First & Second Semester):

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	18 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	18 ME 51A1	Signal Processing in Mechatronic Systems	3	0	0	3
2	18 ME 51A2	MEMS and NEMS	3	0	0	3
3	18 ME 51A3	Vehicle Dynamics and Multi-body Systems	3	0	0	3
Elective-2						
1	18 ME 51B1	Emerging Smart Materials for Mechatronics Applications	3	0	0	3
2	18 ME 51B2	Intelligent Visual Surveillance	3	0	0	3
3	18 ME 51B3	Microprocessors and Embedded Systems	3	0	0	3
Elective-3						
1	18 ME 52C1	Computational Fluid Dynamics	3	0	0	3
2	18 ME 52C2	Nonlinear Optimization	3	0	0	3
Elective-4						
1	18 ME 52D1	Industrial Automation	3	0	0	3
2	18 ME 52D2	Fuzzy Sets and Artificial Intelligence	3	0	0	3

18ME5101-FUNDAMENTALS OF MECHATRONICS

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

Mapping of CO-PO table:

CO#	Course outcome	PO/PSO	BTL
CO1	Apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems.	PO2, PO4	3
CO2	Be proficient in the use of Data conversion devices and Microprocessors controllers and select suitable drives	PO2, PO4	4
CO3	Be able to analyze mechanisms for industrial applications and Design and analyze Hydraulic systems	PO2, PO4	4
CO4	Analyze the Pneumatic systems and understand PID controllers, CNC machines and Industrial Robotics.	PO2, PO4	4

Syllabus:

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems. Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description. Description of PID controllers. CNC machines and part programming. Industrial Robotics.

Text books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile andindustrial applications, SAE, 1994.
3. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
4. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005
5. Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

18ME5102-ADVANCED ENGINEERING MATHEMATICS

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

Mapping of CO-PO table:

CO#	Course outcome	PO/PSO	BTL
CO1	Perform elementary operations on matrices including determination of rank and inverse, demonstrate mastery in using matrix algebra.	PO3, PO4	4
CO2	Interpret and apply differential calculus onproblems involving rate of change	PO3, PO4	4
CO3	Illustrate the applications of integral calculus in solving problems on area, volume, displacement, work	PO3, PO4	5
CO4	Determine gradient, divergence and curl of vector point functions with their properties	PO3, PO4	4

Syllabus:

Linear Algebra: Matrix algebra; basis, dimension and fundamental subspaces; solvability of Ax = b by direct Methods; orthogonality and QR transformation; eigenvalues and eigenvectors, similarity transformation, singular value decomposition, Fourier series, Fourier Transformation, FFT. **Vector Algebra & Calculus:** Basic vector algebra; curves; grad, div, curl; line, surface and volume integral, Green's theorem, Stokes's theorem, Gauss-divergence theorem. **Differential Equations:** ODE: homogeneous and non-homogeneous equations, Wronskian, Laplace transform, series solutions, Frobenius method, Sturm-Liouville problems, Bessel and Legendre equations, integral transformations; PDE: separation of variables and solution by Fourier Series and Transformations, PDE with variable coefficient.

Numerical Technique: Numerical integration and differentiation; Methods for solution of Initial Value Problems, finite difference methods for ODE and PDE; iterative methods: Jacobi, Gauss-Siedel, and successive over-relaxation. **Complex Number Theory:** Analytic function; Cauchy's integral theorem; residue integral method, conformal mapping. **Statistical Methods:** Descriptive statistics and data analysis, correlation and regression, probability distribution, analysis of variance, testing of hypothesis.

Text Books:

1. H. Kreyszig, -Advanced Engineering Mathematics||, Wiley, (2006).
2. Gilbert Strang, -Linear Algebra and Its Applications||, 4th edition, Thomson Brooks/Cole, India (2006).
3. J. W. Brown and R. V. Churchill, -Complex Variables and Applications||, McGraw-Hill Companies, Inc., New York (2004).
4. J. W. Brown and R. V. Churchill, -Fourier Series and Boundary Value Problems||, McGraw-Hill Companies, Inc., New York (2009).
5. G. F. Simmons, -Differential Equations with Applications and Historical Notes||, Tata McGraw-Hill Edition, India (2003).
6. S. L. Ross, -Differential Equations|| 3rd edition, John Wiley & Sons, Inc., India (2004).

18ME5103- SENSORS AND ACTUATORS

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

Mapping of CO-PO table:

CO#	Course outcome	PO/PSO	BTL
CO1	Identify appropriate sensor for a particular Mechatronic system.	PO4	3
CO2	Understand micro electro mechanical system and its manufacturing methods	PO5	2
CO3	Understand the hydraulic and pneumatic actuation systems for selection of appropriate actuation method for a particular Mechatronic system	PO4	5
CO4	Understand the electrical actuation systems for selection of appropriate actuation method for a particular Mechatronic system.	PO4	2

Syllabus:

Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope. Principles and structures of modern micro sensors, micro-fabrication technologies: bulk micromachining, surface micromachining, LIGA, assembly and packaging. **Pneumatic and hydraulic systems:** actuators, definition, example, types, selection. Pneumatic actuator. Electro-pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection. Electrical actuating systems: solid-state switches, solenoids, voice coil;electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors. Piezoelectric actuator: characterization, operation, and fabrication;shapememoryalloys.

Text Books

1. John G. Webster, Editor-in-chief, -Measurement, Instrumentation, and Sensors Handbook‖, CRC Press (1999).
2. Jacob Fraden, -Handbook of modern Sensors‖, AIP Press, Woodbury (1997).
3. Nadim Maluf, -An Introduction to Microelectromechanical Systems Engineering‖, Artech House Publishers, Boston (2000).
4. Marc Madou, -Fundamentals of Microfabrication‖, CRC Press, Boca Raton (1997).
5. Gregory Kovacs, -Micromachined Transducers Sourcebook‖, McGraw-Hill, New York (1998).
6. E. O. Deobelin and D. Manik, -Measurement Systems – Application and Design‖, Tata McGraw-Hill (2004).
7. D. Patranabis, -Principles of Industrial Instrumentation‖, Tata McGraw-Hill, eleventh reprint (2004).
8. B. G. Liptak, -Instrument Engineers' Handbook: Process Measurement and Analysis‖, CRC (2003).

18ME5104-MODELING AND SIMULATION OF MECHATRONIC SYSTEMS

L-T-P: 3-0-2 **Credits: 4** **Pre-requisite: NIL**

Mapping of CO-PO table:

CO#	Course outcome	PO/PSO	BTL
CO1	Build mathematical models of mechatronic systems comprising of combinations of mechanical, electrical, pneumatic/ hydraulic and thermal systems.	PO1	2
CO2	Analyze systems for their time response to a certain input using transfer function and /or state space approach	PO2, PO3	2
CO3	Apply system identification techniques to synthesize system models	PO1, PO4	5
CO4	Evaluate time and frequency response of systems and control system design	PO1, PO4	2
CO5	Modeling and Simulation of Mechatronic Systems using MATALAB/Simulink	PO1, PO3, PO4	

Syllabus:

Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling. **Simulation Techniques:** Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Text Books:

1. L. Ljung, T. Glad, -Modeling of Dynamical Systems‖, Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, -System Dynamics: A Unified Approach‖, 2nd Edition, Wiley-Interscience (1990).
3. G. Gordon, -System Simulation‖, 2nd Edition, PHI Learning (2009).
4. V. Giurgiutiu and S. E. Lyshevski, -Micromechatronics, Modeling, Analysis, and Design with MATLAB‖, 2nd Edition, CRC Press (2009).

18ME51A1-SIGNAL PROCESSING IN MECHATRONIC SYSTEMS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

Mapping of CO-PO table:

CO#	Course outcome	PO/PSO	BTL
CO1	Analyze time signals, Discrete systems	PO2-2	4
CO2	Analyze Frequency filters and phase systems	PO2-2	4
CO3	Design FIR and IIR filter, bilinear transformation and frequency transformations	PO-3-2	5
CO4	Apply DSP to speech, and Radar signal processing	PO-2	3

Syllabus:

Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals. **Discrete systems:** Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems. **Frequency selective filters:** Ideal filter characteristics, lowpass, highpass, bandpass and bandstop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-passfilters, inverse systems, minimum phase, maximum phase and mixed phase systems. **Design of FIR and IIR filters:** Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations, Butterworth, Chebyshev Filters. **Introduction to multi-rate signal processing:** Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding. **Introduction to DSP Processors:** Introduction to various Texas processors such as TMS320C6713, TMS320C6416, DM6437 Digital Video Development Platform with Camera, DevKit8000 OMAP3530 Evaluation Kit. **Applications:** Application of DSP to Speech and Radar signal processing, A few case studies of DSP applications in multimedia using TI DSP kits.

Text books:

1. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e,TMcHl, 2006.
2. A. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007.

References:

1. V.K. Ingle and J.G. Proakis, -Digital signal processing with MATLAB||, Cengage, 2008.
2. T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore,04.

18ME51A2-MEMS AND NEMS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Introduction to MEMS and Microelectronic technologies used for MEMS	PO1, PO2	2
CO2	Microsensors & MEMS applications in Biological, Chemical and Acoustic field	PO1, PO2	2
CO3	Introduction to MEMS based nanotechnology	PO1, PO2	5
CO4	NEMS physics and NEMS architecture	PO1, PO2	2

Syllabus:

Micro and nano mechanics – principles, methods and strain analysis, an introduction to microsensors and MEMS, Evolution of Microsensors & MEMS, Microsensors & MEMS applications, Microelectronic technologies for MEMS, Micromachining Technology – Surface and Bulk Micromachining, Micromachined Microsensors, Mechanical, Inertial, Biological, Chemical,Acoustic, Microsystems Technology, Integrated Smart Sensors andMEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends.

Nanoelectromechanical systems (NEMS) – a journey from MEMS to NEMS, MEMS vs. NEMS, MEMS based nanotechnology – fabrication, film formation and micromachining, NEMS physics – manifestation of charge discreteness, quantum electrodynamical (QED) forces, quantum entanglement and teleportation, quantum interference, quantum resonant tunneling and quantum transport, Wave phenomena in periodic and aperiodic media – electronic and photonic band gap crystals and their applications, NEMS architecture, Surface Plasmon effects and NEMS fabrication for nanophotonics and nanoelectronics, Surface Plasmon detection – NSOM/SNOM

Text Books

1. Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer, 2008.
2. Introduction to Microelectronics Fabrication, Vol. V, G. W. Neudeck and R. F.Pierret (eds.), Addison – Wesley, 1988.
3. Introduction to Microelectromechanical Microwave Systems, H. J. De Loss Santos,2nd edition, Norwood, MA: Artech, 2004.
4. Microsystems Design, S. D. Senturia, Kluwer – Academic Publishers, Boston MA,2001.
5. Principles and Applications of Nano-MEMS Physics, H. J. Delos Santos, Springer,2008.
6. Materials and Process Integration for MEMS Microsystems, Vol. 9, Francis E. H.Tay, Springer, 2002.

Reference Books

1. Quantum Mechanical Tunneling and its Applications, D. K. Roy, World Scientific, Singapore, 1986
2. Encyclopedia of Nanoscience and Technology, Vol. 5, H. S. Nalwa (ed.),American scientific Publishers, 2004
3. Carbon Nanotubes and Related Structures, P. J. F. Harris, Cambridge University Press, UK, 1986.

18ME51A3-VEHICLE DYNAMICS AND MULTI-BODY SYSTEMS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Understand the concept of vehicle dynamics and analyze various parameters affecting it	PO2-2	4
CO2	Analyze the effect of aerodynamics and braking systems on the performance of vehicle	PO2-2	4
CO3	Analyze the steering systema ns suspension system effect on the performance of vehicle	PO2-3	4
CO4	Apply various mathematical models to understand the dynamics of Multi-body systems	PO1-3	3

Syllabus:

Introduction to vehicle dynamics: Vehicle coordinate systems; loads on axles of a parked car and an accelerating car. Acceleration performance: Power-limited acceleration, traction- limited acceleration.

Tire models: Tire construction and terminology; mechanics of force generation; rolling resistance;

tractive effort and longitudinal slip; cornering properties of tire; slip angle; camber thrust; aligning moments. **Aerodynamic effects on a vehicle:** Mechanics of airflow around the vehicle, pressure distribution, aerodynamic forces; pitching, rolling and yawing moments; crosswind sensitivity.

Braking performance: Basic equations for braking for a vehicle with constant deceleration and deceleration with wind-resistance; braking forces: rolling resistance, aerodynamic drag, driveline drag, grade, tire-road friction; brakes, anti-lock braking system, traction control, brakingefficiency.

Steering systems and cornering: Geometry of steering linkage, steering geometry error; steering system models, neutral steer, under-steer, over-steer, steering ratio, effect of under- steer; steering system force and moments, low speed and high speed cornering; directional stability of the vehicle; influence of front-wheel drive. **Suspension and ride:** Suspension types—solid axle suspensions, independent suspensions; suspension geometry; roll centre analysis; active suspension systems; excitation sources for vehicle rider; vehicle response properties, suspension stiffness and damping, suspension isolation, active control, suspension non-linearity, bounce and pitch motion. **Roll-over:** Quasi-static roll-over of rigid vehicle and suspended vehicle; transient roll-over, yaw-rollmodel,tripping.

Multi-body systems: Review of Newtonian mechanics for rigid bodies and system of rigid bodies; coordinate transformation between two set of axes in relative motion between one another; Euler angles; angular velocity, angular acceleration, angular momentum etc. in terms of Euler angle parameters; Newton-Euler equations of motion; elementary Lagrangian mechanics: generalised coordinates and constraints; principle of virtual work; Hamilton's principle; Lagrange's equation, generalized forces. Lagrange's equation with constraints, Lagrange's multiplier.

Text Books

1. T.D. Gillespie, -Fundamental of Vehicle Dynamics||, SAE Press (1995)
.
2. J.Y. Wong, -Theory of Ground Vehicles||, 4th Edition, John Wiley & Sons (2008).
3. Reza N. Jazar, -Vehicle Dynamics: Theory and Application||, 1st Edition, 3rd Printing, Springer (2008).
4. R. Rajamani, -Vehicle Dynamics and Control||, Springer (2006).
5. A.A. Shabanna, -Dynamics of Multibody Systems||, 3rd Edition, Cambridge University Press (2005).

Reference Books

1. G. Genta, -Motor Vehicle Dynamics||, World Scientific Pub. Co. Inc. (1997).
2. H.B. Pacejka, -Tyre and Vehicle Dynamics||, SAE International and Elsevier (2005).
3. Dean Karnopp, -Vehicle Stability||, Marcel Dekker (2004).
4. U. Kiencke and L. Nielsen, -Automotive Control System||, Springer-Verlag, Berlin.
5. M. Abe and W. Manning, -Vehicle Handling Dynamics: Theory and Application||, 1st Edition, Elsevier (2009).
6. L. Meirovitch, -Methods of Analytical Dynamics||, Courier Dover (1970).
7. H. Baruh, -Analytical Dynamics||, WCB/McGraw-Hill (1999).

18ME51B1-EMERGING SMART MATERIALS FOR MECHATRONICS APPLICATIONS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Study of Smart materials and their application for sensing and actuation, Mechatronics aspects	PO1-2	2
CO2	Understand the principle of Piezoelectricity and piezoelectric materials, Constitutive equations, actuator	PO1-2	2

	types and Controls for precise positioning and scanning.		
CO3	Understand the Basics of Ionic polymer metal composites (IPMC), Conductivity, Carbon nanotubes, Dielectric elastomers, Design & control issues and Applications of EAP (electro active polymers).	PO1-2	2
CO4	Understand the magnetic properties of materials, magnetostriction: constitutive equations, types, design & control of magneto strictive actuators. Comparative analysis of different smart materials.	PO1-2	2

Syllabus:

Introduction: Smart materials and their application for sensing and actuation, Mechatronics aspects. **Piezoelectric materials:** Piezoelectricity and piezoelectric materials, Constitutive equations of piezoelectric materials, Piezoelectric actuator types, Control of piezoelectric actuators, Applications of piezoelectric actuators for precise positioning and scanning. **Shape memory alloys (SMA):** Properties of shape memory alloys, Shape memory effects, Pseudo-elasticity in SMA, Design of shape memory actuator, selection of materials, Smart actuation and control, Applications of SMA in precision equipments for automobiles, trains and medical devices. **Electro-active polymers (EAPs):** Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Design & control issues for EAP actuators, Applications of EAP for biomemetic, tactile display and medical devices. **Magnetostrictive materials:** Basics of magnetic properties of materials, magnetostriction: constitutive equations, types of magnetostrictive materials, Design & control of magnetostrictive actuators, Applications of magnetostrictive materials for active vibration control. **Summary, conclusion and future outlook:** Comparative analysis of different smart materials based actuators, Conclusions, Future research trend and applications trends of smart materials and smart materials based actuator technology.

Text books:

1. Jose L. Pons, Emerging Actuator Technologies, a Micromechatronics Approach, John Wiley & Sons Ltd, 2005. .
2. Ralph Smith, Smart Material Systems: Model Development, SIAM, Societyfor Industrial and Applied Mathematics, 2005. .
3. F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, Dielectric Elastomers as Electromechanical Transducers, Elsevier, Hungry, 2008. .
4. Y. B. Cohen, Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality, Potential and Challenges, SPIE press, USA, 2004.

18ME51B2-INTELLIGENT VISUAL SURVEILLANCE

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Apply basics of image processing to understand the video compression standards	PO1-3	3
CO2	Apply the basics of image processing to analyze various object detection techniques	PO2-2	4
CO3	Apply the Muti-object tracking method to understand human activity recognition	PO1-2	3
CO4	Apply the concept of networking to collaborate with camera	PO1-2	3

Syllabus:

Basics of Image Processing: Introduction to Image Processing methods, Image Transforms, Wavelet Transform, JPEG Image Compression, Image Formats, Color Spaces- RGB, CMY, HSI. **Video Compression Standards:** H. 261, H. 263, H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection, motion modeling and segmentation techniques. **Object Detection and Classification-** Shape based object classification, motion based objectclassification, Silhouette-Based Method for Object Classification, Viola Jones object detection framework, Multiclass classifier boosting.**Multi-Object Tracking-** Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects. **Human Activity Recognition-** Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, Description based approaches, Human interactions, group activities, Applications and challenges. **Camera Network Calibration -** Types of CCTV (closed circuit television) camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocal) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras.

Text Books

1. Murat A. Tekalp, ―Digital Video Processing‖, Prentice Hall, 1995.
2. Y. Ma and G. Qian (Ed.), -Intelligent Video Surveillance: Systems and Technology‖, CRC Press, 2009.

18ME51B3-MICROPROCESSORS AND EMBEDED SYSTEMS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Understand the fundamentals of embedded applications	PO1-2	2
CO2	Architectural understanding of processors through interfacing (8086)	PO1-2	3
CO3	Programming model of microcontroller (8051 family)	PO1-3	3
CO4	Interfacing and programming applications using microcontrollers	PO1-3	3

Syllabus:

Introduction to Embedded Systems and microcomputers: Introduction to Embedded Systems, Embedded System Applications, Block diagram of embedded systems, Trends in Embedded Industry, Basic Embedded system Models, Embedded System development cycle, Challenges for Embedded system Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Basics on Computer organizations. Computing performance, Throughput and Latency, Basic high performance CPU architectures, Microcomputer applications to Embedded systems and Mechatronics. **Microprocessor:** 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts. **Microprocessor Programming:** Introduction to assembly language, Instruction format, Assembly language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor. **Microprocessor Interfacing:** Introduction to interfacing, Memory Interfacing, Programmable Peripheral Interfacing, Programmable I/O, Programmable Interrupt Controller, Programmable Timers, Programmable DMA Controller, Programmable Key board Controller, Data acquisition Interfacing: ADC, DAC, Serial and parallel data Communication interfacing. **Microcontroller:** Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, Addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller. **Microcontroller Interfacing:** Introduction to Microcontroller Interfacing and applications: case studies: Display Devices, controllers and Drivers for DC, Servo and Stepper Motor. **Introduction to Advanced Embedded Processor and Software:** ARM Processor, Unified Model Language (UML), Embedded OS, Real Time Operating System (RTOS), Embedded C. **Microprocessor and Embedded system Laboratories:** Basic assembly language programming implementation on Microprocessor and Microcontroller. Interfacing Displays, Key boards and sensors with Microprocessors and Microcontrollers, Data Acquisition using Microprocessor and Microcontroller, Implementation of Controlling schemes for DC, Servo, Stepper motor using assembly and C programming in microprocessors and Microcontrollers.

Text Books:

1. Introduction to Embedded Systems: Shibu K V, McGRAW Hill Publications.
2. Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications.
3. Computer System Architecture: M. Morris Mano.
4. 8086 Microprocessors and Interfacings: D. Hall, TATA McGRAW Hill .
5. The Intel Microprocessors: B. Brey, Prentice Hall Publications.
6. PIC Microcontrollers and Embedded Systems: M. A. Mazidi, R.D. Mckinlay and D. Casey, Pearson Publications.
7. Programming and Customizing the PIC Microcontroller: M. Predko, McGRAW Hill Publications.
8. Embedded C Programming and Microchip PIC: R. Barnett, L. O'Cull and S.Cox

18ME5205-ROBOTICS: ADVANCED CONCEPTS AND ANALYSIS

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Perform Velocity and Static analysis ofManipulators	PO2-3	4
CO2	Formulation of equation of motions by computer simulations	PO3-2	5
CO3	Apply the Planning and control methodsfor robots	PO1-2	3
CO4	Modeling and Controlling of flexible manipulators	PO5-2	4

Syllabus:

Introduction to robotics: brief history, types, classification and usage and the science andtechnology of robots. **Kinematics of robot:** direct and inverse kinematics problems and workspace, inverse kinematics solution for the general 6R manipulator, redundant and over-constrained manipulators. **Velocity and static analysis of manipulators:** Linear and angular velocity, Jacobian of manipulators, singularity, static analysis. **Dynamics of manipulators:** formulation of equations of motion, recursive dynamics, and generation of symbolic equations of motion by a computer simulations of robots using software and commercially available packages. **Planning and control:** Trajectory planning, position control, force control, hybrid control Industrial and medical robotics: application in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc; medical robots: image guided surgical robots, radiotherapy, cancer treatment, etc; **Advanced topics in robotics:** Modelling and control of flexible manipulators, wheeled mobile robots, bipeds, etc. Future of robotics.

Reference Books

1. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, -Industrial Robotics-Technology, Programming and Applications‖, McGraw-Hill Book and Company (1986).
2. S. K. Saha, -Introduction to Robotics‖, Tata McGraw-Hill Publishing Company Ltd. (2008).
3. S. B. Niku, -Introduction to Robotics–Analysis Systems, Applications‖, Pearson Education (2001).
4. . A. Ghosal, Robotics: -Fundamental Concepts and Analysis‖, Oxford University Press (2008).
5. Pires, -Industrial Robot Programming–Building Application for the Factories of the Future‖, Springer (2007).
6. Peters, -Image Guided Interventions – Technology and Applications‖, Springer (2008).
7. K. S. Fu, R. C. Gonzalez and C.S.G. Lee, -ROBOTICS: Control, Sensing, Vision and Intelligence‖, McGraw-Hill (1987).
8. J. J. Craig, -Introduction to Robotics: Mechanics and Control‖, 2nd edition, Addison-Wesley (1989).

18ME5206-CONTROL OF MECHATRONIC SYSTEMS

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Understanding the basic concepts of Modeling, Testing in terms of time domainand frequency domain	PO2-3	4
CO2	Analyze the basic designing concepts of Modern and optimal controllers such as state feedback and state	PO3-2	5

	observers.		
CO3	Analyze the basic designing concepts ofDigital controller for digital systems	PO1-2	3
CO4	Analyze the basic designing concepts of Non-linear controllers for non-linear systems	PO5-2	4

Syllabus:

Time response design: Routh-Hurwitz test, relative stability, Root locus design, constructionof root loci, phase lead and phase-lag design, lag-lead design. **Frequency response design:** Bode, polar, Nyquist, Nichols plot, lag, lead, lag-leadcompensator, time delay, process plant response curve. PID controller design. **Modern control:** Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, Lunenburg observer, reduced order observer, observer based control. **Optimal control design:** Solution-time criterion, control-area criterion, performance indices; zero steady state step error systems; modern control performance index: quadratic performance index, Ricatti equation. **Digital control:** Sampling process, sample and hold, analog to digital converter, use of z- transform for closed loop transient response, stability analysis using bilinear transform and Jury method, digital control design using state feedback. **Non-Linear Control System:** Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Liapunov's stability criterion, Popov's stability criterion.

Text Books:

1. K. Ogata, -Modern Control Engineering||, Prentice Hall India (2002).
2. Gene F. Franklin, J. D. Powell, A E Naeini, -Feedback Control of Dynamic Systems||, Pearson (2008).
3. John Van De Vegte, -Feedback Control Systems||, Prentice Hall (1993).
4. Thomas Kailath, -Linear Systems||, Prentice Hall (1980).
5. Alok Sinha, -Linear Systems: Optimal and Robust Control||, Taylor & Francis (2007).
6. Brian D. O. Anderson and John B. Moore, -Optimal Control: Linear Quadratic Methods||, Dover Publications (2007).
7. K. Ogata, -Discrete-Time Control Systems||, PHI Learning (2009).
8. H.K. Khalil, —Nonlinear Systems||, Prentice Hall (2001).

18ME5207-MECHATRONICS PRODUCT DESIGN

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Identify appropriate sensors, Identifyappropriate actuation system for a given application.	PO1-3, PO3-2	4
CO2	Identify appropriate microcontroller for a given application and to build a mathematical Model of system for evaluating open loop system performance and behavior.	PO3-2, PO4-1	4
CO3	Suggest an appropriate closed loop controlstrategy to attain the desired system behavior.	PO1-3	3
CO4	Suggest a Mechatronic product design for a given application and evaluate its performance.	PO1-3, PO2-3	4

Syllabus:

Introduction: Integrated Design issues in Mechatronics, Mechatronics Design process,Mechatronics Key Elements, Applications in Mechatronics. **Modeling and simulation of physical systems:** Electrical systems, Mechanical systems- translational &rotational systems, fluid systems. **Sensors and Transducers:** Introduction, sensor for motion and position measurement, force,torque and tactile sensors, vibration – Acceleration sensors, sensor for flow measurement, temperature sensing devices, sensor applications. **Actuating Devices:** DC Motors, Stepper motors, fluid power Actuation, fluid power design elements, piezoelectric Actuators. **System Control – Logic Methods:** Number Systems in Mechatronics, Binary Logic, Karnaugh Map Minimization, Programmable Logic Controllers. **Signal Conditioning and Real Time Interfacing:** Elements of a Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for Data Conversion, Data Conversion Process.

Case Studies TEXT

BOOKS:

1. DevdasShetty, Richard A.Kolk, -Mechatronics System Design||, PWS Publishing Company, 1997.

2. Boltan, -Mechatronics-Electronic Control Systems in Mechanical and Electrical Engineering||, 2nd Edition, Addison Wesley Longman Ltd., 1999

REFERENCE BOOK:

1. D.A Bradley, D.Dawson, N.C Burd and A.J.Loader, -Mechatronics|| CRC Press, 2010.

18ME5208-PRECISION ENGINEERING

L-T-P: 3-1-0 **Credits: 4** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	To understand concept of accuracy, errors & its causes.	PO5-3	3
CO2	To know about geometrical dimensioning and tolerance	PO5-2	2
CO3	To understand concept of surface roughness and learn methods to improve surface finish.	PO6-2	
CO4	To understand precision engineering methods		

Syllabus:

Concept of Accuracy and Accuracy of NC Systems: Introduction-General concept of accuracy of machine tool-spindle rotation accuracy- Displacement accuracy-Influence of Geometric Accuracy of Machine Tools on Work pieceAccuracy-Definition of Accuracy of NC system-Errors due to Numerical Interpolation- Errorsdue to displacement measurement system-Periodic errors-Errors due to velocity Lags- Transient Response.

Geometric Dimensioning and Tolerancing: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – DatumOddly Configured and Curved Surfaces as Datum Features, Equalizing Datums – DatumFeature of Representation – Form Controls, Orientation Controls – Logical Approach toTolerancing.

Tolerances and Fits: Sign convention-Tolerance zone-Fits-Basic Hole System of fits-Standards of Limits and Fits-Expected accuracy of a manufacturing process-Commonly used classification of types of fits-Tolerances and Fits for bearings-Methods of specifying Fits on splined shafts and holes- Selective assembly-Gauges for the control of distances between axes. **Surface Roughness and Micro finishing Processes:** Relation among the various indices of surface roughness-Ideal and Final Roughness inMachining-Influence of machining parameters on surface roughness-Ideal surface roughnessin slab milling-Bearing area curves-Micro finishing processes in the machining of metals. **Methods of Improving accuracy and surface finish:** Concept of precision Machining-Finish Turning, Boring and Grinding-Precision CylindricalGrinding-Internal Cylindrical Grinding-Errors in shape of surface grinding **Applications and Future Trends in Nano Technology:** Nano-grating system-

Nanolithography, photolithography, electron beam lithography- Machining of soft metals, diamond turning, mirror grinding of ceramics-Devlopment ofintelligent products-Nano processing of materials for super high density Ics-Nano- mechanicalparts and micromachines.

TEXT BOOKS:

1. Precision Engineering in Manufacturing / murthy R. L., / New Age International(P)
2. limited,1996.
3. Geometric Dimensioning and Tolerancing / James D.Meadows / Marcel Dekker 4. Inc.1995.
5. Norio Taniguchi,- " Nano Technology ", Oxford university,Press,1996.

REFERENCE BOOKS:

1. Precision Engineering- V. C. Venkatesh, & Sudin Izman/ Tata McGraw-Hill

18ME52C1-COMPUTATIONAL FLUID DYNAMICS

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Understand the fundamentals of CFD and deriving governing equations	PO1, PO2	2
CO2	Apply different CFD techniques to diffusion problems	PO3	3
CO3	Solving convection-diffusion problems and N-S equations.	PO3	3
CO4	Understand numerical grid generation and apply Lattice-Boltzmann methods to complex flows	PO1, PO2, PO3	3

Syllabus:

Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behavior, Navier- Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques. **Finite Difference Method (FDM):** Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, direct and iterative solvers. Finite Volume Method (FVM): FVM for diffusion, convection-diffusion problem, different discretization schemes, FVM for unsteady problems. **Prediction of Viscous Flows:** Pressure Poisson and pressure correction methods for solving Navier-Stokes equation, SIMPLE family FVM for solving Navier-Stokes equation, modelling turbulence. **CFD for Complex Geometry:** Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid and transformed equations. **Lattice Boltzman and Molecular Dynamics:** Boltzman equation, Lattice Boltzman equation, Lattice Boltzman methods for turbulence and multiphase flows, Molecular interaction, potential and force calculation, introduction to Molecular Dynamics algorithms.

Text Book/ Reference Books:

1. J. D. Anderson, -Computational Fluid Dynamics||, McGraw-Hill Inc. (1995).
2. S. V. Patankar, -Numerical Heat Transfer and Fluid Flow||, Hemisphere Pub. (1980).
3. K. Muralidhar, and T. Sundarajan, -Computational Fluid Flow and Heat Transfer||, Narosa (2003).
4. D. A. Anderson, J. C. Tannehill and R. H. Pletcher, -Computational Fluid Mechanics and Heat Transfer||, Hemisphere Pub. (1984).
5. M. Peric and J. H. Ferziger, -Computational Methods for Fluid Dynamics||, Springer (2001).
6. H. K. Versteeg and W. Malalaskera, -An Introduction to Computational Fluid Dynamics||, Dorling Kindersley (India) Pvt. Ltd. (2008).

7. C. Hirsch, -Numerical Computation of Internal and External Flows‖, Butterworth-Heinemann, (2007).
8. J. M. Jaile, -Molecular Dynamics Simulation: Elementary Methods‖, Willey Professional, 1997.
9. A. A. Mohamad, -Lattice Boltzman Method: Fundamentals and Engineering Applications with Computer Codes‖, Springer (2011).

18ME52C2-NONLINEAR OPTIMIZATION

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Categorize convexity and non-convexity problems	PO1, PO3	4
CO2	Apply goal programming methods to solve modals	PO1	3
CO3	solve problems with positive coefficients using separable and geometric programming	PO4	4
CO4	Implement search techniques to solveprogramming problems	PO7	4

Syllabus:

Nonlinear programming: Convex sets and convex functions, their properties, convex programming problem, generalized convexity, Pseudo and Quasi convex functions, Invex functions and their properties, KKT conditions. **Goal Programming:** Concept of Goal Programming, Model Formulation, Graphical solution method. **Separable programming. Geometric programming:** Problems with positive coefficientsup to one degree of difficulty, Generalized method for the positive and negative coefficients. **Search Techniques:** Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden Section method, Method of steepest descent, Newton-Raphson method, Conjugate gradient methods. **Dynamic Programming:** Deterministic and Probabilistic Dynamic Programming, Discrete and continuous dynamic programming, simple illustrations. **Multi objective Programming:** Efficient solutions, Domination cones.

Text Books:

1. Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004).

Reference Books:

1. D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003).
2. R. E. Steuer, Multi Criteria Optimization, Theory, Computation and Application, John Wiley and Sons, New York (1986).

18ME52D1-INDUSTRIAL AUTOMATION

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Apply principles of automation towards material handling and analyze their performance.	PO2	3
CO2	Analyze performance of storage systems and product flow in different GT methods and cellular manufacturing.	PO2	4
CO3	Application and analysis of transfer line without internal storage and describe Inspection Technology	PO3	4
CO4	Describe different manufacturing supporting systems.	PO3	2

Syllabus:

Automation: Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems. Material handling: Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including AGV and its various guiding technologies. Storage system: Performance, location strategies, conventional storage methods and equipments, automated storage systems. Automated manufacturing systems: Components, classification, overview, group technology and cellular manufacturing, parts classification and coding, product flow analysis, cellular manufacturing, application considerations in G.T. FMS: Introduction, components, application, benefits, planning and implementation, transfer lines and fundamentals of automated production lines, application, analysis of transfer line without internal storage (numerical problems). Inspection Technology: Introduction, contact and non-contact conventional measuring, gauging technique, CMM, surface measurement, machine vision, other optical inspection techniques, non-contact non-optical inspection technologies versus. Manufacturing support system: Process planning and concurrent engineering- process planning, CAPP, CE and design for manufacturing, advanced manufacturing planning, production planning and control system, master production schedule, MRP. Capacity planning, shop floor control, inventory control, MRP-II, J.I.T production systems. lean and agile manufacturing.

Text Books

1. M.P. Groover, Automation, -Production Systems and Computer Integrated manufacturing‖, 2nd Edition, Pearson Education (2004).

References Books

1. Vajpayee, -Principles of CIM‖, PHI, 1992.
2. Viswanathan and Narahari, -Performance Modeling of Automated Manufacturing Systems‖, PHI, 2000.
3. R.S. Pressman, -Numerical Control and CAM, John Wiley , 1993.

18ME52D2-FUZZY SETS AND ARTIFICIAL INTELLIGENCE

L-T-P: 3-0-0 **Credits: 3** **Pre-requisite: NIL**

CO#	Course outcome	PO/PSO	BTL
CO1	Understanding various concepts Fuzzy Logic System	PO1	2
CO2	Application of fuzzy Sets in Management, Medical and Engineering Fields.	PO2	3
CO3	Introduction to AI, Understand the basic concepts of Artificial Intelligence using various search Techniques	PO1	2
CO4	Neuro Fuzzy Approaches and Applications of AI in various Domains	PO3	3

Syllabus:

Basic Concepts of Fuzzy Sets, Fuzzy Logic, Zadeh’s Extension Principle, Operations on Fuzzy Sets, Fuzzy Measures, Probability and Possibility Measures, Fuzzy Inference Methodologies, Fuzzy Relations, Applications of Fuzzy Sets in Management, Decision Making, Medicine and Computer Science. Introduction to Artificial Intelligence, Production System and Artificial Intelligence, Problem Solving by Search, Predicate Calculus, Knowledge Representation, Semantics Nets, Frames, Conceptual Dependencies, Knowledge Bases and Expert Systems, Fuzzy Rule, Neuro Fuzzy Approaches, Case Studies in Various Domain.

Text books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed,Prentice Hall, 2003.
2. H.J.Zimmermann, Fuzzy Set Theory and Its Applications, 2nd Ed., Kluwer Academic Publishers, 1996.
3. D.Dubois and H. Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, 1980.

Reference books:

1. E. Charniak and D. McDermott, Introduction to Artificial Intelligence,Addison-Wesley, 1985.
2. E. Rich, Artificial Intelligence, McGraw-Hill, 1983.
3. P. H. Winston, Artificial Intelligence, Addison Wesley, 1993.
4. J.Yen and R.Langari, Fuzzy Logic Intelligence, Control, and Information,Pearson Education, 2005.
5. T.J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
6. J.Kacprzyk, Multistage Fuzzy Control, Wiley, 1997.