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XXIV Academic Council (AC) Minutes- Annexure-A4

Dt:22-06-2018

Department of Electrical & Electronics Engineering

Minutes of the XXI BOS Meeting

The Department XXI BOS meeting is held on 22nd June 2018 from 2.00 PM onwards in Room No C323.

The following members were present:

1. Dr.K Narasimha Raju, Professor & HoD, Department of EEE, KLEF-Chairman
2. Dr. Praveen Singh Satvat, Dean Academics, KLEF- Patron
3. Dr. K Siva Kumar, Associate Professor, IIT Hyderabad-External Member
4. Mr. ESS Sastry, Chief Consultant REC, External Member
5. Mr.H.B.Shivuni, Sales & Mkt., Head-AMS electric mobility, External Member
6. Mr.D.Ravi Thej, Validation Engineer Panasonic-External Member
7. Dr. M V V K Srinivasa Prasad, Assistant Professor & Associate Dean Curriculum Aspects TLP, KLEF Invited Member from DAO
8. Mr. T Ratna Prasad, Assistant Professor, ME Department, KLEFCo-Optedd Member
9. Dr. K Subba Rao, Professor, Department of EEE, KLEF-Internal Member
10. Dr. S V N L Lalitha, Professor, Department of EEE, KLEF-Internal Member
11. Dr. J Somlal, Professor, Department of EEE, KLEF-Internal Member
12. Dr. A Pandian, Professor, Department of EEE, KLEF-Internal Member
13. Dr. B Loveswara Rao, Professor, Department of EEE, KLEF-Internal Member
14. Dr. P Srinivas Varma, Associate Professor, Department of EEE, KLEF-Internal Member
15. Dr. M Kiran Kumar, Associate Professor, Department of EEE, KLEF-Internal Member
16. Dr. B Jyothi, Associate Professor, Department of EEE, KLEF-Internal Member
17. Dr.S.Palani Kumar, Assistant Professor, Department of EEE, KLEF-Internal Member
18. Mr. R Bhanu Prakash, Associate Professor, Department of EEE, KLEF-Internal Member
19. Mr. D Seshi Reddy, Associate Professor, Department of EEE, KLEF-Internal Member
20. Mr. D Narasimha Rao, Associate Professor, Department of EEE, KLEF-Internal Member.
21. M. GRS Nag Kumar, Assistant Professor, Department of EEE, KLEF-Internal Member

Members Not Attended: NIL

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Opening Remarks by Chair

1. Dr. O. Chandrasekhar, Chairman of BoS, opened the meeting by welcoming and introducing the external members to the internal and co-opted members and thanked them for accepting to become members of the Board of Studies. The Chairman then put forward the agenda items before the Board.
2. The Chairman of the BoS informed the members present about the Department Academic Committee (DAC) meeting held on 17th June 2018. He highlighted the major resolutions of discussion as brought to the notice of the DAC by the student members. The board unanimously resolved to approve the recommendations made by the DAC. (Annexure II: DAC Meeting minutes dt. 17/06/2019).

AGENDA and RESOLUTIONS

AGENDA ITEM-1

Department achievements for the academic year 2017-2018 to the members	**BoS appreciated the efforts of faculty and the university management for their achievements done by the students.**

The chairman reported the faculty awards and recognitions, research activities and placement status of the department for the current semester before the BoS members.

Placements & Progression:

Placement statistics for the A.Y:2017-2018 were presented to all the members.

All the 55 students registered for placements were successfully placed in various core and software companies.

15 students got multiple job offers, got more than three job offers

The average salary package is 6.5 Lakhs per annum.

Research & Development

Fifty publications, including Scopus and SCI, indexed by the department in the A.Y: 2017-2018.

Three department scholars were awarded a PhD in A.Y: 2017-2018.

External member Dr. K Siva Kumar, IIIT Hyderabad, has appreciated the department faculty and HoD for successfully conducting all the academic activities.

AGENDA ITEM-2

Introduction of Core courses and Specializations of the EEE department for Y17 and Y18 admitted students because of stakeholder feedback and approved DAC meeting.	It is resolved to approve the courses for core and new specializations for 2017-2018 and 2018-2019 admitted batch students, and the same is recommended for the academic council for approval.

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SL	Course Code	Course Title	Course Type	Remarks
1	17EE3102	Power System Protection & Control	Core	New course inplace of Power System Protection

- Ms. K Sarada, Associate Professor-EEE, KLEF, recommended the Power System Protection and Control course to enhance GATE and competitive exam scores.
- D. Kalyan proposed Technical Skill 3 & 4 courses on PLC given suggestions recommended by Dr. S. Venu, Asst. prof., NIT Delhi can include the concepts of Sensors and Instrumentation as per requirements.

The following three Specializations are introduced based on the feedback of Industrial peers: Mr. Raja Phanideep, Electric Design Engineer, Alexender Dennis, Chassis group EV Technology. Mr. Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India and V. Jayadhar Babu, Assistant R &D engineer, recommended implementing new specializations from Y17 admitted students. The recommendations of DAC approved by the BoS members.

➢ Green Technologies Specialization

SL	Course Code	Course Title	Course Type	Remarks
1	17EE3281	SOLAR PV AND THERMAL TECHNOLOGIES	Professional Elective	New course
2	17EE3282	WIND AND MICRO ENERGY SOURCES	Professional Elective	New course
3	17EE4162	ENERGY CONSERVATION & AUDIT	Professional Elective	New course
4	17EE4181	ENERGY STORAGE SYSTEMS	Professional Elective	New course
5	17EE4182	ENERGY MANAGEMENT SYSTEMS	Professional Elective	New course

Given recent advancements Green Energy Technologies Mr. Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India has recommended SOLAR PV AND THERMAL TECHNOLOGIES (L-T-P-S: 3-0-0-0), WIND & MICRO ENERGY SOURCES (L-T-P-S: 3-0-0-0), ENERGY CONSERVATION & AUDIT (L-T-P-S: 3-0-0-0), ENERGY STORAGE SYSTEMS (L-T-P-S: 3-0-0-0), ENERGY MANAGEMENT SYSTEMS (L-T-P-S: 3-0-0-0)

➢ Smart Grid Technologies

SL	Course Code	Course Title	Course Type	Remarks
1	17EE3271	ENERGY ACCOUNTING AND MANAGEMENT SYSTEMS	Professional Elective	New course
2	17EE3272	SUBSTATION PRACTICE	Professional Elective	New course

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3	17EE3273	DISTRIBUTION SYSTEM TESTING AND SAFETY PRACTICES	Professional Elective	New course
4	17EE4171	SMART GRID COMMUNICATION AND CYBER SECURITY	Professional Elective	New course
5	17EE4172	SMART DISTRIBUTION SYSTEMS	Professional Elective	New course

Mr. Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India, has recommended ENERGY ACCOUNTING AND MANAGEMENT SYSTEMS (L-T-P-S: 3-0-0-0), SUBSTATION PRACTICE (L-T-P-S: 3-0-0-0), DISTRIBUTION SYSTEM TESTING AND SAFETY PRACTICES (L-T-P-S: 3-0-0-0), SMART GRID COMMUNICATION AND CYBER SECURITY (L-T-P-S: 3-0-0-0), SMART DISTRIBUTION SYSTEMS (L-T-P-S: 3-0-0-0) under Smart Grid Technologies specialization.

- Electric vehicle Technologies with the following courses

SL	Course Code	Course Title	Course Type	Remarks
1	17EE3262	BATTERY MODELLING FOR ELECTRIC VEHICLES	Professional Elective	New course
2	17EE3263	CHARGING STATION FOR ELECTRIC VEHICLE	Professional Elective	New course
3	17EE4161	BATTERY STATES ESTIMATION	Professional Elective	New course
4	17EE4163	ELECTRIC VEHICLE FAULT DIAGNOSIS AND CONTROL	Professional Elective	New course
5	17EE3261	Introduction to Electric Vehicle	Professional Elective	New course

Mr. Raja Phanideep, Electric Design Engineer, Alexender Dennis, Chassis group EV Technology has recommended elective courses under Electric Vehicle Technology Specialization, BATTERY MODELLING FOR ELECTRIC VEHICLES (L-T-P-S: 3-0-0-0), CHARGING STATION FOR ELECTRIC VEHICLE (L-T-P-S: 3-0-0-0), BATTERY STATES ESTIMATION (L-T-P-S: 3-0-0-0), ELECTRIC VEHICLE FAULT DIAGNOSIS AND CONTROL (L-T-P-S: 3-0-0-0).

Dr. K Narasimha Raju, Professor, EEE, KLEF, has recommended including Introduction to Electric Vehicle (L-T-P-S:3-0-0-0) in elective courses. He also suggested including project-based labs in core courses.

The syllabus of these courses is shown in Annexure IV

AGENDA ITEM-3

Proposed curriculum for 2018-2019 admitted batches for the B.Tech EEE program as per the suggestions and feedback	It is resolved to approve the 2018-2019 admitted batch's curriculum,

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received from stakeholders and approved in DAC	which is recommended to the academic council for approval.

- Mr. D Seshi Reddy, associate professor, EEE, KLEF, recommended incorporating the PSSC syllabus in the curriculum for students to get global certificates.
- Muppanneni Manoj Kumar, a business owner in Amway, India, teaches life and entrepreneurial skills.
- Abburi Ajay Kumar, CEO of Samrat Industries, to train students in coding skills especially for advanced learners
- GUNTURI SRI KRISHNA SANKALP, 150060030, has requested industrial internships in core companies from a placement perspective.
- Nallani Koteswara Rao has suggested that emphasis on communication and soft skills be given the highest priority in the curriculum for acquiring placements.
- Based on the discussions of Dr. S. Venu, Asst. prof., NIT Delhi and other Academic Peer feedback are recommended to rename Basic Engineering Measurements L-T-P-S:2-0-2-0 as Electrical Engineering Measurements.

Given all the feedback received from the external members of BOS, Dr. K Siva Kumar - Associate Professor, IIT Hyderabad, Mr. ESS Sastry-Chief Consultant REC, Mr.H.B.Shivuni- Sales & Mkt., Head-AMS electric mobility, Mr.H.B.Shivuni, Sales & Mkt., Head-AMS electric mobility, Mr.D.Ravi Thej - Validation Engineer Panasonic were impressed with the changes done in the finalized course structure for 2018-19 B.Tech-EEE provided in Point 1 of Annexure II

AGENDA ITEM-4

Proposed to revise the Syllabus for the Y18 batch courses based on the feedback received from stakeholders	It is resolved to approve the course revisions of A.Y: 2018-2019, and the same is recommended for the academic council for approval from the Y17 batch onwards.

Based on stakeholders' contemporary requirements and feedback, syllabus revisions for the following courses are shown in the table below.

SL	Course Code	Course Title	Course Type	Percentage of Revision	Remarks
1	18EE2101	Electrical Circuits	Core	15%	L-T-P-S: 3-0-2-0 is changed to L-T-P-S: 3-1-0-0 by introducing a tutorial component instead of a practical one.

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- Dr. K. Sivakumar, Professor, IIT Hyderabad - suggested including tutorial hours rather than lab hours for the **Electrical Circuits** (L-T-P-S:3-1-0-0) course.

To apply the changes made in professional electives to the y17 batch as well(Point 3 of Annexure-II)

AGENDA ITEM-5

Value-added courses to be offered in AY 2018-19 for B.Tech EEEprogram	BOS members approved the proposal for value-added courses and recommender to the academic council

The syllabus of value-added courses is reviewed for mapping to employability entrepreneurship or career progress. The courses are planned to be delivered by APSSDC. The reputation of the class-delivering organizations and the usefulness of the certificate were discussed, and the BoS members approved the courses.

- Mr. D Seshi Reddy recommended incorporating the PSSC syllabus in the curriculum to get global certificates for the students.
- N Naga Sai Koushik 150060064 has recommended a certification on IOT
- Dr.G.SUNITA SUNDARI, Professor in the Physics Dept, suggested offering global certifications with industry tie-up

Value added courses are shown in Point 1 of Annexure-IV

AGENDA ITEM-6

Introduction of courses for 2018-2019 admitted batches for the M.Tech (Power System) program as per the suggestions and feedback received from stakeholders and approved in DAC	It is resolved to approve the curriculum of the M.Tech (PS) 2018-2019 admitted batch's curriculum, which is recommended to the academic council for approval.

In view of feedback received following courses were introduced for

SL	Course Code	Course Title	Course Type	Remarks
1	18EE5103	Deregulated Operation of Power Systems	Core	New course in place of Restructured Power System Market
2	18EE5208	Digital Protection in Power Systems	Core	New course in place of Power Systems Digital Protection
3	18EE5207	Smart Grid Technologies	Core	New course in place of Smart Grids
4	18EE52D1	EHVAC & HVDC Transmission	Elective	New course added in list of electives
5	18EE52D3	Integration of Energy Sources	Elective	New course added in list of electives

- As per the contemporary requirements of local/global/national needs **EHVAC & HVDC**

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Transmission is introduced as a new course.

- M Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India, suggested including **Digital Protection in the Power Systems** curriculum instead of Advanced Power System Protection.
- Dr. A Pandian, a professor at the Department of EEE, KLEF, suggested introducing a **Smart Grid Technologies** course for the PG system.
- Dr. S. Venu, Asst. prof., NIT Delhi- suggested offering **Integration of Energy Sources** as an elective course L-T-P-S:3-0-0-0 in the M. tech program.

BOS members approved the M.TECH (Power Systems) curriculum for the admitted students in 2018-2019. **Point 1 of Annexure III**

The proposed new courses syllabi were shown in point3 of Annexure III

AGENDA ITEM-7

Introduction of courses for 2018-2019 admitted batches for the M.Tech (Power Electronic Drives) program as per the suggestions and feedback received from stakeholders and approved in DAC	It is resolved to approve the M.Tech (PED) 2018-2019 admitted batch's curriculum, which is recommended to the academic council for approval.

SL	Course Code	Course Title	Course Type	Remarks
1	18EE5116	FPGA Controllers and Applications	Core	New course in place of Instrumentation and Control
2	18EE52D1	Digital Simulation of Power Electronic Systems	Elective	New course added in list of electives

- As per the contemporary requirements of local/global/national needs **EHVAC & HVDC Transmission and Digital Simulation of Power Electronic Systems** is introduced as a new course.
- Dr. S Palani Kumar- Associate Professor, Department of EEE, KLEF, suggested having **FPGA controllers and Applications.**

BOS members approved the M.TECH (Power Electronic Drives) curriculum for the admitted students in 2018-2019. The syllabus of these courses is shown in Point 2 of Annexure III

The proposed new courses syllabi were shown in point4 of Annexure III

AGENDA ITEM-8

Review of Percentage of courses mapped to employability, entrepreneurship and skill development for 2018-2019 B. Tech EEE,	BOS members recommended for academic

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M.Tech PS, M.Tech PED.	council approval

BoS members reviewed the finalized courses for mapping employability, entrepreneurship, and skill development. The weightage of course mapping for each component is analyzed. They are shown in points 2 of Annexure- II and 2 and 4 of Annexure III.

AGENDA ITEM-9

Approval of Program Development Document for 2018-19 admitted B. Tech and M.Tech Programs.	BOS members recommended for academic council approval

All the BOS members reviewed the program development document for 2018-19 B. Tech and M.Tech structures, highlighting Local/Regional/National/ Global needs. Mapping to courses is presented to all the BoS members and reviewed for significance in introducing or revising courses. (Annexure-V, Annexure-VI, Annexure-VII)

AGENDA ITEM-10

Approval of MOOC courses	Bos members recommended MOOC courses to academic council approval

BoS members recommended COURSERA, SWAYAM, and various platforms for knowledge gain. They instructed me to identify the courses available on multiple platforms.

AGENDA ITEM-11

Review of Results obtained last semester and CO-PO attainment	It is resolved to approve CO-PO attainment of the previous semester, and the same is recommended to the Academic Council

AGENDA ITEM-12

ANY other items

Bos members discussed the admission process of next academic year

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Annexure-

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERINGDEPARTMENT

ACADEMIC COMMITTEE (DAC) MEETING MINUTES

The department academic committee meeting was held from 10:00 A.M. on **16/06/2018** in the HoD Chamber,with Dr. K Narasimha Raju HoD - EEE in the chair.

Agenda:

1. To discuss the feedback received from stakeholders on the curriculum.
2. To modify the Curriculum & syllabus for the B.Tech 2018 admitting batch
3. To alter them Curriculum & syllabus for the M.Tech 2018 admitting batch
4. To discuss Course Closer minutes
5. Any other points with the permission of the DAC chairman

The following members were present:

1. Dr. A. Pandian, Group Head, PE Research
2. Dr. P. S. Varma, RPAC chairman, Group Head, PS Research
3. Dr.S.V.L.N.Lalitha, Professor, Dept. of EEE
4. Dr. J. Somlal, Associate Dean, Competitive exams
5. Dr.B.Loveswara Rao, Professor, Dept. of EEE
6. Dr.M.Kiran Kumar, Associate Professor, Dept. of EEE
7. Dr.B.Pakkiriah, Associate Professor, Dept. of EEE
8. Dr.B.Jyothi, Assistant Professor, Dept. of EEE
9. Dr.S.Palani Kumar, Assistant Professor, Dept. of EEE
10. Mr. R .Bhanu Prakash, Alt. HoD, Dept. of EEE
11. Mr. D.Seshi Reddy – Associate Professor, Dept. of EEE
12. Mr. D. Narasimha Rao, Professor In-charge-Academics, Dept. of EEE
13. Mr.G.R.S.Naga Kumar– Assistant Professor, Dept. of EEE

The following points were discussed, resolved and recommended to the Board of Studies for consideration:

I. Up on discussing the feedback from **students, the** following points were discussed by the student members:

   a. Based on the request made by the students, Energy-Related certificate courses are to be planned for certification. HoD informed them that the same will be implemented for the 2019 admitted batches

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b. Student members requested to arrange for Industrial Visits from II years for better practical learningof the courses.

II. Based on discussing the feedback from **Alumni**, the following changes are to be suggested in the curriculum.

a. Global Certificate courses will be offered in tie-up with the industry and provided during the entire semester rather than for one week, which is being done now.

III. Based on discussing the feedback from **Academic Peers**, the following changes are to be suggested in thecurriculum.

a) In the Y198 curriculum, technical skill courses will merge with the course.

IV. Based on the feedback from the Industry peers(Mr. Raja Phani Deep and Chaitanya Sai), The DAC discussed and resolved the changes.

In the Y18 Curriculum, **Three New specialisations** are to be

a) Green Technologies
b) Smart Grid Technologies
c) Electric vehicle technologies

V. Based on the feedback of the faculty (course coordinators), the DAC discussed and resolved the changes mentioned below.

(i) Duration of practical laboratory courses is to be increased to 3 based on the complexity of experiments.

VI. Upon considering the feedback mentioned above, it is resolved to propose the enclosed updated Programdevelopment documents and curriculum for the B.Tech-Electrical Engineering Program & M.Tech- PS & PED for 2018 curriculum for BOS approval.

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(Dr. K. Narasimha Raju)
Chairman, DAC Dept. of EEE

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Stake Holders Feedback Summary for A.Y 2018-19

Feedback from different stakeholders has been collected concerning the curriculum offered for the academic year2018-19

Serial Number	Type of Stakeholder	Number of feedbacks
1	Students	58
2	Parents	14
3	Alumni	19
4	Faculty	25
5	Academic peers	10
6	Industry persons	10
	Total	133

SL	Recommendations	Action taken in BoS
Students Feedback		
1	Naga Koushik requested for a certificate course on IoT	A certificate on PLC in association with APSSDC is proposed
2	G. Sri Krishna Sankalp requested an industrial internship in core companies from a placement perspective.	The Department planned the same for the 2017 admitted batch of students through Industry Connect Cell to make the students industry-ready
Faculty Feedback		
3	Mr. D Seshi Reddy recommended incorporating the PSSC syllabus in the curriculum to get global certificates for the students.	Power Sector Skill Council (PSSC) proposed a syllabus to be incorporated into the curriculum for PSSC certification and was forwarded to the academic council for approval.
4	Dr. K Narasimha Raju recommended including Project-based labs to define a particularcourse in the curriculum.	Project-based labs can be implemented for the DAC-identified and BoS-approved core courses and forwarded for academic council approval.
Academic peers Feedback		
5	For the 2018 curriculum, Analog Electronic Circuits Design (AECD) Course syllabus is to be modified.	The AECD course syllabus was modified as 3-0-2-0-3 Structure.
6	Dr S Venu, Assistant Professor, NIT-Delhi, suggested floating of Sensors & Instrumentation as standard courses for all specializations in B.Tech.	It is resolved in the BoS to offer Sensors & Instrumentation as standard courses for all specializations in B.Tech.
7	Dr S Venu, Assistant Professor, NIT-Delhi, recommended integrating Energy Resources for PG programs.	BoS recommended offering Integration of Energy Resources for the M.Tech PS program.

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8	Dr. K. Sivakumar, Professor, IIT Hyderabad - suggested including tutorial hours rather than lab hours for Electrical circuits course	Tutorial hours are included in Electric Circuits, and BOS members recommended to forward for academic Council approval.
Industry Person Feedback		
9	V. Jayadhar Babu, Assistant R &D engineer, recommended implementing new specializations for Y17 admitted students.	Bos member recommends all new specializations for Y17 admitted students along with Y18.
10	Abburi Ajay Kumar, CEO of Samrat Industries, to train students in coding skills especially for advanced learners	Bos has recommended training on coding skills to be planned throughout the semester as a part of the curriculum and forwarded to the academic council for approval.
Parents Feedback		
11	Nallani Koteswara Rao suggested emphasizing communication and soft skills as the highest priorities in the curriculum for acquiring placements.	The extra Communication Skill course was introduced from the Y17 batch onwards.
12	Dr. G Sunitha Sundari suggested Global Certificate courses can be offered in tie-up with the industry and are to be offered during the entire semester rather than for one week, which is being done now.	Bos recommended identifying the Global certification courses.
Alumni Feedback		
14	M Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India, suggested including digital protection in the curriculum.	The Digital Protection of Power System course was modified for M. Tech Power system and was forwarded to the academic council for approval.
15	Muppanneni Manoj Kumar, a Business owner in Amway, India, teaches life and entrepreneurial skills.	Life skills and Entrepreneurial skills were included in the curriculum as value-added courses and open electives.
16	Mr Raja PhaniDeepi, Electric Design Engineer, Alexender Dennis, Chasis group London suggested to offer new specialization for y18	It is resolved to offer Electric Vehicle Technology specialization to offer to Y18.

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Annexure-II

Course Structure and Syllabus Revision for 2018-2019 B.Tech EEE Program

1. Course structure for 2018-19 admitted BTech-EEE program

SNO	COURSE CODE	COURSE NAME	L	T	P	S	Cr	Pre requisites
I		**HUMANITIES & SOCIAL SCIENCES**						
1	18UC1101	Basic English	0	0	4	0	2	NIL
2	18UC1202	English Proficiency	0	0	4	0	2	NIL
3	18UC2103	Professional Communication Skills	0	0	4	0	2	NIL
4	18UC2204	Aptitude Builder -1	0	0	4	0	2	NIL
5	18UC3105	Aptitude Builder -2	0	0	4	0	2	NIL
6	18UC3206	Campus to Corporate	0	0	4	0	2	NIL
7	18UC0007	Indian Heritage and Culture	2	0	0	0	2	NIL
8	18UC0008	Indian Constitution	2	0	0	0	2	NIL
9	18UC0009	Ecology & Environment	2	0	0	0	2	NIL
10	18UC0010	Universal Human Values & Professional Ethics	2	0	0	0	2	NIL
11	18UC0011	Entrepreneurship	2	0	0	0	0	NIL
			10	**0**	**24**	**0**	**20**	
II		**BASIC SCIENCES**						
1	18SC1103	Single Variable Calculus and Matrix Algebra	3	0	0	0	3	NIL
2	18MT1201	Multivariate Calculus	3	0	2	0	4	NIL
3	18SC1105	Logic and Reasoning	0	0	2	0	1	NIL
4	18SC1104	Foundations of Computational Mathematics	0	0	2	0	1	NIL
5	18BT1001	Biology for Engineers	2	0	0	0	2	NIL
6	18PH1004	Solid State Physics	2	0	2	0	3	NIL
7	18CY1001	Engineering Chemistry	3	0	2	0	4	NIL
			13	**0**	**10**	**0**	**18**	
III		**ENGINEERING SCIENCES**						
1	18SC1101	Problem Solving and Computer Programming	3	0	2	0	4	NIL
2	18SC1202	Data Structures	3	0	2	0	4	NIL
3	18EC1002	Engineering Graphics & Design for Electronic and Computer Engineers	0	0	4	0	2	NIL
4	18EE1003	Workshop Practice for Electrical & Electronics Engineers	0	0	4	0	2	NIL
5	18SC2004	Object Oriented Programming	2	0	2	0	3	NIL
6	18EE1201	Network Theory	3	0	2	0	4	NIL
7	18EE3201	Electrical Engineering Measurements	2	0	2	0	3	NIL
8	18EE1202	Electromagnetic Fields	3	1	0	0	4	NIL
9	18MT1004	Probability& Numerical Methods	2	1	0	0	3	NIL
			18	**2**	**18**	**0**	**29**	
IV		**PROFESSIONAL CORE COURSES**						
1	18EC1101	Digital System Design	3	0	2	0	4	Nil
2	18EC2103	Analog Electronic Circuit Design	3	0	2	0	4	Nil
3	18EE2101	Electrical Circuits	3	1	0	0	4	18EE1201
4	18EE2102	DC Machines and Transformers	3	0	2	0	4	NIL
5	18EE2103	Electrical Power Generation, Transmission & Distribution	3	1	0	0	4	NIL

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6	18EE2201	AC Rotating Machines	3	0	2	0	4	18EE2102
7	18EE2202	Control Systems	3	0	2	0	4	NIL
8	18EE2203	Power System Analysis & Stability	3	1	0	0	4	18EE2103
9	18EE3101	Power Electronics	3	0	2	0	4	18EE2101
10	18EE3102	Power System Protection & Control	3	0	2	0	4	18EE2203
11	18EC2205	EMBEDDED CONTROLLERS	2	0	3	2	4	NIL
12	18EM3201	SIGNAL PROCESSING	2	1	2	0	4	Nil
			34	**4**	**19**	**2**	**48**	
V		**COUNSELLING AND CO-CURRICULAR ACTIVITIES**						
1	18GN1101	Counselling -1	0	0	1	0	0	NIL
2	18GN1202	Counselling -2	0	0	1	0	0	NIL
3	18GN2103	Counselling -3	0	0	1	0	0	NIL
4	18GN1107	Cocurricular Activity -1	0	0	0	2	0.5	NIL
5	18GN1107	Cocurricular Activity-I	0	0	0	2	0.5	NIL
6	18GN2109	Cocurricular Activity -3	0	0	0	2	0	NIL
			0	**0**	**3**	**6**	**1**	
VI		**SKILLING COURSES**						
1	18SC1106	Technical Skill - 1	0	0	0	6	1.5	NIL
2	18SC1207	Technical Skill - 2	0	0	0	6	1.5	NIL
3	18TS601	Technical Skill - 3 (Matlab)	0	0	0	8	2	NIL
4	18TS602	Technical Skill - 4 (Matlab)	0	0	0	8	2	NIL
5	18TS605	Technical Proficiency & Training-1	0	0	0	4	1	NIL
6	18TS606	Technical Proficiency & Training-2	0	0	0	4	1	NIL
			0	**0**	**0**	**36**	**9**	
VII		**TERM PAPER & PROJECT**						
1	18IE2246	Industrial Training	0	0	0	0	2	NIL
2	18IE3247	Term Paper	0	0	4	0	2	NIL
3	18IE4048/ 18IE4050	Project (Part - 1)/Practice School	0	0	0	24	6	NIL
4	18IE4049/1 8IE4051	Practice School / Project (Part - 2)/Internship	0	0	0	24	6	NIL
			0	**0**	**4**	**48**	**16**	
VIII		**OPEN ELECTIVES**						
1	OE-1	OPEN ELECTIVE-1	3	0	0	0	3	NIL
2	OE-2	OPEN ELECTIVE-2	3	0	0	0	3	NIL
3	ME	MANAGEMENT ELECTIVE	3	0	0	0	3	NIL
4	FL	FOREIGN LANGAUGE ELECTIVE	2	0	0	0	2	NIL
			11	**0**	**0**	**0**	**11**	
IX		**PROFESSIONAL ELECTIVES**						
1	PE-1	PROFESSIONAL ELECTIVE-1	3	0	0	0	3	
2	PE-2	PROFESSIONAL ELECTIVE-2	3	0	0	0	3	
3	PE-3	PROFESSIONAL ELECTIVE-3	3	0	0	0	3	
4	PE-4	PROFESSIONAL ELECTIVE-4	3	0	0	0	3	
5	PE-5	PROFESSIONAL ELECTIVE-5	3	0	0	0	3	
			15	**0**	**0**	**0**	**15**	
			101	**6**	**78**	**92**	**167**	

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2. The course structure of B.Tech 2018-2019 admitted students mapped to employability, entrepreneurship, and skill development

Sl	COURSE CODE	COURSE NAME	CAT	L	T	P	S	Cr	Prerequisites	New Course/Revised Course/ Retained Course	Changes Proposed by	Focused on Employability/ Entrepreneurship/ Skill Development	Justification
1	18UC1101	BASIC ENGLISH	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
2	18UC1202	ENGLISH PROFICIENCY	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
3	18UC2103	PROFESSIONAL COMMUNICATION SKILLS	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
4	18UC2204	APTITUDE BUILDER - 1	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
5	18UC3105	APTITUDE BUILDER - 2	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
6	18UC3206	CAMPUS TO CORPORATE	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.
7	18UC0007	INDIAN HERITAGE AND CULTURE	HSS	2	0	0	0	2	NIL	Retained	No Change	Employability	It covers soft, verbal, and quantitative reasoning skills that help students attain better employment.

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8	18UC0008	INDIAN CONSTITUTION	HSS	2	0	0	0	0	NIL	Retained	No Change	Employability	Cotemporary knowledge as required for entrance tests of PSU Graduate engineer trainees
9	18UC0009	ECOLOGY & ENVIRONMENT	HSS	2	0	0	0	2	NIL	Retained	No Change	Employability	Cotemporary knowledge as required for entrance tests of PSU Graduate engineer trainees
10	18UC0010	UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS	HSS	2	0	0	0	2	NIL	Retained	No Change	Skill Development	Covers essentials values and ethics needed for human beigns
11	18UC0011	ENTREPRENEURSHIP	HSS	2	0	0	0	0	NIL	Retained	No Change	Entrepreneurship	Develops entrepreneurial hinking among graduates
12	18SC1103	SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA	BS	3	0	0	0	3	NIL	Retained	No Change	Skill Development	Covers the applications of mathematics for core domain courses
13	18MT1201	MULTIVARIATE CALCULUS	BS	3	0	2	0	4	NIL	Retained	No Change	Skill Development	Covers the applications of mathematics for circuit branches which helps the students for attaining better employment
14	18SC1105	LOGIC AND REASONING	BS	0	0	2	0	1	NIL	Retained	No Change	Employability	Covers the soft, verbal and reasoning skills Concepts which helps the students for attaining better employment
15	18SC1104	FOUNDATIONS OF COMPUTATIONAL MATHEMATICS	BS	0	0	2	0	1	NIL	Retained	No Change	Skill Development	Covers the applications of mathematics for computation in domain courses

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16	18BT1001	BIOLOGY FOR ENGINEERS	BS	2	0	0	0	2	NIL	Retained	No Change	Employability	Enhances the general science knowledge for engineers
17	18PH1004	SOLID STATE PHYSICS	BS	2	0	2	0	3	NIL	Retained	No Change	Employability	Enhances the general science knowledge for engineers
18	18CY1001	ENGINEERING CHEMISTRY	BS	3	0	2	0	4	NIL	Retained	No Change	Employability	Enhances the general science knowledge for engineers
19	18SC1101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ES	3	0	2	0	4	NIL	Retained	No Change	Skill Development	Problem solving and algorithms development
20	18SC1202	DATA STRUCTURES	ES	3	0	2	0	4	NIL	Retained	No Change	Skill Development	Data structures are needed for many job roles
21	18EC1002	GRAPHICS & DESIGN FOR ELECTRONIC AND COMPUTER ENGINEERING	ES	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Design software needed for electrical engineering
22	18EE1003	WORKSHOP PRACTICE FOR ELECTRICAL & ELECTRONICS ENGINEERS	ES	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Design software needed for electrical engineering
23	18SC2004	OBJECT ORIENTED PROGRAMMING	ES	2	0	2	0	3	NIL	Retained	No Change	Employability	Develops modern programming structures

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24	18EE1201	NETWORK THEORY	ES	3	0	2	0	4	NIL	Retained	No Change	Employability	Basic course for Electrical Engineering
25	18EE3201	ELECTRICAL ENGINEERING MEASUREMENTS	ES	2	0	2	0	3	NIL	New	Academic peers	Employability	Measurement knowledge is required for most specialization courses
26	18EE1202	ELECTROMAGNETIC FIELDS	ES	3	1	0	0	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
27	18MT1004	PROBABILITY & NUMERICAL METHODS	ES	2	1	0	0	3	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
28	18EC1101	DIGITAL SYSTEM DESIGN	PC	3	0	2	0	4	Nil	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
29	18EC2103	ANALOG ELECTRONIC CIRCUIT DESIGN	PC	3	0	2	0	4	Nil	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
30	18EE2101	ELECTRICAL CIRCUITS	PC	3	1	0	0	4	18EE121	Retained	No Change	Employability	Covers the core engineering concepts which core companies
31	18EE2102	DC MACHINES AND TRANSFORMERS	PC	3	0	2	0	4	NIL	Retained	No Change	Employability	Covers the core engineering concepts which helps the students for attaining better employment in EEE core companies
32	18EE2103	ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION	PC	3	1	0	0	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies

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33	18EE2201	AC ROTATING MACHINES	PC	3	0	2	0	4	18EE2102	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
34	18EE2202	CONTROL SYSTEMS	PC	3	0	2	0	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
35	18EE2203	POWER SYSTEM ANALYSIS & STABILITY	PC	3	1	0	0	4	18EE2103	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
36	18EE3101	POWER ELECTRONICS	PC	3	0	2	0	4	18EE2101	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
37	18EE3102	POWER SYSTEM PROTECTION & CONTROL	PC	3	0	2	0	4	18EE2203	Retained	No Change	Employability	Covers the core engineering concepts which helps the students for attaining better employment in EEE core companies
38	18EC2205	EMBEDDED CONTROLLERS	PC	2	0	3	2	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
39	18EM3201	SIGNAL PROCESSING	PC	2	1	2	0	4	Nil	Retained	No Change	Employability	Covers the core engineering Concepts which helps the students for attaining better employment in EEE core companies
40	18GN2103	COUNSELING - 3	Co-cur	0	0	1	0	0	NIL	Retained	No Change	Employability	Develops co-curricular and career building aspects
41	18GN1107	CO-CURRICULAR ACTIVITY -1	Co-cur	0	0	0	2	0.5	NIL	Retained	No Change	Employability	Develops co-curricular and career building aspects

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42	18GN1107	COCURRICULAR ACTIVITY.-I	Co-cur	0	0	0	2	0.5	NIL	Retained	No Change	Employability	Develops co- curricular and career building aspects
43	18GN2109	COCURRICULAR ACTIVITY -3	Co-cur	0	0	0	2	0	NIL	Retained	No Change	Employability	Develops co- curricular and career building aspects
44	18SC1106	TECHNICAL SKILL - 1	PR	0	0	0	6	1.5	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain.
45	18SC1207	TECHNICAL SKILL - 2	PR	0	0	0	6	1.5	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain.
46	18TS601	Technical Skill - 3 (Matlab)	PR	0	0	0	8	2	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain.
47	18TS602	Technical Skill - 4 (Matlab)	PR	0	0	0	8	2	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain
48	18TS605	Technical Proficiency & Training-1	PR	0	0	0	4	1	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain
49	18TS606	Technical Proficiency & Training-2	PR	0	0	0	4	1	NIL	Retained	No Change	Employability	Develops knowledge of latest tools in electrical & electronics domain
50	18IE2246	Industrial Training	PR	0	0	0	0	2	NIL	Retained	No Change	Employability	Eenables students to produce technical problems solving industrial problems

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51	18IE3247	Term Paper	PR	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Covers the practical knowledge on tools required for required for technical problem solving
52	18IE4048/ 18IE4050	Project (Part - 1) / Practice School	PR	0	0	0	24	6	NIL	Retained	No Change	Employability	Covers the practical knowledge on tools required for required for technical problem solving
53	18IE4049/18IE4	Practice School / Project (Part - 2)/Internship	PR	0	0	0	24	6	NIL	Retained	No Change	Employability	Covers the practical knowledge on tools required for required for technical problem solving
54	18EE3211	INDUSTRIAL COMMUNICATI ON PROTOCALS & CYBER SECURITY	PE	3	0	0	0	3	NIL	New	Alumni	Employability	Covers the advanced Concepts in industrial automation technologies which helps the students for attaining better employment
55	18EE3212	IOT FOR INDUSTRIAL AUTOMATION	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced Concepts in industrial automation technologies which helps the students for attaining better employment
56	18EE3213	SCADA AND DCS	PE	3	0	0	0	3	NIL	New	Academic peers	Entrepreneurship	Covers the advanced concepts in industrial automation technologies which helps the students for attaining better employment
57	18EE4112	INDUSTRIAL PROCESS CONTROL & AUTOMATION	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced Concepts in industrial automation technologies which helps the students for attaining better employment

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58	18EE3221	SOLAR PV AND THERMAL TECHNOLOGIES	PE	3	0	0	0	3	NIL	New	Alumni	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students for attaining better employment
59	18EE3222	WIND & MICRO ENERGY SOURCES	PE	3	0	0	0	3	18EE2101	New	Alumni	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students for attaining better employment
60	18EE3223	ENERGY CONSERVATION & AUDIT	PE	3	0	0	0	3	NIL	New	Academic peers	Employability	Covers the advanced concepts in renewable energy technologies which helps the students for attaining better employment
61	18EE4121	ENERGY STORAGE SYSTEMS	PE	3	0	0	0	3	18EE3121	New	Academic peers	Entrepreneurship	Covers the advanced concepts in renewable energy technologies which helps the students for attaining better employment
62	18EE4122	ENERGY MANAGEMENT SYSTEMS	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced concepts in renewable energy technologies which helps the students for attaining better employment
63	18EE3231	ENERGY ACCOUNTING AND MANAGEMENT SYSTEMS	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced concepts in renewable energy technologies which helps the students for attaining better employment
64	18EE3232	SUBSTATION PRACTICE	PE	3	0	0	0	3	18EE21	New	Academic peers	Employability	Covers the advanced concepts in smart grid technologies which helps the students for attaining better employment
65	18EE3233	DISTRIBUTION SYSTEM TESTING AND SAFETY PRACTICES	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced concepts in smart grid technologies which helps the students for attaining better employment

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66	18EE4131	SMART GRID COMMUNICATION AND CYBER SECURITY	PE	3	0	0	0	3	NIL	New	Academic peers	Employability	Covers the advanced concepts in smart grid technologies which helps the students for attaining better employment
67	18EE4132	SMART DISTRIBUTION SYSTEMS	PE	3	0	0	0	3	18EE3133	New	Academic peers	Entrepreneurship	Covers the advanced concepts in smart grid technologies which helps the students for attaining better employment
68	18EE3241	INTRODUCTION TO ELECTRIC VEHICLE	PE	3	0	0	0	3	NIL	New	Alumni	Employability	Covers the advanced concepts in electric vehicle technologies which helps the students for attaining better employment.
69	18EE3242	BATTERY MODELLING FOR ELECTRIC VEHICLES	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced concepts in electric vehicle technologies which helps the students for attaining better employment.
70	18EE3243	CHARGING STATION FOR ELECTRIC VEHICLE	PE	3	0	0	0	3	18EE311	New	Industry Expert	Entrepreneurship	Covers the advanced concepts in electric vehicle technologies which helps the students for attaining better employment.
71	18EE4141	BATTERY STATES ESTIMATION	PE	3	0	0	0	3	18EE3141	New	Alumni	Entrepreneurship	Covers the advanced concepts in electric vehicle technologies which helps the students for attaining better employment.
72	18EE4142	ELECTRIC VEHICLE FAULT DIAGNOSIS AND CONTROL	PE	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the advanced concepts in electric vehicle technologies which helps the students for attaining better employment.
73	18BT40A1	IPR & Patent Laws	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the practical knowledge on tools required for required for technical problem solving.

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74	18CE40A2	Environmental Pollution Control Methods	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students.
75	18CE40A4	Remote Sensing & GIS	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
76	18CS40A6	Fundamentals of DBMS	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
77	18EC40C9	Nano Electronics	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
78	18OL40A1	GRAPHIC DESIGN	OE	4	0	0	0	4	NIL	Retained	No Change	Skill Development	Covers the contemporary interdisciplinary knowledge required for core domain students
79	18CE40A3	Solid and Hazardous waste management	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
80	18CE40A5	Disaster Management	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
81	18EC40A9	Image Processing	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
82	18EC40C9	Nano Electronics	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students

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83	18ME40B4	Robotics	OE	3	0	0	0	3	NIL	Retained	No Change	Skill Development	Covers the contemporary interdisciplinary knowledge required for core domain students
84	18OL40B2	SMART CITIES - MANAGEMENT OF SMART URBAN INFRASTRUCTURES	OE	2	0	0	0	2	NIL	Retained	No Change	Entrepreneurship	Covers the contemporary interdisciplinary knowledge required for core domain students
85	18OL40B3	INTRODUCTION TO ELECTRIC VEHICLE	OE	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
86	18ME40B6	OPERATION RESEARCH	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
87	18EM40B1	LINUX PROGRAMMING	OE	3	0	0	0	3	NIL	Retained	No Change	Skill Development	Covers the contemporary interdisciplinary knowledge required for core domain students.
88	18PH40B7	NANO MATERIALS & TECHNOLOGY	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students.
89	18FL3054	FRENCH LANGAUGE	FL	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the foreign language requirement to be able to work or study abroad.
90	18FL3055	GERMAN LANGUAGE	FL	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the foreign language requirement to be able to work or study abroad.
91	18FL40F1	LEARN SPANISH: BASIC SPANISH VOCABULARY	FL	4	0	0	0	4	NIL	Retained	No Change	Employability	Covers the foreign language requirement to be able to work or study abroad.

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92	18FL40F2	RUSSIAN FOR BEGINNERS	FL	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the foreign language requirement to be able to work or study abroad.
93	18FL40F3	LEARN CHINESE: HSK TEST PREPARATION	FL	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the foreign language requirement to be able to work or study abroad.

Percentage of Courses focusing on Employability= 74/93=79.56%
Percentage of Courses focusing on Entrepreneurship= 7/93=7%
Percentage of Courses focusing on Skill Development = 12/93=12.76%

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3. Course-wise Syllabus revision of approved structure as mentioned

Course Code	Course Name	Course Category	Existing Syllabus	New Syllabus	Topics Added/Removed/Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
18EE2101	Electrical Circuits	Core	Transient response: R-L, R-C, R-L-C circuits (Series and parallel combinations) for D.C impulse, step, ramp and sinusoidal excitations, initial conditions, time domain and Laplace transform methods of solutions. Coupled Circuits: concept of mutual inductance, dot convention, coefficient of coupling, Magnetic Circuits, Analysis of series and parallel magnetic circuits. Filters: Low pass, High Pass, Band Pass, Band Elimination, Prototype filters design Low and High pass filter – M - derived filters of Low Pass and High Pass - Numerical Problems. Two port networks: one port and two port networks, two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships. Network functions, driving point and transfer functions – poles and Zeros. Network topology: definitions, graph, tree, primitive matrices, basic node incidence, basic cut-set and basic tie set matrices for planar networks, Loop and Nodal methods of analysis of networks, introduction to network matrices.	Network topology: definitions, graph, tree, primitive matrices, basic node incidence, basic cut-set and basic tie set matrices for planar networks, Loop and Nodal methods of analysis of networks, dual & duality. Transient response: R-L, R-C, R-L-C circuits (Series and parallel combinations) for DC impulse, step, ramp and sinusoidal excitations, initial conditions, time domain and Laplace transform methods of solutions. Two port networks: one port and two port networks, two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships, introduction to network matrices. Network functions, driving point and transfer functions – poles and Zeros. Magnetic Circuits: concept of self and mutual inductance, dot convention, coefficient of coupling, , Coupled Circuits, Analysis of series and parallel magnetic circuits. Filters: Low pass, High Pass, Band Pass, Band Elimination, Prototype filters design Low and High pass filter – M - derived filters of Low Pass and High Pass - Numerical Problems.	Added: Tutorial component is added for the course Removed: Labaratory component is removed	Yes	A tutorial component is included in the course as per the feedback from alumni	15%

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BASIC ENGLISH

Mapping of Course Outcomes to Program Outcomes: The students will be able to

Co.No	Course outcome's	PO/PSO	BTL
1	Apply the practical knowledge of using action words in sentence construction.	10/2	3
2	Apply and analyse the right kind of pronunciation with regards to speech sounds and able to get different types of pronunciations.	10/2	3
3	Apply the concept of fundamental principle of counting to solve the problems on linear, circular permutations and also for the problems on selections. Apply the concept of probability, while doing the problems on Leap year & Non-Leap year problems, coins, dice, balls and cards.	1/2	3
4	Analyze the given conditions and finding out all the possible arrangements in linear & circular order. Analyze the given numbers or letters to find out the hidden analogy and apply that analogy to find solutions. Finding the odd man out by observing the principle which makes the others similar.	5/2	4

Syllabus:

Worksheets (Revision tests of Bridge Course topics) -Parsing
Sentence Skills: Tense, Voice, Case, Gender, Reported Speech, Syntax, Types of Sentences, Syntactic Ordering
Introduction to the Sounds of English: Basic English Sounds, Distinctive Sounds of English, Assimilation, Contraction, Elision, Twinning, Stress, Syllables, Word- stress, Tone and Intonation- Rising, Falling, Rise-fall and Fall-rise.
Language Laboratory Interactive: Esca talk, JAM, Ranking, Shrinking Story, Desperate Decision, Listening for Specifics, Pronunciation Practice.
Quantitative Aptitude: Permutations and Combinations, Probability
Reasoning: Number and Letter Analogy, Odd Man out, Analytical Reasoning-I

Reference Books:

1. Kerry Patterson, Joseph Grenny, Ron McMillan:*Crucial Conversations: Tools for Talking When Stakes Are High.*Switzler: Paperback – Animated, September 9, 2011.
2. Douglas Stone, Bruce Patton, Sheila Heen, and Roger Fisher :*Difficult Conversations: How to Have Conversations that Matter the Most* .Paperback – November 2, 2010
3. R.K. Bansal, J.B. Harrison: *Spoken English*. Delhi: Orient Black Swan.2009.
4. Language LaboratoryTeacher Manual, KLEFU

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ENGLISH PROFICIENCY

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No	CO	PO/PSO	BTL
1	Identify the structure and usage of phrases, clauses and sentences along with the techniques of learning vocabulary, concord and sentence equivalence and demonstrate the strategies in different contexts.	7,10/1	2
2	Identify formats and parameters of writing skills and apply in product and process descriptions.	9/2	3
3	Apply the methods of fundamental concepts of tabulation, line-graphs, bar-graphs and pie charts in Data Interpretation and statements in Data Sufficiency	1,2/2	3
4	Identify the basic symbols and notations to find out the hidden analogy to solve sequences	1/1	2

Syllabus:

Writing Skills: How to Write a Definition, Defining Technical Terms, Product and Process Description.

Advanced Grammar Skills: Transformation of Sentences, Phrases, Clauses, Sentences Simple, Compound, Complex Sentences, Concord,Lexis 1:Synonyms, Antonyms, Analogies, Sentence Equivalence-One-Word Substitutes.

Language Laboratory Interactive: Debate, Blind-fold, Role Play, Situation Reaction Test--Build an Island nation

Quantitative Aptitude: Data Interpretation, Data Sufficiency

Reasoning: Symbols and Notations, Clocks and Calendars, Analytical Reasoning-II

Online Resources:

1. Lynn Stafford-Yilmaz Lawrence J. Zwier, *400 Must Have words for TOFEL*: Tata Mc-Graw-Hill publications, 2005https://list-english.ru/pdf/400.pdf
2. Sue Gilbert, *The Grammar Tree: 8 Essentials of Grammar and Composition*, Oxford University Press.https://docplayer.net/29843107-The-grammar-tree-teaching-guide-sue-gilbert-essentials-grammar-and-composition.html
3. Brian Galvin, Chris Kane, *Text Completion & Sentence Equivalence*: Veritas Prep, LLC, Second edition, 2016https://www.veritasprep.com/account/gre/pdf/Book_3_Text.pdf

Text Books:

1. R.S. Aggarwal, *Quantitative Aptitude:* S. Chand publication, Third edition
2. Abhijit Guha, *Quantitative Aptitude:* Tata Mc-Graw Hill co. Third edition
3. R.S. Aggarwal, *Verbal and Non-verbal Reasoning:* Tata Mc-Graw Hill co. Third edition
4. B.S. Sijwali and InduSijwali, *Reasoning: Verbal, Non-verbal and Analytical:* Third edition

Reference Books:

1. *501 Sentence Completion Questions*, 2004 Learning Express, LLC, New York
   http://www.misd.net/languageart/grammarinAction/501SentenceCompQuestions.pdf
2. *501 Word Analogy Questions*, 2002 Learning Express, LLC, New York
   https://elearning.shisu.edu.cn/pluginfile.php/36509/mod_resource/content/1/ANALOGIES.pdf
3. *1001 Vocabulary & Spelling Questions*, 2003 Learning Express, LLC, New Yorkhttp://elibrary.bsu.az/books_250/N_164.pdf
4. Language Laboratory Teacher Manual: KLEFU
5. Arun Sharma, *Quantitative Aptitude for CAT*; Tata Mc-Graw-Hill publications, Sixth edition
6. Gautam Puri, *Data interpretation for CAT*; GK publishers, third edition
7. Arun Sharma, *Logical Reasoning* by, Tata Mc-Graw-Hill publications, Fourth edition

Web References /MOOCS:

1. www.english-for-students.com/Easy-English-Conversations.html
2. www.indiabix.com
3. www.sawaal.com
4. https://www.ieltsbuddy.com
5. https://www.espressoenglish.net

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6. http://www.uefap.com/speaking/function/process.htm
7. https://www.test-preparation.ca/analogies-practice-questions
8. http://www.englishforeveryone.org/Topics/Sentence-Completion.html
9. https://www.youtube.com/watch?v=urr55rAreWc
10. https://www.youtube.com/watch?v=8fhX6q4UzqE
11. https://www.ieltsachieve.com/ielts-academic-writing-task-1/2017/5/22/ielts-academic-writing-task-1-process

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PROFESSIONAL COMMUNICATION SKILLS

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No	Course outcome's	PO/PSO	BTL
1	Able to spot the common grammatical errors related to Sentence Structure, Preposition, Concord, Relative and Conditional Clauses, and Parallel Structures. The learner should be efficient to construct a context-determined text in addition to learning Technical Writing Skills. One should be enabled to use English Language efficiently in the written medium to communicate Personal as well as Professional.	9, 10/2	3
2	Able to read, understand, and interpret a text intrinsically as well as extrinsically. The learner can browse a text quickly to come-up with a gist and personal interpretation. One is able to create a healthy work-environment and prove to be an asset or one of the most reliable resources to the Organization. As a professional, one is mature to bridge the gulf between the existing behavior/ lifestyle and the expected corporate behaviour cum lifestyle.	8/1	4
3	Apply the concepts of Time and work, the students will be able to solve the questions related to Men-Time-Work, problems based on wages, pipes and cisterns. Apply the concepts of Time and Distance and solve the problems related to average speed, relative speed, problems based on trains, boats, circular tracks, races and games.	1/2	3
4	Apply Venn diagrams to the given statements to find out whether the given conclusions can be deducted from the given statements. Apply the logical implications and also the negations of various connectives to find the solutions. Analyze the given data and representing the data in the form of Venn Diagrams to find relations between any given set of elements.	1,5/2	3

Grammar and Usage: Error Analysis.
Writing Skills: Topic sentence, Linkers, Connectors and Transition, Paragraph Writing, Letter Writing
Reading Comprehension: Techniques, Skimming and Scanning, Vertical Reading, Reading Perception Tests (RPT): (Graphic) Reading Perception Tests (RPT), Semantic Interpretation of the Text, Reading Speed Enhancement.
Soft Skills: Interpersonal Skills, Adjusting Your Attitude-Arrogance has no Place in the Workplace, Cultural Sensitivity in the Workplace, Corporate Culture: Learning How to Fit In.
Quantitative Aptitude: Time and Work, Time and Distance
Reasoning: Deductions, Logical Connectives, Venn Diagrams

Reference Books:

1. Gajendra Singh Chauhan and SmitaKashiramka. *Technical Communication.* Delhi:Cengage Learning India.2018.
2. Andrea Penruddocke and Christopher A. Warnasch.English for the Real World.USA:Living Language.2004
3. GeraldJ Alfred, Charles T Brusaw and Walter E.Oliu. Hand Book of Technical Writing. USA:Betford.2000.
4. Asher Cashdan: Language, Reading and Learning.Oxford:Basil Blackwell.1979.

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APTITUDE BUILDER –I

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No	Course outcome's	PO/PSO	BTL
1	Apply the concept of Critical Reading and Analytical Reading and comprehend the keyideas and gist of a passage.Understand the importance of the presentation skills, analyze the given topic, apply various strategies and the principles of grammar in written expression.	5,6/2	3
2	Apply the concepts of grammar, various strategies and the usage of formal language in written expression. By using synonyms rewrite the same text in the same format and meaning. Write the gist of the given text.	7,10/2	3
3	Apply the concepts of Numbers to solve the problems related to divisibility rules, problems based on Unit's digit, Remainders, Successive Division, Prime Factorization, LCM & HCF problems. Apply the concepts of Averages &Alligations, students will be able to solve the problems related to Averages as well as problems based on Mixtures.	1, 5/2	3
4	Apply the various concepts of cubes to find out how to cut a cube to get the maximum number of smaller identical pieces, how to minimize the number of cuts required to cut a cube into the given number of smaller identical pieces, how to count the number of smaller cubes which satisfy the given painting scheme. Apply the principles of binary logic to solve problems involving truth-tellers, liars and alternators. Analyze the given data to form an ordered arrangement from an unorganized raw data.	1, 5/1	4

Syllabus:

Directed Listening and Thinking Activity (DLTA) Skills: Reading, Listening, Thinking, Writing, Presentation - Method: Flipped Classroom.

Writing Skills**:** Paraphrasing, Summarizing, Notice, Circular, Agenda, Minutes, Memo

Body Language (Kinesics) :Postures, gestures, eye contact

Self-confidence: Self-esteem

Soft Skills: The Art of Compromise, Learn to Say: "I Don't Know", Being organized, Showing Self-awareness, An eye on success, being self-motivated, Showing self-awareness, Find Direction from Someone Who Is Lost: "The Drifter"

Self-Assessment for Attainable Career Objectives--Defining a Career Objective

Quantitative Aptitude: Numbers, Averages and Alligations, Mensuration

Reasoning: Cubes, Binary Logic, Ordering and Sequencing

Reference Books:

1. Daniel G.Riordan and Steven E. Pauley: *Technical Report Writing Today.* New Delhi: Biztantra.2004.
2. Ken Taylor.Telephoning and Teleconferencing Skills. Hyderabad:Orient Black Swan.2008.
3. E. Suresh Kumar, B. Sandhya.Communication for Professional Success. Delhi: Orient Black Swan.2013
4. Reasoning Trainer Plus.:Hyderabad:Brain Mapping Academy.2012

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APTITUDE BUILDER-2

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No	Course outcome	PO/PSO	BTL
1	Apply the strategies and techniques learnt in carrying out conversations in different contexts. Analyse the different parameters and formats of written technical communication and apply in everyday work and life.	8, 10/2	3
2	Analyse the concepts of critical and analytical reading skills. Analyze the strategies and techniques learnt in handling interviews in different contexts.	8, 10/1	4
3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest, students will be able to solve the problems based on Ratios, problems involving Percentages, problems related to cost price, selling price, profit, loss, marked price and discounts, problems involving interest.	1, 5/2	3
4	Analyze the given series of numbers to predict the next number in the series. Analyze the given set of numbers or letters to find the analogy. Analyze the given data to find the code which is used to encode a given word and use the same code in the process of decoding. Apply the given set of conditions to select a team from a group of members.	1/1	4

Syllabus:

Critical Reading: Reading to Identify the Theme, Reading to Identify the Central Idea; Reading to Identify the Tone, Reading to Identify Writer's Attitude, Reading to Identify Parallel Ideas, Reading to Identify Logical Conclusions.

Writing Skills: Note- making and Note- taking, Report Writing.

Presentation Skills- Preparing for the Presentation, Audience Analysis, Processing Information, Ice-breakers, Quotations, Presentation Structure, Say what you want to say- Say it, Say what you have said to say, Preparing for Question Hour, Funnel Effect and How to Overcome it.

Trinity Guild Hall - Communication Skills - Graded Evaluation and Testing-1-8 grades

Quantitative Aptitude: Ratio and Proportion, Percentages, Profit and Loss, Simple Interest and Compound Interest

Reasoning: Number and Letter Series, Number and Letter Analogy, Coding and decoding, Odd man out. Selections

Reference Books:

1. Dr. Meenakshi Raman and Dr. Sangeetha Sarma: *Technical Communication*.Oxford University Press: Delhi.2016.
2. M. Ashraf Rizvi: *Effective Technical Communication.* New Delhi:McGraw Hill Education(India) Private Limited
3. Tom Rath: Strengths Finder2.0. New York:Gallup Press.2007.
4. C. Weaver. *Reading Process and Practice*. Portsmouth US: Heinemann Educational Bokks.1988.

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CAMPUS TO CORPORATE

Mapping of Course outcomes with Program Outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyze basic concepts of critical and analytical reasoning skills apply strategies analyze issues, arguments and some aspect of corporate communication.	PO5,PO6,PO9/PSO-1	4
CO2	Creativity in writing of any given context like sending Emails, Reports, Proposals etc. Make the student to face HR interviews.	PO7,PO8,PO10/PSO-1	4
CO3	Enable the students to decipher the meaning of the context in the given texts. It also helps students to develop critical thinking.	PO1,PO4,PO5	3
CO4	Comprehension passages assist in developing writing skills and in grooming them to be ready for placements.	PO1,PO5	3

Syllabus

600 Word list (continue assessment), Idiomatic Expressions, One word substitutions, Sentence Completion, Reading Comprehension , Time Management, Stress Management, Problem Solving, Situation Reaction, Grooming, Mock Interviews.

Language Laboratory Interactive: Online practice test, Time Management Matrix, Interactive Problem Solving, Designing Tasks for the Communicative Classroom, classroom activity, mock interviews.

Reference books

1. KenTaylor.TelephoningandTeleconferencingSkills. Hyderabad: OrientBlackSwan.2008.
2. E.SureshKumar,B.Sandhya.CommunicationforProfessionalSuccess.Delhi:OrientBlackSwan.2013
3. JudithVerify:SucceedingatInterview.Mumbai:VivaBooksPrivateLimited.2000
4. NormanL.Frigon, Sr. &HarryK.Jackson, Jr.TheLeader-DevelopingtheSkillsandPersonalQualities.Mumbai:MagnaPublishingCoLtd.2000.

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INDIAN HERITAGE & CULTURE

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No:	Course Outcome	PO/PSO	BTL
1	To familiarize with various aspects of the culture and heritage of India through ages.	1/1	1
2	To acquaint with the contributions of Indians in the areas of languages and literature, religion and philosophy	1/1	1
3	To understand the Social structure and the spread of Indian culture abroad	1/1	2
4	To know the development of Science and Technology in India through ages and to appreciate the contributions of some of the great Indian scientists	1/1	1

Syllabus:

Introduction-Concept of Culture-Culture and Civilization-General Characteristics of Indian Culture-Importance of Culture-Unity in Diversity

History and Culture through the Ages – Fundamental Unity of Harappan and Vedic Culture – Jainism and Buddhism-Mauryan Period-Post-Mauryan Period-Gupta Period-Pallavas and Cholas

Advent of Islam in India-Islam and Sufism-Islamic Art and Architecture-Bhakti Movement-Vijayanagar Period-Art and Architecture and Literature

Rise of the West and its impact on India-Social and Religious reformers in the 18th and 19th centuries-Press and growth of modern Indian literature-Rise of Indian Cinema-Indian Independence

Reference Books:

1. Facets of Indian Culture- Spectrum Publications
2. Ancient India: National Council of Educational Research and Training
3. Medieval India: Part I & Part II: National Council of Educational Research and Training.
4. Modern India: National Council of Educational Research and Training.
5. An Advance History of India: R.C. Majumdar, H.C. Raychaudhuri &KalikinkarDatt: Macmillan India Ltd.
6. The Wonder that was India : A.L.Bhasham

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INDIAN CONSTITUTION

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO No	Course outcome's	PO	BTL
1	To understand Constitutional development after Independence	12/1	2
2	To learn the fundamental features of the Indian Constitution	12/1	2
3	To get a brief idea of the powers and functions of Union and State Governments	12/1	2
4	To understand the basics of working of Indian Judiciary and the Election Commission	12/1	2

Syllabus:

Making of the Constitution: A brief analysis of National Movement.Constitutional Development with reference to Government of India Act 1909, 1919, 1935 and Indian Independence Act 1947.The Constituent Assembly of India.

Basic features of the Indian Constitution: the Preamble, Fundamental Rights, Directive Principles of State Policy – Fundamental Duties

Government of the Union : The Union Executive – the President and the Vice-President – The Council of Ministers and the Prime Minister – Powers and functions, The Union legislature – The Parliament – The Lok Sabha and the Rajya Sabha, Composition, powers and functions – the role of the Speaker.**Government of the State:** The Governor – the Council of Ministers and the Chief Minister – Powers and Functions, The State Legislature – composition, powers and functions.**The Indian Judicial System:** the Supreme Court and the High Courts – composition, Jurisdiction and functions, Judicial review, Judicial activism, Independence of Judiciary In India.**Election Commission:** Role and Functioning, Chief Election Commissioner and Election Commissioners

Reference Books:

1. Indian Polity' by Laxmikanth
2. Indian Administration' by Subhash Kashyap
3. 'Indian Constitution' by D.D. Basu
4. 'Indian Administration' by Avasti and Avasti
5. 'Constitutional Law of India' by Seervai H.M.
6. 'Constitution Of India' by Shukla V.N.
7. 'The Indian Constitution: Cornerstone of a Nation' by Granville Austiin
8. 'Indian Constitutional Law' by M.P. Jain

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ECOLOGY AND ENVIRONMENT

Mapping of Course Outcomes (CO) to Program outcomes:

CO No.	Course Outcome	PO	BTL
1	Understand the importance of Environmental education and conservation of natural resources.	6/1	1
2	derstand the importance of ecosystems and biodiversity.	12/1	1
3	ply the environmental science knowledge on solid waste management, disaster management and EIA process.	6/2	3

Syllabus:

The Multidisciplinary nature of Environmental Studies - Natural Resources- Forest resources - Mining its impact on environment - Water resources - Mineral resources-. Energy resources -Land resources- Soil erosion - Ecosystems - Biodiversity and its ConservationEnvironnemental Pollution - Soil waste management - Electronic waste management, biomedical waste management - Disaster management –.Environmental Legislation Environmental Impact Assessment Process.

Text Books:

1. Anubha Kaushik, C.P.Kaushik, "Environmental Studies", New Age International, (2007).
2. Benny Joseph, "Environmental Studies", Tata McGraw-Hill companies, New Delhi, (2009).

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UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS

Mapping of Course Outcomes (CO) to Program outcomes:

Co No.	Course Outcome	PO/PSO	BTL
1	Understand and identify the basic aspiration of human beings.	8,9/1	2
2	Understand the harmony in human being.	8,9/1	2
3	Understand the harmony in family, society and nature (existence).	8,9/1	2
4	Understand the profession and his role in this existence.	8,9/1	2

Syllabus:

Introduction to Value Education: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - The Basic Human Aspirations, Right Understanding, Relationship and Physical Facilities, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.

Harmony in the Human Being: Understanding the Human Being as Co-existence of Self ('I') and Body, Discriminating between the Needs of the Self and the Body, The Body as an Instrument of 'I', Understand Harmony in the Self ('I'), Harmony of the Self ('I') with the Body, Program to Ensure Sanyam and Svasthya.

Harmony in the Family and Society: Harmony in the Family - the Basic Unit of Human Interaction, Values in Human-to-Human Relationships, 'Trust' – the Foundational Value in Relationships, 'Respect' – as the Right Evaluation, Understand Harmony in the Society, Vision for the Universal Human Order.

Harmony in the Nature (Existence): Understand Harmony in the Nature, Interconnectedness, Self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing 'Existence is Co-existence' at All Levels, The Holistic Perception of Harmony in Existence.

Implications of the Right Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models - Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Book:

1. R R Gaur, R Sangal and G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 1st Ed, Excel Books.

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SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA

Mapping of Course Outcomes (CO) to Student outcomes:

CO No:	COURSE OUT COME	PO/PSO	BTL
1	Model the physical laws and relations mathematically as a first order differential equations, solve by analytical and numerical methods also interpret the solution.	1/1	2
2	Model physical laws and relations mathematically as a second/higher order differential equations, solve by analytical method and interpret the solution.	1/1	2
3	Obtain the Fourier series expansions of periodic functions and use the series to solve ordinary differential equations.	1/1	2
4	Model physical problems mathematically as a system of linear equations and solve them by analytical and numerical methods. Also, determine the nature of Quadratic form using Eigen values.	1/1	2
5	Verify the solution of problems through MATLAB.	5/1	2

SYLLABUS:

Differential Equations: Definitions and terminology and mathematical models used in differential equations. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with first and higher-order also systems of linear first-order differential equations. Solutions of first order ordinary differential equations by Numerical methods.

Fourier series: Definitions and Fourier series for a periodic signal. Fourier series for simple functions.Fourier series of the summation of sinusoids directly from the definition by using Euler's formula.Solving particular solution to differential equation by Fourier series.

Matrix algebra: Solving linear System of equations by Gauss-elimination, L U decomposition and Jacobi, Gauss Seidal iteration methods, orthogonal, symmetric, skew-symmetric, Hermitian, Skew-Hermitian and unitary matrices, Eigen values, Eigen vectors and their properties, Cayley -Hamilton theorem (without proof) and its applications, and quadratic forms.

Text books:

1. Advanced Engineering Mathematics, Erwin Kreyszig. John Wiley & Sons, Inc. 10 th Edition.
2. Advanced Engineering Mathematics, Greenberg, PHI Publishers, 2nd Edition.

Reference Books:

1. Differential Equations for Engineers, Wei-Chau Xie, Cambridge University Press, New York. R1
2. Higher Engineering Mathematics, BS Grewal. Publisher: Khanna, New Delhi. R2
3. Advanced Numerical Methods with MATLAB, SC Chapra, Tata McGraw-Hill. R3

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MULTIVARIATE CALCULUS

Mapping of Course Outcomes (CO) to Student outcomes:

CO No:	Course Outcome	PO/PSO	BTL
1	termine extreme values for functions of several variables	1/1	4
2	termine area, volume moment of inertia through multiple integrals in Cartesian or polar co ordinates.	1/1	4
3	Apply the concepts of vector calculus to calculate the gradient, directional derivative, arc length, areas of surfaces and volume of solids in practical problems	1/2	3
4	Obtain analytical and numerical solutions of Heat and wave equations	1/1	4
5	Verify the solution of problems through MATLAB	5/2	3

SYLLABUS:

Differential Calculus: Partial derivatives, Jacobian, total differentiation and their applications, chain rule, Taylor's series for function of two variables, maxima and minima of functions of two variables, Lagrange's multipliers method.

Integral Calculus: Line integrals- double and triple integrals and applications to area, volume, mass & moment of inertia. Change of order of integration, change of variables in polar, cylindrical and spherical polar coordinates.

Vector Calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of a vector point function. Line, surface and volume integrals, Green's, Gauss divergence and Stoke's theorems and their applications

Partial differential equations: Formation of partial differential equations, solutions of first order linear and nonlinear PDEs by Lagrange method, solution of second order PDEs by method of separation of variables i.e., one dimensional wave and heat equations, Laplace equation in two dimensions. Solving Laplace equation by Finite difference method.

Text books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10 thEdition, John Wiley &Sons, Inc, Newyork . (2015)
2. Nakhle H Asmar, Partial differential equations with Fourier series and boundary value problems, Second edition Pearson Pub.

Reference Books:

1. Michael Greenberg, Advanced Engineering Mathematics. Second edition, Prentice **Hall, USA.**
2. Zafar Ahsan, Differential equations and their applications, second edition, PHI
3. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, India.

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LOGIC AND REASONING

Mapping of Course Outcomes (CO) to Student outcomes:

CO No	Course Outcome (CO)	PO	BTL
1	ply the fundamental principle of counting and use them to measure the uncertainty in random experiments.	1,5/2	3
2	Apply Venn diagrams to find the conclusion of statements , solve puzzles using binary logic and problems relating to cubes.	1,5/2	3
3	Apply the available models for Data sufficiency & redundancy and interpret it , when given, in tabular and graphical forms.	1,5/2	3
4	Apply the Reasoning techniques to solve problems on arrangements, series, analogies, coding and decoding.	1,5/2	3

SYLLABUS:

Permutation and Combinations: Fundamental Principle of Counting, Counting Methods, Definition of permutation, Linear Permutations, Rank of a word, Circular Permutations, Definition of Combinations, Problems on Combinations

Probability: Definitions of Probability, Addition and Multiplication Theorems.

Deductions: Introduction, expressing different types of statements using Venn diagrams, Definition of complimentary pairs, Finding the conclusions using Venn diagrams for two and more statements.

Logical Connectives: Definition of simple statement, Definition of compound statement, Finding the implications for compound statements, Finding the negations for compound statements.

Binary Logic: Definition of a truth-teller, Definition of a liar, Definition of an alternator, solving problems using method of assumptions, solving analytical puzzles using binary logic.

Cubes: Basics of a cube, Finding the minimum number of cuts when the number of identical pieces are given, Finding the maximum number of pieces when cuts are given, Problems on painted cubes of same and different colors, Problems on cuboids, Problems on painted cuboids, Problems on Dice.**Data Sufficiency:** Different models in Data Sufficiency, Problems on Data sufficiency, Problems on data redundancy.**Data Interpretation:** Problems on tabular form, Problems on Line Graphs, Problems on Bar Graphs, Problems on Pie Charts.**Analytical Reasoning puzzles:** Problems on Linear arrangement, Problems on Circular arrangement, Problems on Double line-up, Problems on Selections, Problems on Comparisons.

Number and letter series: Difference series, Product series, Squares series, Cubes series, Alternate series, Combination series, Miscellaneous series, Place values of letters.

Number and Letter Analogies: Definition of Analogy, Problems on number analogy, Problems on letter analogy, Problems on verbal analogy.

Odd man out: Problems on number Odd man out, Problems on letter Odd man out, Problems on verbal Odd man out.**Coding and decoding:** Coding using same set of letters, Coding using different set of letters, Coding into a number Comparison & Elimination

Text Books

1. A modern approach to Logical reasoning, R S Agarwal, S. Chand Publications.

Reference Text Books

1. Logical Reasoning, Arun Sharma, Mc Graw Hill.
2. Analytical & Logical Reasoning, Peeyush Bhardwaj, Arihant Publications

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FOUNDATIONS OF COMPUTATIONAL MATHEMATICS

Course Outcomes (CO):

CO No:	Course out come	PO	BTL
1	Identify the quantities of Real world problems by using the concepts of arithmetic.	1,7/1	2
2	mputing the areas of regular and irregular solids of real world problems.	1,7/1	2
3	Identifying the numbers by successive division also finding the solution of equations.	1,7/1	2
4	Estimating the roots of an equations and find the unknown values from the data by numerical methods	1,7/1	2

SYLLABUS:

Fundamentals of Mathematics: (6 hrs)
Order of operations &brackets , fractions and decimals, Binary numbers, Divisibility rules, factorization, successive division, Finding unit digits, Remainders involving higher powers

Fundamentals of Algebra: (6 hrs)
Simple equations, simultaneous equations, quadratic equations, progressions, Transposing formulae ,logarithms, exponential functions.

Fundamental of Arithmetic: (6 hrs)
Ratio, Proportion, variation, percentages, profit & loss, time &distance , time & work
Or
Fundamentals of Statistics : (6 hrs)
Mean, Median, Mode (grouped and discrete data), standard deviation, laws of probability

Practical applications of common solids, irregular solids: (6 hrs)
Triangles, quadrilaterals, polygons, cylinders, cones, Irregular areas

BoS Approved Text Books:

1. Basic Engineering Mathematics, John Bird, sixth Edition, Elsevier.

BoS Approved Reference Books:

1. Quantitative Aptitude, R. S. Aggarwal, Schand Publications.
2. Quantitative Aptitude - G. L. Barrons.
3. Quantitative Aptitude - Abhijit Guha, Mc Graw Hills.

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BIOLOGY FOR ENGINEERS

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Acquire the Knowledge of basic biology	PO6, PO7/PSO-1	2
CO2	Acquire the Knowledge of Human Biological Systems	PO6, PO7/PSO-1	2
CO3	Acquire Knowledge on Microorganisms and Biosensors	PO6, PO7/PSO-1	2

Syllabus

Basic Biology: Introduction, Living organisms, Cell structure and Organelles, Organogenesis, Human Anatomy.

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination and Defense,

Diet and Nutrition: Macro (Carbohydrates, proteins, lipids) - and Micronutrients (vitamins), Essential minerals and their role; deficiency symptoms; and their role; deficiency symptoms.

Micro-Organisms: Classification of Microorganisms, beneficial and harmful effects of Bacteria, Fungi and Viruses.

Biosensors, biomechanics and Medical Imaging technology, Applications of Biosensor in Food and Agriculture.

Text books

1. Dr RC Dubey ,"Advanced Biotechnology", S Chand Publications.
2. P K Gupta ,"Elements of Biotechnology", RASTOGI Publications.

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SOLID STATE PHYSICS

Mapping of Course Outcomes (CO) to Student outcomes:

CO No:	Course Outcome(CO)	PO/PSO	BTL
1	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	**1,8/1**	2
2	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering applications.	**1,8/1**	2
3	Understands the role of electronic energy band structures of solids ingoverning various electrical and optical properties of materials.	**1,8/1**	2
4	Understands the formation of various energy band structures if various types of solids using various models. Applies the knowledge of band structures for various semiconductor applications.	**1,8/1**	2
5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	**1,8/2**	3

SYLLABUS:

Magnetic properties: Origin of Magnetic Moment, Dia, Para, Ferro, Antiferro and Ferri Magnetism, Domain theory and Hysteresis Effect of Ferro and Ferri Magnetism, Soft and Hard Magnetic Materials.

Thermal properties: Iron-Carbon Diagram, Heat capacity, Thermal Expansion and Thermal Conductivity in Metals, Ceramics and Polymers, Heat treatment of Materials, Hardening, Tempering, Quenching and Nitriding.

Mechanical Properties: Stress, Strain, Hooke's Law, Elasticity, Plasticity, Creep, Ductility, Brittle, Hardness, Strength, Modulus of Elasticity, Fracture, Fatigue, Stress- Strain Behavior of Ductile and Brittle Materials, Hardness Tests- Vickers, Rockwell and Brinell.

Electrical Properties: Energy band theory, Band structures in Conductors, Semi conductors and Insulators, Electrical properties of conductors- Ohms, Mathiessen rule, conductivity, Mobility, Electrical properties of Semi conductors, Factors effecting the carrier concentration, Conductivity and Mobility of charge carriers. Electric properties of Insulator-Dielectrics- Types of Dielectrics, Dielectric Constant, Polarization, Types of Polarizations, Frequency Dependence of Polarization, Ferro, Piezo Electrics.

Introduction to Solids and Semiconductors:

Free electron theory of metals, Fermi level, density of states in 1, 2 and 3 dimensions,
Bloch's theorem for particles in a periodic potent ial, Kronig-Penney model and origin of
energy bands. Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p -n junction.

Optical properties: Optical reflectance, Optical Absorption, snell's law, Total Internal reflection in optical fibers.

List of Experiments:

1. Energy loss of a magnetic material
2. Determination of Hall coefficient of a semiconductor
3. Lee's Method – Determination of Specific heat of bad conductor.
4. Young's modulus by uniform bending method
5. Creep behavior of a metal wire
6. Dielectric constant of solid
7. Energy band gap of a semiconducting diode
8. Particle size by LASER diffraction
9. Refractive Index of a liquid by minimum deviation
10. P-N Junction diode characteristics
11. Solar Cell Characteristics
12. Lattice constant by powder XRD

TEXT BOOKS:

1. Callister William D., Jr. "Materials Science and Engineering: An Introduction" 6th edition,

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2007, Wiley
India Pvt. Ltd. ISBN-10: 0471135763.
2. Rangwala, Engineering Materials (Material Science), Charotar Publishing House PVT. LTD. ISBN10: 9380358261.

REFERENCE BOOKS:

1. Dekker. Adrianus J. *"Solid State Physics"* 1st Edition *2002,* Macmillan India Ltd. ISBN 10: 0333918339.
2. Pillai. S. O., "Solid state physics" Revised 6th edition, New Age International Publishers. ISBN:9781906574109.
3. Kittel. Charles, "Introduction to Solid State Physics" 8th edition, 2012, Wiley India Pvt. Ltd. ISBN: 978-0-471-41526-8.

WEB REFERNCES/MOOCs:

1. https://nptel.ac.in/courses/113106032/
2. https://www.livescience.com/38059-magnetism.html
3. https://nptel.ac.in/courses/113106032/15%20-%20Magnetic%20Properties.pdf
4. https://nptel.ac.in/courses/112108150/pdf/Web_Pages/WEBP_M15.pdf
5. https://nptel.ac.in/courses/112108150/pdf/PPTs/MTS_15_m.pdf
6. http://www.me.nchu.edu.tw/lab/CIM/www/courses/Manufacturing%20Processes/Ch03-Mechanical-Wiley.pdf
7. https://nptel.ac.in/courses/112108150/pdf/PPTs/MTS_14_m.pdf
8. https://nptel.ac.in/courses/112108150/pdf/PPTs/MTS_17_m.pdf
9. https://www.tf.uni-kiel.de/matwis/amat/elmat_en/kap_4/backbone/r4_4_1.html
10. https://web.utk.edu/~prack/MSE%20300/FeC.pdf
11. https://www.tf.uni-kiel.de/matwis/amat/iss/kap_6/illustr/s6_1_2.html

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ENGINEERING CHEMISTRY

Mapping of Course Outcomes (CO) to Student outcomes:

CO No:	Course Outcome	PO/PSO	BTL
1	Describe some important design considerations in choosing a battery for a specifi application.	1,3,7/1	2
2	Predict potential complications from combining various chemicals or metals in a engineering setting	1,3/1	2
3	Examine water quality and select appropriate purification technique for intende problem	1,7/1	2
4	Explain the role of chemical kinetics in the formation and destruction of ozone i the atmosphere and predict the connection between molecular behavior an observable physical properties.	1,7/1	2
5	An ability to analyze& generate experimental skills	1,4/1	4

SYLLABUS:

Energy and Chemistry: Energy Use and the World Economy, Defining Energy, Energy Transformation and Conservation of Energy, Heat Capacity and Calorimetry. Enthalpy, Hess's Law and Heats of Reaction, Energy and Stoichiometry.

Electro Chemistry: Single electrode potential and its measurement, Electrochemical cells, EMF series, Nernst equation, Cell emf measurement, Reversible and irreversible cells, Concentration cells, Reference electrodes--Determination of pH using glass electrode. Gas Sensors: Capacitance Manometer and Mass Spectrometer.

Batteries: Chemistry, construction and engineering aspects of Primary (mercury battery) and secondary (lead-Acid cell, Ni-Metal hydride cell, Lithium cells) and fuel cells– Hydrogen–Oxygen fuel cell, advantages of fuel cell.

Corrosion: Causes and different types of corrosion and effects of corrosion. Theories of corrosion– Chemical, Electrochemical corrosion, Pitting corrosion, stress corrosion, Galvanic corrosion.Factors affecting corrosion– Nature of metal, galvanic series, over voltage, purity of metal, nature of oxide film, nature of corrosion product. Nature of environment- effect of temperature, effect of pH, Humidity, effect of oxidant. Cathodic protection, sacrificial anode, impressed current cathode, electroplating.

Water Chemistry: Introduction, Hardness:Causes, expression of hardness – units – types of hardness, estimation of temporary and permanent hardness of water, numerical problems. Alkalinity and estimation of alkalinity of water, numerical problems.**Boiler troubles** – Scale & sludge formation, caustic embrittlement, Boiler corrosion, priming & foaming. **Softening of water**: Internal and external treatments -Lime soda, Ion exchange process.**Desalination-**reverse osmosis and electro dialysis.

Chemical Kinetics: Ozone Depletion, Rates of Chemical Reactions, Rate Laws and the Concentration Dependence of Rates, Integrated Rate Laws, Temperature and Kinetics, Reaction Mechanisms, Catalysis, insight into Troposphere Ozone.

Molecules and Materials: polymers- Types of polymerization-Mechanisms, Plastics – Thermoplastic resins and thermosetting resins - Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde. Conducting Polymers: Polyacetylene, polyaniline, conduction, doping and applications.Carbon nano tubes and Applications.

Text Books:

1. EngineeringChemistry,Jain&Jain,DhanpatRaiPublishingCompany.NewDelhi.
2. Engineering Chemistry, O G Palanna, The Tata McGraw Hill, NewDelhi.

Reference Books:

1. ChemistryinEngineeringandTechnology,Volume2,JCKuriacose&JRajaram,TataMcGrawHill,NewDelhi.
2. Chemistry for Engineers Rajesh Agnihotri, Wiley, NewDelhi.
3. EngineeringChemistry,B.Sivasankar,TheTataMcGrawHill,NewDelhi.
4. AtextbookofEngineeringChemistry,ShashiChawla,DhanpatRai&Co.NewDelhi.
5. Engineering Chemistry, C Parameswara Murthy, C V Agarwal and Andra Naidu, B S Publications,Hyderabad.
6. Engineering Chemistry, Shikha Agarwal, Cambridge University Press.

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PROBLEM SOLVING AND COMPUTER PROGRAMMING

Course Outcomes:

CO No:	Course Outcome	PO/PSO	BTL
1	Illustrate how problems are solved using computers and programming.	1,2/,2	**3**
2	Illustrate and use Control Flow Statements in C.	1,2/2	**3**
3	Interpret & Illustrate user defined C functions and different operations on list of data.	1,2/2	**3**
4	Implement Linear Data Structures and compare them.	4/2	**3**
5	Apply the knowledge obtained by the course to solve real world problems.	1,2,4/2	**3**

Syllabus:

Problem Solving Approach, **Algorithms and Algorithm Analysis**, Program Development Steps, Structure of C Program, Pre-Processor Directives, **Formatted I/O,C Tokens, Data Types**: Primitive, Extended and Derived Including Pointers, Operators, Precedence, Associativity , **Redirecting I/O** :Files and File Operations , **Control Flow Statements, Functions, Recursion**, Scope of Variables and Storage classes, **Arrays,** 2-DimensionalArrays,Dynamic Memory Allocation, **Searching:** Linear Search and Binary Search, **Sorting:** Bubble Sort, **Strings**, **Structures and Unions**, Introduction to **Stacks**-Implementation using array, Introduction to Queues – Linear **Queue**-Implementation using array, Introduction to **Lists:** Single Linked List- Insertion, Deletion, Display.

Text Books:

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. E. Balagurusamy ,"Programming in ANSI C" 4thed.,Tata McGraw-Hill Education, 2008 .
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:-

1. Mark Allen weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction To Data Structures with applications", 2nd Edition.

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DATA STRUCTURES

Course Outcomes:

CO	CO Description	PO/PSO	BTL
1	Apply measures of efficiency on algorithms and Analyze different Sorting Algorithms.	1,2/,1	4
2	Analyze and compare stack ADT and queue ADT implementations using linked list and applications.	1,4/1	4
3	Analyze the linked implementation of Binary, Balanced Trees and different Hashing techniques.	1,4/1	4
4	Analyze different representations, traversals, applications of Graphs and Heap organization.	2,4/1	4
5	Develop and Evaluate common practical applications for linear and non linear data structures.	1,2/,1	5

Syllabus:

Algorithm Analysis: Mathematical Background, Model, Analyze, Running Time Calculations, Lists.
Stacks and Queues: Abstract Data Types (ADTs), The List ADT, The Stack ADT, The Queue ADT.
Trees: Preliminaries, Binary Trees, The Search Tree ADT—Binary Search Trees, AVL Trees, Splay Trees, Tree Traversals (Revisited), B-Trees, Red black trees
Hashing: General Idea, Hash Function, Separate Chaining, Hash Tables without Linked Lists, Rehashing, Hash Tables in the Standard Library, Extendible Hashing.
Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Applications of Priority Queues.
Sorting: Preliminaries, Insertion Sort, A Lower Bound for Simple Sorting Algorithms, Shell sort, Heap sort, Merge sort, Quick sort, Indirect Sorting, A General Lower Bound for Sorting, Bucket Sort, External Sorting.
Graph Algorithms: Definitions, Topological Sort, Shortest-Path Algorithms, Minimum Spanning Tree.

Text Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2010 , Second Edition, Pearson Education.
2. Ellis Horowitz, Fundamentals of Data Structures in C: Second Edition, 2015

Reference Books:

1. A.V.Aho, J. E. Hopcroft, and J. D. Ullman, "Data Structures And Algorithms", Pearson Education, First Edition Reprint 2003.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of datastructures in C" , Second Edition-2007.
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", Second Edition, Thomson India Ed ition, 2005
4. Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, "Data Structures & Program Design in C", Fourth Edition-2007.

List of Experiments:

1.Develop a set of programs to implement Linear and Binary searching techniques (both iterative and recursive)
2. Develop a set of programs to find the solution for the maximum subsequence sum problem with different time complexity solutions.
3.Develop a set of programs to implement below sorting techniques and analyses its time complexities

a. Insertion Sort

b. Shell sort

c. Selection Sort

4. Develop a set of programs to implement below sorting techniques (Divide and conquer method)
a. Quick sort with median of three.
b. Merge Sort
5. Develop a Program to implement operations of doubly linked list
• Create • Insert • Display • Delete • Search
6. Develop a program to perform operation on stack using linked list
7.Develop a program to perform operations on queue using linked list
8.Develop a program to implement Binary Search Tree with Traversal Operations
9.Develop a program to perform following operations on AVL tree

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a. Insertion
b. Deletion
10.Develop a program to implement the following
a. Separate chaining for collision handling
b. Open Addressing Technique
11.Develop a program to implement Heap sort
12.Develop a program to implement
a. Breadth First Search
b. Depth First Search
c. Dijkstra's Algorithm
13.Program to implement Minimal Spanning by
a. Prim's algorithm
b. Kruskal's algorithm

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ENGINEERING GRAPHICS& DESIGN FOR EECTRICAL ENGINEERS

Course Outcomes:

CO No	Course Outcome (CO)	PO/PSO	BTL
1	Construct and Interpret drawing scale to visualize the geometries of Engineering objects using points, lines both manually and by AutoCAD.	2/1	2
2	Draw projection of planes, solids and Generate the sectional views of solids both manually and by AutoCAD.	2, 5/1	2
3	Draw Engineering curves and develop the lateral surface of solids both manually and by AutoCAD.	1, 5/1	2
4	Build orthographic projections, create isometric sketches and identify standard features both manually and by AutoCAD.	10,2/2	3
5	Draft appropriate Electrical and Electronics symbols, with PCB structure and house wiring layouts.	9/2	3

Syllabus:

Introduction to Engineering Drawing : Principles of Engineering Graphics and their significance – Drawing Instruments and their Use- Conventions in Drawing – Lettering – Geometric Constructions – Scales: Plain and Vernier scales

Orthographic Projection in First Angle Projection: Principles of Orthographic Projections- conventions- First and Third Angle, Projections of Points and Lines inclined to both planes, True lengths, traces.

Projections of Planes & Solids: Projections of regular planes inclined to both planes . Projections of Regular solids inclined to one plane

Sections and Sectional Views:-Right Regular Solids - Prism, Cylinder, Pyramid, Cone

Engineering Curves used in Engineering Practice & their Constructions:

Conic Sec

tions: Ellipse, Parabola, Hyperbola and Rectangular Hyperbola – oblong, concentric method

Special Curves: Cycloid, Epicycloid, Hypocycloid and Involute

Developments of solids: Development of surfaces of right regular solids – Prisms, Cylinder, Pyramid cone and their parts

Isometric Projections: Principles of Isometric Projection- Isometric Scale- Isometric view conventions- Isometric View of Lines, Plane Figures, simple problems

Transformation of Projections: Conversion of Isometric Views to Orthographic Views – Conventions

Introduction of Computer Graphics covering & Customisation & CAD Drawing

Demonstrating knowledge of the theory of CAD software, Drawing Area, Dialog boxes and windows, Shortcut menus, Command Line, Status Bar, Different methods of zoom, erase objects. scale settings,applying dimensions to objects and annotate; use of Layers, Create, edit and use customized layers.

Electrical and Electronics drawings

Difference between electronic drawing and other practiced engineering drawing, types of electronics drawing used in the industry , standardized schematic symbols for electronic devices, identify different types of circuit board drawings. PCB structure and its components , PCB Terminology, PCB layers and its shapes , House wiring diagrams, Electric line diagrams

Text Books:

1. Engineering Drawing, N.D.Bhat/ Charotar
2. Engineering Drawing , N.S.Parthasarathy,VelaMurali
3. Dash.S.S, Subramani.C, Vijayakumar.K, "Basic Electrical Engineering", First edition,Vijay Nicole Imprints Pvt.Ltd,2013
4. Printed Circuit Boards, Design, Fabrication, Assembly and testing , Dr.R.S.Khandpur
5. Printed Circuit Board Designer's , Christopher T. Robertson

REFERENCE BOOKS:

- Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
- Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
- Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

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- (Corresponding set of) CAD Software Theory and User Manuals
- Electrical and Electronics Drawing, C.J. Baer
- Printed Circuit Boards: Design and Technology ,By Bosshart

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WORKSHOP PRACTICE FOR ELECTRICAL & ELECTRONICS ENGINEERS

CO No.	Course Outcome (CO)	PO/PSO	BTL
1	Prepare wooden Lap T, Plus joints. Prepare square and L fits. Fabricate parts made of sheet metal. Demonstrate the ability to execute stair-case lighting and godown lighting house wiring connections	12/1	2
2	Use arc welding equipment and tools to prepare butt joint for joining mild steel metal flats in a safe manner. Demonstrate the ability to melt and pour molten material into dies. Perform facing and plain turning on Lathe to prepare cylindrical jobs. Drill holes on Mild steel metal flats using drilling machine.	12/1	2
3	Identify hardware components in a computer system, Assemble and disassemble a computer system, Install operating system and software	12/ 1	2
4	Identify electronics components& soldering practice, connect identified computers in a network,	12/ 1	2
5	Demonstrate the ability of fabricating a product involving multiple trade skills (at least three trades)	5/ 2	3

Syllabus:

COMMON TO ALL BRANCHES.

CARPENTRY - Hands on practice on wood working operation using hand tools to prepare Lap T joint and plus joint.

FITTING - Hands on practice on preparing square fit and L fits.

TIN SMITHY - Hands on practice on sheet metal working for preparing cylindrical pipe and rectangular tray / Pipe T joint.

HOUSE WIRING - Hands on practice on electrical house stair-case and godown connections

WELDING - Hands on practice joining of metal plates using arc welding equipment

CASTING – Hands on practice on Gravity die casting for preparation of wax pipe flange / dumb bell.

MACHINE SHOP – Hands on practice on Lathe, Drilling machine tools

SPECIFIC TO ECE/EEE/ECMENGINEERING BRANCH:

1. Identification of components in a computer system & network
2. Assembling and disassembling of a computer system
3. Installation of operating system and software
4. Networking of computers
5. Soldering practice
6. Identification of electronics components

TEXT BOOKS:

T1 P.Kannaiah and K. L. Narayana, Engineering Practices Laboratory, 2009, SciTech Publications, Chennai

REFERENCE BOOKS:

R1 KLEF workshop lab manual

R2 K. Venkata Reddy, "Workshop Practice Manual", Sixth edition, 2011 print, BS Publications, Hyderabad.

R3 B S Nagendra Parashar and R K Mittal, "Elements of Manufacturing Process", 2010 print, Prentice Hall of India, New Delhi

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OBJECT ORIENTED PROGRAMMING

Mapping of Course outcomes with Student outcomes

CO.NO.	Course outcome's	Mapped SO	BTL
1	Understand Basic Concepts of OOP, introduction to classes and objects through Java Language and apply.	5/1	2
2	Understand the concepts of constructors, Overloading,parameter passing, access control, Inheritance and apply	5/1	2
3	Understand Packages, Interfaces, and Exception Handling and apply.	5/1	2
4	Understand I/O Streams & apply and understand Basic Concepts of Multi –Threading	11/1	2

Syllabus:

Introduction: Object-Oriented Programming, OOP Principles, Encapsulation, Inheritance and Polymorphism Java as a OOPs & Internet Enabled language, The Byte code, Data types, Variables, Dynamic initialization, scope and life time of variables, Arrays, Operators, Control statements, Type Conversion and Casting, Compiling and running of simple Java program. **Classes and Objects:** Concepts of classes and objects, Declaring objects, Assigning Object Reference Variables, Methods, Constructors, Access Control, Garbage Collection, Usage of static with data and methods, usage of final with data, Overloading methods and constructors, parameter passing - call by value, recursion, Nested classes. **Inheritance:** Inheritance Basics, member access rules, Usage of super key word, forms of inheritance, Method Overriding, Abstract classes, Dynamic method dispatch, Using final with inheritance, The Object class. **Packages and Interfaces:** Packages, Classpath, Importing packages, differences between classes and interfaces, Implementing & Applying interface.**Exception Handling:** Exception Handling fundamentals.

Text Books:

1. Herbert Schildt, "The Complete Reference Java", 7th edition TMH.
2. Timothy A. Budd, "An Introduction to Object-Oriented Programming", 3/e, Pearson, 2008.

Reference Books:

1. Deitel&Deitel, "'Java – How to program", 6th edition, PHI, 2007

2. Cay.S.Horstmann and Gary Cornell "Core Java 2, Vol 1, Fundamentals", Seventh Edition, Pearson Education.

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NETWORK THEORY

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the circuit elements, Kirchhoff's law, mesh & nodal Analysis	2, 5/1	2
2	Understand the steady state behaviour of AC networks and apply laws to interpret the circuit parameters	2, 5/2	3
3	Apply network theorems to solve electrical networks	2, 5/2	3
4	Apply AC fundamentals to solve three phase circuits	2, 5/2	3
5	Apply basic circuit laws, network theorems and three phase AC circuits to interpret the circuit parameters	2,5/2	3

SYLLABUS:

Circuit Concept, R, L, C parameters, voltage and current sources, specifications of Active and Passive elements, voltage – current relationship for passive elements Kirchoff's Laws, Loop and Nodal methods of analysis of networks, source transformation.

AC Circuits- RMS and average values and form factor of different periodic wave forms (Sinusoidal, rectangular, triangle and saw tooth), steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation, concept of reactance, impedance, susceptance and Admittance, Phase and Phase difference, concept of power factor, Real and Reactive powers, j-notation, complex and polar forms of representations, complex power.

Resonance:-Series and parallel resonance, bandwidth, selectivity, Q factor, current locus diagrams.

Network theorems (AC & DC circuits)- Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer, compensation, Tellegen's, Milliman's Theorem.

Three phase circuits- phase sequence, star and delta connection,Star/delta transformation, Relation between line and phase voltages and currents in balanced systems, Analysis of balanced and unbalanced 3 phase circuits, introduction to symmetrical components.

Text books:

1. M. E. Van Valkenberg, "Network Analysis", Prentice-Hall of India Pvt. Ltd., 3rd edition, 1998
2. William Hayt and jack E. Kemmerly, "Engineering circuit analysis" Tata Mc Graw-Hill Companies, 5th edition.

Reference Books:

1. D. Roy Choudhury, "Networks and Systems", New Age International Limited publishers
2. J. Edminister& M. Nahvi, "Electric circuits", Schaum's outlines Tata Mc GrawHill Publishing Company Ltd., 1999.

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ELECTRICAL ENGINEERING MEASUREMENTS

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome	PO/PSO	BTL
1	Understand the important aspects of torques generated in instruments	1, 4/1	2
2	Analyse the measurement of Voltage, current & power	1, 4/1	4
3	Analyse the measurement of physical parameters (RLC) & frequency and their instruments	1, 4/1	4
4	Understand the basic concepts of transducers and analyze the working of Oscilloscopes	1, 4/1	4

Syllabus:

Introduction to Measuring Instruments: Classification —deflecting, control and damping torques — Ammeters and Voltmeters — PMMC, moving iron type instruments — expression for the deflecting torque and control torque — Errors and compensations, extension of range using shunts and series resistance. Electrostatic Voltmeters-electrometer type and attracted disc type — Extension of range of E.S. Voltmeters. **Potentiometers & Instrument Transformers:** Principle and operation of DC. Crompton's potentiometer—standardisation — Measurement of unknown resistance, current, voltage. A.C. Potentiometers: polar and coordinate types standardisation — applications. CT and PT — Ratio and phase angle errors.

Measurement of Power & Energy: Single phase dynamo meter watt meter, LPF and UPF, Double element and three element dynamo meter watt meter, expression for deflecting and control torques — Extension of range of watt meter using instrument transformers — Measurement of active and reactive powers in balanced and unbalanced systems. Single phase induction type energy meter — driving and braking torques — errors and compensations — testing by phantom loading using R.S.S. meter. Three phase energy meter — tri-vector meter, maximum demand meters.

Bridges: Method of measuring low, medium and high resistance — sensitivity of wheat-stone's bridge — Carey foster's bridge, kelvin's double bridge for measuring low resistance, measurement of high resistance — loss of charge method.Measurement of inductance- Factor – Maxwell's bridge, Hay's bridge, Anderson's bridge, Owen's bridge. Measurement of capacitance and loss angle – Desauty Bridge.Wien's bridge — Schering Bridge.

Transducers & Oscilloscopes: Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermo couples, Piezo electric transducers, photovoltaic, photo conductive cells, photo diodes. **CRO:** Cathode ray oscilloscope-Cathode ray tube-time base generator- horizontal and vertical amplifiers-CRO probes-applications of CRO-Measurement of phase and frequency-lissajous patterns.

Text Books:

1. Electrical and Electronic Measurements and Instrumentation, R. K. Rajput, S. Chand & Company Ltd.
2. Electrical Measuring Instruments and Measurements, S. C. Bhargava, BS Publications.

Reference Books:

1. Electrical & Electronic Measurement & Instruments, A.K.Sawhney Dhanpat Rai & Co. Publications.
2. Electrical and Electronic Measurements, G. K. Banerjee, PHI Learning Pvt. Ltd.
3. Electrical Measurements and Measuring Instruments, Golding and Widdis, Reem Publications.
1. Electrical Measurements, Buckingham and Price, Prentice — Hall
2. Electrical Measurements: Fundamentals, Concepts, Applications,
3. Reissland, M.U, New Age International (P) Limited, Publishers.
4. Electrical Measurements and measuring Instruments, E.W. Golding and F.C. Widdis, fifth Edition, Wheeler Publishing.

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ELECTROMAGNETIC FIELDS

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	PO/ PSO	BTL
1	Apply Coulomb's and Gauss's laws to different electrostatic field distributions	1,5/2	3
2	Apply Biot-Savart's and Ampere's laws to different magnetic field distributions	1,5/2	3
3	Understand force existence in different field distributions and inductance phenomenon	1,5/1	2
4	Apply Maxwell's equations for time varying fields	1,5/2	3

Electrostatics: Review of Coordinate Systems and vector algebra, Electrostatic Fields Coulomb's Law Electric Field Intensity (EFI) – EFI due to a line and a surface charge Work done in moving a point charge in an electrostatic field Electric Potential Properties of potential function Potential gradientGauss's law Maxwell's first law, div(D)=ρ_v Laplace's and Poison's equations and Solution of Laplace's equation in one variable.

Conductors Dielectrics and Capacitance: Electric dipole, Dipole moment, potential and EFI due to an electric dipole,Behaviour of conductors in an electric fieldConductors and Insulators Polarization capacitancecapacitance of parallel plates, spherical and coaxial cables with composite dielectrics Energy stored and energy density in a static electric field – Current density conduction and Convection current densities Ohm's law in point form Equation of continuity.

Magneto statics and Ampere's Law: Static magnetic fields BiotSavart's law Magnetic field intensity (MFI) MFI due to a straight current carrying filament MFI due to circular, square and solenoid current Carrying wire Relation between magnetic flux, magnetic flux density and MFI Maxwell's second Equation, div(B)=0 Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long filament carrying conductor Point form of Ampere's circuital law Field due to a circular loop, rectangular and square loops, Maxwell's third equation, Curl (H)=J.

Force in Magnetic fields: Magnetic force Moving charges in a Magnetic field Lorentz force equation force on a current element in a magnetic field Force on a straight and a long current carrying conductor in a magnetic field Force between two straight long and parallel current carrying conductors Magnetic dipole and dipole moment a differential current loop as a magnetic dipole Torque on a current loop placed in a magnetic field. Torque on an Electric dipole in an electric field.

Self and Mutual inductance: Self and Mutual inductance – determination of selfinductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

Time Varying Fields: Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms – Maxwell's fourth equation, Curl (E)=∂B/∂t – Statically and Dynamically induced EMFs – Simple problems Modification of Maxwell's equations for time varying fields – Displacement current – Poynting Theorem and Poynting vector. Boundary Conditions.

TEXT BOOKS:

1. Elements of Electromagnetic – Matthew N.O. Sadiku, Oxford Univ. Press, 3rd ed., 2001.
2. Electromagnetic Fields and Wave Theory –GSN Raju, Pearson Education 2006.
3. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan,Oxford higher Education.

REFERENCE BOOKS:

1.Engineering Electromagnetics:Nathan Ida, Springer(India)Pvt.Ltd., New Delhi, 2nd ed., 2005.
2. Engineering Electromagnetics – William H. Hayt Jr. and John A. Buck, TMH, 7th ed., 2006.

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SIGNALS AND SYSTEMS

Course Rationale:

CO. No.	Course Outcome	PO/PSO	BTL
1	Understand the representation, manipulation and operations of Continuous-Time and Discrete Time signals and systems.	1/1	2
2	Explore the Continuous-Time signals in Fourier domain and illustration of sampling theorem.	2,3/1	2
3	Understand the Laplace Transforms and application to LTI systems.	3,4/1	2
4	Analyze Discrete Time signals in in Fourier and Z-Transform domain. Apply and evaluate signals and systems concepts to various applications under transform domain.	3,4/1	4

Syllabus: Introduction: Basic Continuous Time signals. Classification of signals. Basic elementary signals;sinusoidal and exponential signals, Singularity functions: Introduction to Systems: Classification of systems, Linear time invariant (LTI) system,impulse response, Convolution and interconnections of LTI systems.
Fourier Analysis of Continuous Time Signals: Fourier Transform: Deriving Fourier transform from Fourier series, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Inverse FT, Correlation of Signals. **Hilbert Transform** and their relationship with FT.
Laplace Transforms: Introduction to LT. Analysis and synthesis equations, LTof standard signals, Conceptof region of convergence (ROC) for LT, Constraints on ROC for various classes of signals, Propertiesof L.T's, Relation between L.T's, and F.T., Inverse LT, Partial fraction expansion method. Analysis of LTIsystems using LT.
Sampling and Reconstruction: Sampling theorem-Graphical and analytical proof for band limited signals, Band pass sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing.
Z-Transform:Concept of Z. Transform and its ROC (region of convergence) Inverse Z-Transform,properties of Z-Transforms.
DTFT: Analysis and synthesis equations, DTFT of standard sequences, magnitude and phase spectrum, Properties of DTFT.

Text Books :

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
2. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition
3. Discrete Time Signal Processing by A. V. Oppenheim and Shafer
4. Signals, Systems, and Transforms, Phillips, Parr and Riskin, Fourth Edition, Pearson Education, 2008.

Reference Books:

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
2. Signals and Systems – K R Rajeswari
3. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008.
4. Vinay. Ingle, John G Proakis, "Digital Signal Processing Using Matlab", Pearson

LIST OF EXPERIMENTS

1. Characteristics of sinusoidal signals.
2. Generation and plots of Elementary C.T signals.
3. Interacting with real time signals.
4. Manipulation/operation of continuous time signals.
5. Linear convolution.
6. Fourier series representation of continuous time periodic signals.
7. Fourier transform of continuous time aperiodic signals.
8. Sampling and Reconstruction of signals.
9. Laplace transform of continuous time signals.
10. Frequency response of LTI systems.
11. Z-transform and inverse Z-transform.
12. Discrete time sequences: Frequency domain representation (DTFT).

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PROBABILITY AND NUMERICAL METHODS

COURSE OUTCOMES (COs):

CO No	CO	PO	BTL
1	Identify the types of random variables and also obtain the mean and variance using mathematical expectation	1, 5/2	3
2	Apply discrete and Continuous distributions to analyze various real-world situations	1, 5/2	3
3	Draw conclusion about the population based upon samples drawn from it	1, 5/2	3
4	Obtain the solutions of transcendental equations using numerical methods and also determine the future predictions using interpolation and different numerical techniques	1, 5/2	3

SYLLABUS:

Probability: Introduction to Probability, Conditional probability and Baye's theorem. Random variables, distribution functions, binomial, Poisson, geometric, Normal and exponential distributions.

Inferential Statistics: Test for means-single and two sample means.

Numerical methods: Non linear equations: False position method, Newton's method, Convergence criteria. Interpolation: Lagrange's polynomial, divided differences.

Differentiation and Integration: Numerical differentiation evenly spaced and unevenly spaced data. Numerical Integration:Trapezoidal rule, Simpson's 1/3 and 3/8th rule.

Text books:

1. Richard A Johnson, Miller& Freund's, Probability and statistics for Engineers, Prentice Hall, New Delhi 2015.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons Inc. Newyork (2015).

Reference Books:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, India
2. S. C. Chapra, Advanced Numerical methods with MATLAB, Tata Mc Graw Hill publishers.

Other Books, References: (As recommended for reference by the course team, if any):

1. Ronald E. Walpole, Sharon L. Myers and Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson.
2. S. C. Gupta and V. K. Kapoor, "Fundamental of Mathematical Statistics" Sultan Chand & Sons Publication, 11th Edition.

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DIGITAL SYSTEM DESIGN

Course Outcomes (CO):

CO. No.	Course outcome's	PO/PSO	BTL
1	Describe the concepts of number systems with codes and logic gates usage in digital circuit design and identify the logical expressions in different forms and their minimization techniques for logical circuit optimization	5/1	1
2	Employ Combinational logic circuits with minimization techniques and logical verification through hardware description language	5/1	2
3	Substantiation of Sequential logic circuits and logical verification through hardware description language	5/1	2
4	Implementation of digital circuits using PAL, PLA, FPGA and CPLD	5/1	2
5	Analyze the digital IC logic for combinational and sequential circuits implementation	11/1	2

Syllabus: Logic Simplification and Combinational Logic Design: Number Systems, Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Karnaugh maps, Binary codes, Code Conversion, Integrated Circuit Logic Gates.

Combinational Logic Functions: Adder and Substractor, Decoders, Encoders, Multiplexers, Demultiplexers, Magnitude Comparators, Parity Generators and Checkers, BCD to seven segment decoders. Verilog HDL design for Combinational Logic Functions.

Sequential Logic Functions: NAND/NOR Latches Gated Latches, Edge- Triggered Flip-flops. Registers and Counters: Shift register, Universal Shift Register, Design of Synchronous and Asynchronous Counters, Modulus counters.Mealy and Moore machines, State diagrams and Tables, FSM, Introduction to ASM charts. Verilog HDL design for Sequential Logic Functions.

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Logic implementation using Programmable Devices. Complex Programmable Logic Devices, Field Programmable Gate Arrays, Applications of CPLDs and FPGAs.

Text Books:

1. Stephen Brown and ZvonkoVrane "Fundamentals of Digital Logic with Verilog Design" Second Edition, McGraw-Hill.
2. M. Morris Mano, "Digital Logic and Computer Design", Pearson

Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
2. J. Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing.
3. Digital Fundamentals by A Anand Kumar, PHI

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ANALOG ELECTRONIC CIRCUIT DESIGN

Course Outcomes (CO):

CO#	Course Outcome	PO/PSO	BTL
CO1	Study of BJT's and Various application in Amplifiers	1,3/1	2
CO2	Understand various types of FET's, IC Types and analyze FET as an Amplifier	1,3/1	2
CO3	Understand the Linear & Non-linear application of Op-AMP and analyze active filters	1,3/1	2
CO4	Analysis of different types of oscillators, filter and regulators.	1,3/1	4
CO5	Design and Testing of Analog circuits for realistic applications	5/1	4

Syllabus: Diodes: Concepts of diode as a switching element, diode as Limiter, design of: Clipper, half wave & full wave rectifier, Clamper, Voltage multiplier, Capacitor filters, Concepts of Regulators: Series and shunt voltage regulator, Zener diode, Design of Zener diode regulator, Concept of junction capacitance, Varactor diode, LED.
Transistors: Concepts of amplifier, Q point, load line analysis, Biasing of BJT, Self-Bias-CE, High and low frequency –small signal models of Transistors, Expression of voltage gain, current gain, input & output impedance, Designing CE amplifier, FET fundamentals, Configurations, current-voltage characteristics, Biasing of JFET, Biasing of MOSFET FET small signal model, Design and analysis of RC coupled amplifier, Concept of Feedback, Feedback amplifier configurations, Emitter follower.
Op-amps: Ideal OPAMP, Concept of differential amplifier, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, Voltage follower, Adder, Design and analysis of Integrator & Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier. Filter Circuits: Design and Analysis of Low pass, High pass, Bandpass, Band reject filters
Design and analysis ofOscillators: Barkhausen criterion, Colpitt, Hartley's, RC Phase shift, Wien bridge, & Crystal oscillators.
555 applications: Design and analysis of Monostable &Astable multi vibrators using 555 and their applications.
Textbooks:
1. Muhammad H. Rashid, "Microelectronic Circuit Analysis and Design", Oxford Press.
2. Sedra& Smith, "Micro-Electronic Circuits theory and applications" 2nd edition, Cengage Learning.
Reference Books:
1. JacobMillman& Christos C. Halkias, "Integrated Electronics", Tata -McGraw Hill, 2nd Edition,(2010).
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", PHI.9th Edition.

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ELECTRICAL CIRCUITS

Mapping of the Course Outcomes with Student Outcomes

CO No	(CO)	PO/PSO	(BTL)
1	Apply network topology concepts to electrical networks	1, 2, 5/2	3
2	Understand the Transient response of series and parallel circuits	1, 2, 5/1	2
3	Analyze the physical circuits with two port networks	1, 2, 5/1	4
4	Understand the concepts of coupled circuits & passive filters	1, 2, 5/1	2

Syllabus:

Network topology: definitions, graph, tree, primitive matrices, basic node incidence, basic cut-set and basic tie set matrices for planar networks, Loop and Nodal methods of analysis of networks, dual & duality,

Transient response: R-L, R-C, R-L-C circuits (Series and parallel combinations) for DC impulse, step, ramp and sinusoidal excitations, initial conditions, time domain and Laplace transform methods of solutions.

Two port networks: one port and two port networks, two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships, introduction to network matrices. Network functions, driving point and transfer functions – poles and Zeros.

Magnetic Circuits: concept of self and mutual inductance, dot convention, coefficient of coupling, , Coupled Circuits, Analysis of series and parallel magnetic circuits.

Filters: Low pass, High Pass, Band Pass, Band Elimination, Prototype filters design Low and High pass filter – M - derived filters of Low Pass and High Pass - Numerical Problems.

Text Books:

1. W. H. Hayt and J. E. Kimmerly "Engineering circuit analysis", 5th Edition, McGraw Hill,(1993).
2. J. Edminister& M. Nahvi, "Electric circuits", Schaum's outlines Tata Mc GrawHill Publishing Company Ltd., 1999.

Reference Books:

1. N. C. Jagan, C.Lakshmi Narayana., "Network analysis and synthesis" BS Publications, (2004).
2. Ravish R singh, "Network Analysis and Synthesis" The Mc-Graw Hill Publication.
3. David A Bell, Fundamentals of Electric Circuits, 7th Edition, Oxford University Press.
4. A Sudhakar and Shyammohan S Palli, Circuits & Networks,3E: Analysis and Synthesis, 3rd Edition, The Mc-Graw Hill Publication

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DC MACHINES & TRANSFORMERS

Mapping of the Course Outcomes with Student Outcomes Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	B.T.L
1	Understand the basic principles of electro mechanical energy conversion to DC machines	1/1	2
2	Analyze the operating characteristics of various types of DC machines	4/1	4
3	Determine the performance of DC machines.	4, 5/2	3
4	Analyze the performance of Transformers.	4, 5/1	4
5	Test the DC machines and transformers to analyze their performance	1, 4/1	4

Syllabus:

Electromechanical Energy Conversion: Basic principle Energy, Force and Torque in singly and multiply excited systems. Working principle and construction of DC machines, methods of excitation.Armature Winding- Detailed study of simple lap and wave windings.emf equation.

DC. Generators: Circuit models, Armature reaction, commutation process, Compensating winding, Characteristics of various types of generators, parallel operation, losses & efficiency calculations, applications.

DC. Motors: Torque equation, Characteristics of DC shunt, series and compound motors, efficiency calculations, applications.

Performance of DC Machines- Starting methods and speed control of DC shunt and series motors. Testing- Direct, indirect and regenerative methods of DC machines.

Transformers: Principle, construction and operation of single phase transformers, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency. Testing- Open & short circuit tests, All-day efficiency, Sumpner's test, Separation of hysteresis and eddy current losses, Parallel operation, Autotransformer, Three phase Transformer, Scott connections, cooling methods.

Text Books:

1. "Electrical Machines", P.S. Bimbra, 7th ed., Khanna Publishers., 2007.
2. "Electrical Machines", I.J Nagrath& D.P Kothari, 3rd ed., Tata Mc Graw-Hill, 2009.

Reference Books:

1. "Performance and Design of DC Machines", by . A.E. Clayton & Hancock, 3rd ed., BPB Publishers, 2004.
2. "Performance and Design of A.C Machines", M.G Say, 3rd ed., BPB Publishers, 2002.
3. "Electric Machinery", by A.E.Fitzgerald, C Kingsley and S Umans, 7th ed., McGraw Hill, 2013.

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ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand working of various generating stations and economical aspects of generation.	1, 3/1	2
2	Analyseparameters of overhead transmission lines and underground cables.	1, 2 /1	4
3	Analyse performance of overhead transmission lines andAC / DC distribution networks.	1, 3/1	4
4	Analyse Mechanical Sag, corona, Insulators and substation layouts.	1, 3/1	4

Syllabus:

Introduction: Organization of power sector in India, Layout & Operation of Thermal, Hydro, Nuclear and combined cycle power stations. Overview of Solar, Wind Power Plant and Fuel Cells. Economics of generation, load curves, Demand Factor, load factor, diversity factor, Plant Capacity Factor, Plant Use Factor & Utilization Factor, Characteristics of Tariff, Types of Tariff.

Transmission line parameters: Types of conductors - calculation of resistance for solid conductors - Calculation of inductance for single phase and three phase, single and double circuit lines, concept of GMR & GMD, Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines.

Underground cables Types of cables, grading concepts, Capacitance of three core belted type cable. Cable sizing.

Transmission line theory: Introduction, short transmission line, medium transmission line, evaluation of A,B,C,D Constants, Surge Impedance Loading of Long Lines, Ferranti effect,elementary concepts of AC DC distribution.

Corona:factors affecting corona, critical voltages and power loss; Radio interference due to Corona. **Insulators:** Types of Insulators, String efficiency and Methods for improvement, calculation of string efficiency, Capacitance grading and Static Shielding. Mechanical sag.

Substation practice: Classification of substations, layout, bus bar arrangements.

Text Books:

1. J B Gupta "A Course in Power Systems" S. K. Kataria& sons, 15th Edition, 2013.
2. C. L. Wadhwa "Electrical Power Systems" New Age International (P) Limited Publishers, 6th Edition, 2010.

Reference Books:

1. J. Nagarath and D.P Kothari "Power System Engineering" Tata Mc Graw-Hill, 2nd Edition, 2008.
2. Soni, Gupta and Bhatnagar "A Course in Electric Power" Dhanpat Rai & Sons.
3. S. N. Singh "Electric Power Generation, Transmission & Distribution" PrenticeHall India.

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AC ROTATING MACHINES

Mapping of the Course Outcomes with Student Outcomes Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	B.T.L
1	Understand the concepts of the 3- phase induction motor	4, 5 /1	2
2	Select different speed control and starting methods of induction machine.	4, 5/2	3
3	Understand the concepts of 3-phase alternator.	4, 5/1	2
4	Analyze the performance of 3-phase synchronous motor	4, 5/1	4
5	Test the performance of AC Rotating Machines	1, 4/1	4

Syllabus:

Induction Machines: Constructional features, rotating magnetic field, production of torque, phasor diagram, equivalent circuit, performance analysis, torque-slip characteristics. Testing-No load, blocked rotor test & load test. Effect of rotor resistance, Circle diagram, crawling & cogging. Generator Operation, Starting- Starting methods of squirrel cage and wound rotor induction motor.

Speed Control- Various methods of speed control of squirrel cage and wound rotor induction motor. Effects of space harmonics.Single phase induction motors- Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split phase starting methods &applications.

Synchronous Machines: Constructional features. Cylindrical rotor machine- Synchronous Generator- Generated e.m.f., circuit model and phasor diagram, armature reaction, synchronous impedance, voltage regulation - EMF, MMF, ZPF methods,

Synchronous Motor- Operating principle, circuit model, phasor diagram, effect of load. Operating characteristics of synchronous machines, V-curves, starting methods of synchronous motors. Salient pole Machine- Two reaction theory, analysis of phasor diagram, power angle characteristics, determination of Xd and Xq. Parallel operation of Alternators-Synchronization and load division.

Text Books:

1. "Electrical Machines", P.S. Bimbra, 7th ed., Khanna Publishers., 2007.
2. "Electrical Machines", I.J Nagrath& D.P Kothari, 3rd ed., Tata Mc Graw-Hill, 2009.

Reference Books:

1. "Theory of Alternating Current Machinery" by Alexander S Langsdorf,2nd ed., Tata Mc Graw-Hill,2001.
2. "Performance and Design of A.C Machines", M.G Say, 3rd ed., BPB Publishers, 2002
3. "Electric Machinery", A.E. Fitzgerald, C.Kingsley and S.Umans, Mc Graw-Hill Companies, 7th edition, 2013.
4. M.Ramamoorthy&O.Chandrasekhar, "Electrical Machines", PHI Publishers, 2017.

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CONTROL SYSTEMS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Analyse the concepts of control systems such as open loop, closed loop, transfer function approach, mathematical modelling of physical systems, similarities between synchro's and AC generators.	1, 5/1	4
2	Analyse the control systems in time domain andstability analysis of physical systems	1, 5/1	4
3	Analysestabilityin frequency domain and different compensation techniques.	1, 5/1	4
4	Understand the concepts of state space analysis	1, 5/1	2
5	Test and apply the knowledge obtained in the subject by MATLAB or hardware.	1, 5/2	3

Syllabus:

Control system terminology, examples of simple control systems, open loop and closed loop control systems, Types of control systems.

Mathematical models of physical systems: Analogy with mechanical systems, Formulation of differential equations for electrical systems Transfer functions of open and closed loop systems, DC & AC servomotors, synchro pair as error detector, block diagram representation of control systems: block diagram algebra, signal flow graph, Mason's gain formula.

Time domain analysis: Standard test signals – step, ramp, parabolic and impulse; impulse response, characteristic equation of feedback systems, transient response of first order and second order systems to standard test signals, time domain specifications, steady state error and error constants, Introduction to P, PI, PID controllers.

Stability analysis: Concept of stability and conditions for stability, Routh – Hurwitz criterion, dominant poles of transfer function.

Root Locus Technique: The root locus concept, basic properties, magnitude and angle conditions, properties and construction of the complex root loci, effects of adding poles and zeros to G(s) H(s) on the root loci.

Frequency response Analysis: Introduction, frequency response specifications, correlation between time and frequency response, specifications, stability analysis from Bode plot, Nyquist plot, effect of adding poles & zeros to G(s) H(s) on the shape of polar plots. Introduction to lead, lag, lead - lag compensation techniques.

State space analysis: Concepts of state, state variables, state vector, input vector, output vector; development of state models for simple systems, solution of state equation, the state transition matrix and its properties; characteristic equation and transfer function from state models, eigen values and eigen vectors. Diagonalization; transformation to phase variable canonical form, diagonal canonical form, Jordan canonical form.Concepts of controllability and observability.

Text Books:

1. J Nagrath& M Gopal, "Control System Engineering", 5th Edition New Age International Publication, New Delhi 2011.
2. B.C. Kuo," Automatic ontrol Systems", Prentice Hall India Publications, NewDelhi , Eighth Edition,2010.

Reference Books:

1. K Ogata, "Modern Control Engineering", Prentice Hall India Publication, New Delhi , Fifth Edition,2010.
2. M.Gopal, " Control Systems Principles and Design" Tata Mc-Graw Hill Publications, Fourth Edition,2012.
3. Dhanesh N. Manik, "Control Systems", Cengage Learning Pvt. Ltd., First edition, 2012

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POWER SYSTEM ANALYSIS & STABILITY

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

CO. No	Course outcome	PO/PSO	BTL
1	Apply the network matrices for solution of power flow problems	1, 2/2	3
2	Apply the reactance diagrams for symmetrical short circuit faults in a power system	1, 2/2	3
3	Analyze unsymmetrical faults in a power system using Symmetrical components	1, 2/1	4
4	Understand various aspects of power system stability	1, 2/1	2

Syllabus:

Power Flow Solutions: Network model formulation, Formation of YBUS by Direct Inspection Method, Formation of ZBUS, Power flow problem formulation, GS method, NR Method (Polar Coordinate Approach), FDLF.
Symmetrical Fault Analysis: Representation of Power Systems Components, Per Unit System, Reactance diagrams, change of base values, Short circuit of synchronous machine unloaded, Calculation of symmetrical short circuit currents for simple systems.
Unsymmetrical Fault Analysis: Symmetrical components transformation, Sequence Impedance and Networks of Power System Components, Unsymmetrical Faults on an Unloaded Generator and Power Systems.
Power System Stability: Dynamics of a synchronous machine, Swing equation, power angle equation, Single machine connected to infinite bus, two machine system, steady state stability, Transient stability analysis using Equal Area Criterion, critical clearing angle.

Text Books:

1. John J Grainger, William D Stevenson,"Power System Analysis", 4th edition ,TMH Companies,(2005).
2. C.L.Wadhwa ,"Electrical Power Systems", New Age International (P) Limited,(2008).

Reference Books:

1. I.J.Nagarath and D.P.Kothari ,"Modern Power System Analysis", 3rd Edition, Tata McGraw Hill,(2008).
2. B.R. Gupta "Power System Analysis and Design", 3rd edition wheeler publishers (2003).

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POWER ELECTRONICSMapping of the Course Outcomes with Student Outcomes

CO. No.	Course outcome	PO/PSO	BTL
1	Understand the differences between signal level and power level devices.	1/1	2
2	Analyse the operation and performance of DC-DC Converters	1,5/1	4
3	Analyse the operation and performance of voltage source inverters	1,5/1	4
4	Understand the operation of phase controlled converters	1,5/1	2
5	Demonstrate and test basic power electronic converters by hardware realization and MATLAB software.	11/1	2

Syllabus:

Power switching devices

Ideal Switch Characteristics, Power Diode, SCR, static and dynamic characteristics and ratings, Brief overview of these devices with their characteristics, ratings and applications: GTO, TRIAC, IGBT, MOSFET, SiC and GaN power devices.

DC-DC converters

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage. Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Buck-Boost converter, DCM operation Chopper based dc drives

Single-phase voltage source inverter

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching
cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage. AC drives using inverters. **Three-phase voltage source inverter** Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation.

Controlled rectifiers

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor. AC Voltage controllers. Cyclo-converters, Controlled converters based DC drives.

Text/References:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

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POWER SYSTEM PROTECTION & CONTROL

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the principle of protective relays & circuit breakers	5/1	2
2	Apply overcurrent, distance and differential protection schemes.	1, 2, 5/1	4
3	Analyze over voltage protection and economic operation of power system	1, 2/1	4
4	Analyse automatic generation control and voltage regulators	1, 2/1	4
5	Experimental verification of characteristics of differential relays and operation and control of power systems through programming /simulation.	5/2	3

Syllabus:

Power System Protection: Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays &static relays. Introduction to Digital Protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings. Protection schemes-over current, differential and distance.

Protection against Over Voltages: Causes of over voltages, ground wires, lightning arresters, **Neutral Grounding:** Necessity of earthling, step voltage, Types of neutral grounding.

Economic Dispatch: Optimal operation of generators on a Bus Bar, optimal unit commitment, optimum generation schedulingwith and without constraints.

Automatic Generation Control & Automatic Voltage Regulator: Load frequency control single area (Single area case), Load frequency control and economic dispatch control, Introduction to two area load frequency control, automatic voltage control,AVR block diagram, PV curves.

Text Books:

1. D. P. Kothari, I. J Nagrath, "Modern Power System Analysis", 3rd Edition, Tata Mc-Graw Hill Publications.
2. Badri Ram, D N Vishwakarma, "Power System Protection and Switchgear", Tata Mc-Graw Hill Publications.

Reference Books:

1. Jhon J Grainger, William D Stevenson Jr., "Power System Analysis", Tata Mc-Graw Hill Publications.
2. Sunil S Rao, "Switch Gear Protections", Khanna Publications.
3. C L Wadhwa, "Electrical Power Systems", New Age International (P) Ltd..
4. Van. C. Warrington A.R., "Protective Relays"Vol. 1 & 2, Chapman & Hall.

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PROCESSORS AND CONTROLLERS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Apply assembly level programming concepts of 8086 microprocessor	2,5/2	3
2	Apply assembly level programming concepts of 8051 microcontroller	2,5/2	3
3	Apply programming concepts of on chip peripherals of 8051.	2,5/2	3
4	Apply interfacing concepts, program different off chip peripherals and Understand the architecture of PIC microcontroller	2,5/2	3
5	Apply programming concepts of the 8086 microprocessor and 8051 microcontroller using assembly language	11/2	3

SYLLABUS:

8086 Microprocessor: Introduction to Microprocessor, Intel Microprocessor families ,8086 Microprocessor architecture, Register Organization, Pin Description, Physical Memory Organization, Modes of operation. 8086 Instruction set & Assembly Language programming: Addressing modes, Instruction set, Assembler directives, simple Programs, Procedures and Macros, 8086 Interrupts.

8051 Microcontroller: Microcontroller families, 8051 Architecture, Signal Description, Register organization, Internal RAM, Special Function Registers, Interrupt control flow, Timer/Counter Operation, Serial Data Communication, and RS-232C Standard.

8051Programming & Interfacing: Addressing modes, Instruction set, Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Serial Communication & Interrupts.

PIC Microcontroller: Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers. Interfacing: Matrix Key Board, Stepper Motor, LCD's, DAC & ADC. using 8051 and PIC Microcontroller.

TEXT BOOKS

1. D.V.Hall "Microprocessor and Interfacing", 2nd Edition Tata McGraw Hill Publishing Company,2006.
2.Mazidi&McKinley "The 8051 Micro controller and Embedded systems: using assembles and C, 2nd edition,2007.

REFERENCE BOOKS

1. A.K. Ray & K. M Bhurchandi, "Advanced Microprocessors & peripherals", Tata McGraw Hill Publishing Company 2002.
2. Rajkamal, "Microcontrollers - Architecture, Programming, Interfacing & System Design", 2nd edition, Pearson Education,2009.

List of Experiments:

1. Develop an Assembly Language Program (ALP) to perform arithmetic operation by using 8086.
2. Develop an ALP to find minimum/maximum number of an array of signed and unsigned numbers.
3. Develop an ALP to find factorial of given number using Procedures.
4. Develop an ALP to perform basic arithmetic operations using 8051.
5. Develop an ALP to perform addition of an array elements of 8-bit using 8051.
6. Develop an ALP involving bit/byte manipulations to toggle an LED with random delay
7. Develop an ALP to accept timer interrupts and to toggle the LED.
8. Develop an ALP to accept external interrupts and to toggle the LED.
9. Develop an ALP to perform serial communication with 8051.
10. Develop an ALP to interface aseven segment displaying using 8051.
11. Develop an ALP to interface LCD to 8051.
12. Develop an ALP to interface stepper motor with 8051.

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TECHNICAL SKILLS – 1 (CODING)

Mapping of Course Outcomes (CO) to Program Outcomes:

CO No.	Course Outcomes (CO)	PO	BTL
1	Problems are solved using computer programming.	1,2/2	3
2	Apply concepts of Control Flow Statements in C for solving problems.	1,2/2	3
3	Apply concept of user defined functions and different operations on list of data.	1,2/2	3
4	Apply concept of Linear Data Structures problems and compare them.	4/2	3
5	Apply the knowledge obtained by the course to solve real world problems.	1,2,4/2	3

SYLLABUS:

Problem Solving Approach, **Algorithms and Algorithm Analysis**, Program Development Steps, Structure of C Program, Pre-Processor Directives, **Formatted I/O,C Tokens, Data Types**: Primitive, Extended and Derived Including Pointers, Operators, Precedence, Associativity , **Redirecting I/O** : Files and File Operations , **Control Flow Statements, Functions, Recursion**, Scope of Variables and Storage classes, **Arrays,** 2-D Arrays, Dynamic Memory Allocation, **Searching:** Linear Search and Binary Search, **Sorting:** Bubble Sort, **Strings**, **Structures and Unions**, Introduction to **Stacks**-Implementation using array, Introduction to Queues – Linear **Queue**-Implementation using array, Introduction to **Lists:** Single Linked List- Insertion, Deletion, Display, Introduction to **Trees**- Binary tree, Definition, Terminology.

TEXT BOOKS:-

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. E. Balagurusamy, "Programming in ANSI C" 4th ed., Tata McGraw-Hill Education, 2008.
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

REFERENCE BOOKS:-

1. Mark Allen weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of Data structures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction to Data Structures with applications", 2nd Edition.

OTHER BOOKS, REFERENCES: (As recommended for reference by the course team, if any): Nil

WEB REFERNCES/MOOCs:

1)www.hackerrank.com
2) www.codechef.com
3) www.spoj.com
4)www.hackerearth.com

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TECHNICAL SKILLS – 2 (CODING)

Mapping of Course Outcomes (CO) to Program Outcomes:

CO No:	Course Outcome (CO)	PO/PSO	BTL
1	Apply the concepts of basic programming to solve the basic problems, patternbased problems	1,2/2	3
2	Build solutions for problems on Numbers and array based problems , functions,	1,2/2	3
3	Solve problems solutions for character/string based problems and pointers	1,2/2	3
4	Build solutions to programs on Data structures concepts.	1,2/2	3

SYLLABUS:

Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments. Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension. Illustrative programs: selection sort, Insertion sort, merge sort, histogram.

Text Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3,Shroff/O'Reilly Publishers, 2016 http://greenteapress.com/wp/thinkpython/)

2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Reference Books:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

2. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised And expanded Edition, MIT Press, 2013

3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.

4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers,LLC,2013.

5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

6. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd.,, 2015.

WEB REFERNCES/MOOCs:

1) **www.hackerrank.com**
2) **www.codechef.com**
3) **www.spoj.com**
4) **www.hackerearth.com**
5) **www.geeksforgeeks.com**
6) **www.w3resource.com**
7) http://poj.org/problem?id=1000
8) **https://uva.onlinejudge.org**

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TECHNICAL SKILLS- 3 (MATLAB)

Course Outcomes:

CO No:	CO	PO/PSO	BTL
1.	Able to implement loops, branching, control instruction and functions in MATLAB programming environment.	1,5/2	3
2.	Able to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.	1,5/2	3
3.	Able to understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB	1,5/2	3
4.	Able to simulate MATLAB Simulink examples	1,5/2	3

Syllabus:

Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples. **Numerical Methods and their applications: Curve Fitting:** Straight line fit, Polynomial fit.**Numerical Integration and Differentiation:** Trapezoidal method, Simpson method. **Linear and Nonlinear Equations:** Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss siedal and Newton-Raphson method. **Ordinary Differential Equations:** Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariables. **Transforms:** Discrete Fourier Transforms, **Applications to electrical engineering problems**.

MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems.

Text Books:

1. Agam Kumar Tyagi, "**MATLAB and Simulink for Engineers**", OXFORD Higher Education.
2. Dr. Shailendra Jain, "**Modeling& Simulation using MATLAB – Simulink**", Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "**Applied Numerical Methods Using MATLAB**", A John Wiley & Sons.
2. Steven T. Karris, "**Introduction to Simulink with Engineering Applications**", Orchard Publications.

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TECHNICAL SKILLS- 4 (Electronic Systems Design & PCB prototyping)

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	PO/ PSO	BTL
CO1	rify parameters of basic electrical circuits for various analyses using NI Multisim	5/2	3
CO2	velop PCB layouts for diode applications circuits using NI Ultiboard	5/2	3
CO3	velop PCB layouts for BJT applications circuits using NI Ultiboard	5/2	3
CO4	velop PCB layouts for linear and digital IC applications circuits using NI Ultiboard	5/2	3

SYLLABUS (As approved by BoS):

Multisim tool – schematic capture tools, devices library, analyses-dc, ac, transient, Laplace, Fourier, capture to layout

Ultiboard tool – design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers

PCB layout design for diode and BJT applications – rectifier based applications, regulator based applications, waveform shaping applications, audio amplifier

PCB layout design for Op-AMP and 555 timer based applications – integrator, differentiator, function generator, fist order low pass, high pass x and band pass filters, oscillators –RC phase shift, Hartley, colpit, LC oscillator for communication receiver

Text books:

1. Fawwaz T. Ulaby and Michel M. Maharbiz, "NI My DAQ and MULTISIM problems for circuits
2. NI ULTIBOARD user manual

Reference Books:

1. Muhammad H. Rashid, "Microelectronic Circuit Analysis and Design", Oxford Press.
2. Electronics workbench NI ultiboard 9 PCB layout user guide

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TECHNICAL SKILLS- 5 (Process Automation through PLC))

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	PO/ PSO	BTL
CO1	Understand process automation components and architecture and programming structures of PLC	1,5/1	2
CO2	Model ladder logic for various process control applications	2,5/2	3
CO3	Apply PLC based control to two or three stage automation processes	2,5/2	3
CO4	Apply PLC based control multiple stage automation processes	2,5/2	3

SYLLABUS:

Introduction: Review of Sensors, actuators and controllers. PLC Overview - PLC Selection - Number Systems & Codes - I/O Devices & Motor Controls - NO/NC & RLO Concept - Creating Relay Logic Diagrams.

PLC Programming - Programming Logic Gate Functions - Ladder Logic – Relay type instructions - PLC Timer Instructions - PLC Counter Instructions - Math Instructions - – Data manipulation and math instructions – Programming Examples.Compare, Jump & MCR Instructions - Subroutine Functions - Logic & Bit Shift Instructions - Data Handling Instructions

Communication architectures - PID modules - functions-PWM modules

PLC Based control systems:, Temperature controller, Water-level control, conveyer control, elevator control, bottle filling system, traffic light controller, Motor control

Text Books

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2010
McMillan, G.K., "Process/Industrial Instrument and Controls Handbook", 5thEdition,
McGraw- Hill handbook, New York, 1999.
2. Hughes, T.A., "Programmable Logic Controllers: Resources for Measurements and
Control Series", 3rd Edition, ISA Press, 2004.

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TECHNICAL SKILLS- 6 (Mi POWER)

CO No:	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Apply Mipower for steady state analysis of power system	1,5/1	2
CO 2	Apply Mipower for stablity analysis of power system	1,5/2	3
CO 3	Apply Mipower for electromagnetic transient analysis, security and monitoring control of power system	1,5/2	3
CO 4	Apply Mipower for protection coordination of power system	1,5/2	3

SYLLABUS:

STEADY STATE ANALYSIS

Load Flow Analysis: Gauss Seidel (GS)-Newton Raphson (NR)-Fast Decoupled Load Flow (FDLF), **Harmonic Load Flow:** Computation of VTHD, ITHD-Modeling harmonic voltage and current source. **Short Circuit Analysis:** Symmetrical and Asymmetrical Faults-Modeling of Self and Mutual Impedances, **Network Reduction:** Computation of Static and dynamic equivalents for the power system networks-Computation of YBUS and ZBUS-Static equivalent: YBUS based reduction, seen from the desired nodes, Dynamic equivalent: Single machine equivalent of the power system. **DC Network Solutions:** D.C. Load Flow Analysis-D.C. Short Circuit Analysis-Enables Battery Sizing.

STABILITY ASSESSMENT

Transient Stability Study: Supports LG/LL/LLG/LLL/ LLLG fault at user defined location, Turbines governors and Excitation systems (AVR)-Power System Stabilizers (PSS)-Static VAR compensators (SVC). **Voltage Instability Analysis:** Voltage instability assessment using L-Index and Centroid Voltage methodologies-Stability margin computation under steady state condition-Identify weak buses and areas in the system from Voltage Instability perspective. **Dynamic Stability Analysis:** Identification of the mode of oscillation-Examine the most effective control location-Adjustment in control parameters to improve system damping-Simulate disturbances to understand potential risk of oscillatory instability.

TRANSIENT STUDIES

Electromagnetic Transient Analysis: Computation of highest discharge currents and energy stresses for the protective equipment-Assessment of withstand levels of currents and voltages for protected equipment-Supports energization of lines, transformers and shunt elements-Computes over voltages during fault inceptions and clearing of faults. **Sub Synchronous Resonance:** Frequency response method-Multiple synchronous machines-Series compensation in transmission network-Detailed modeling of machine shafts and control loops.

SECURITY MONITORING, ASSESSMENT & CONTROL

State Estimation: Standard Weighted Least Square (WLS) method-Bad data identification and suppression-Observability analysis for RTU Locations. **Real Power Optimization:** Generation cost minimization-System loss minimization-Overload alleviation. **Reactive Power Optimization:** Alleviation of the system bus voltages-Enhance voltage stability or loadabilityusing the control variables such astransformer tap settings (T), The generator excitation settings (V), The switchable and controllable VAR compensator. **Economic Dispatch:** sharing the total load to minimize the overall generation cost.

PROTECTION COORDINATION

Over Current Relay Coordination: Plug Settings for the phase/ earth relays-Time dial settings for the phase/ earth relays-Instantaneous settlng for the phase/ earth relays-Primary and Backup Pairs. **Distance Relay Coordination:** Phase loop and earth loop impedance settings as per relay make and model-Load encroachment settings-Power Swing Blocking settings-Arc and Tower footing resistance-Impedance seen by relays for given fault location and type. **Unit Protection Schemes:** Transformer Differential Protection scheme-Line Differential Protection scheme-Bus bar Differential Protection scheme-Partial Bus bar Differential Protection scheme-Generator Protection scheme-Restricted Earth Fault.

Text Books:

1. D. P. Kothari, I. J. Nagrath, "Modern Power System Analysis", Mc Graw Hill Education, 4th Edition, 2011.
2. Prabha Kundur, "Power System Stability and Control", Mc Graw Hill Education, 5th Edition, 2008.
3. C.L.Wadwa, "Electrical Power Systems", New Age International, 5th Edition, 2009.

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DISTRIBUTION SYSTEM PLANNING AND AUTOMATION

Mapping of the Course Outcomes with Student Outcomes

Co. No:	Course Outcomes	PO/PSO	BTL
1	Understand the methods to find load forecasting, various tariffs and meters.	1,5/1	2
2	understandthe optimal locations of substation, types of distribution feeders.	1,5/1	2
3	Understand the capacitor importance with optimum location of it and various protection schemes and coordination of different protective devices.	1,5/1	2
4	Analyse various earthing schemes,understand SCADA required components and its functions.	1,5/1	4

Syllabus:

Distribution System Planning and Load Characteristics: Planning and forecasting techniques, present and future role of computer, load forecasting definition, methods of forecasting, regression analysis, correlation analysis and time series analysis, load management, tariff and metering of energy.

Distribution Transformers, transmission line and Distribution Sub-Station: Distribution Sub-Station, bus schemes, description and comparison of switching scheme, sub-station location and rating. Types of feeders, voltage levels, radial type feeders, 3-phase primary lines, copper loss, distribution feeder costs, loss reduction and voltage improvement in rural network.

Capacitors in distribution systems and System protection: Effects of series and shunt capacitors, justification of capacitors, procedure to determine optimum capacitor size and location, basic definition and types of over current protection device, objective of distribution system protection.

Distribution system automation: Reforms in power sector, methods of improvement, reconfiguration, reinforcement, automation, communication systems, sensors, automation systems architecture, software and open architecture, RTU and Data communication, SCADA requirement and application functions, GIS/GPS based mapping of distribution network, communication protocol for distribution systems, integrated substation, metering system, revenue improvement, issuing multi year tariff and availability based tariff.

Grounding System: Earth and safety, nature and size of earth electrodes, design of earthing schemes.

Text Books:

1. TuranGonen ,"Electrical Power Distribution Engineering", McGraw Hill.

Reference Books:

1. A S Pabla ,"Electric Power Distribution" ,5th Ed., TMH, 2004

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POWER QUALITY

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No	Course outcome	PO/PSO	BTL
1	Outline the Power Quality problems in power system.	7/1	2
2	Model the characteristics of Long and short interruptions.	5/2	3
3	Model the characteristics of voltage sag.	5/2	3
4	Demonstrate various mitigation methods for interruptions and voltage sag.	5/1	2

Syllabus:

Introduction: Power or voltage quality, terms and definitions: short duration voltage variations, Interruptions – Voltage sag – Swell – Surges – Harmonics – Voltage fluctuations. **Long duration voltage variations:** Over voltage – Under voltage – Sustained interruptions, Transients: Impulse transients – Oscillatory transient, Power quality terms. Long Interruptions - Definition – Interruptions – Causes of long interruptions – Origin of interruptions – Limits for the interruptions frequency – Limits for the interruption duration. **Short Interruptions**: Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

Voltage sag analysis: Voltage sag magnitude – Monitoring - Theoretical calculations – Examples - Sag magnitude in non-radial systems, Voltage calculation in meshed systems, Voltage sag duration, Fault clearing time – Magnitude duration plots- Measurement of sag duration, Magnitude and Phase angle jumps for three phase unbalanced sags – Phase to phase fault – Single phase faults – Two phase to ground faults – High impedance fault – Meshed systems.

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods – From fault to trip, Reducing the number of faults, Reducing the fault clearing time changing the power system, Installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, series voltage controller, Shunt voltage controller, combined shunt and series controller. Typical wiring and grounding problems.

Text Books:

1. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press, 1999.
2. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power system quality", Third edition, TMH, 2012.

Reference Book:

1. Angelo Baggini, "Hand book of power quality", Wiley publications, 2008.
2. Edward F Fuchr, Mohammad A S Masoum "Power Quality in Power System and Electrical Machine", 1st Edition, Elsevier,2008

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HVDC AND FACTS

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand various HVDC transmission systems converter circuits and its control scheme.	1/1	2
2	Understand the basic concepts of Transmission system and FACTS devices.	4/1	2
3	Apply shunt compensators to improve power system stability.	4/2	3
4	Apply series and combined compensators to improve power system stability.	1/2	3

Syllabus:

General Considerations of AC And DC Systems: Introduction, Economic advantages of DC over AC transmission, types of DC links, technical advantages of DC over AC transmission, application of DC transmission system, Properties of converter circuits, different kinds of arrangements, choice of converter configuration, analysis of Graetz circuit, 12 pulse converter.

Control of Converter and DC Link: Principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link ;power control.

FACTS Concept and General System Considerations: FACTS concepts, transmission inter connections, power flow in AC Systems. Loading capability limits, dynamic stability considerations, Importance of controllable parameters, Basic types of FACTS controllers, benefits from FACTS controllers.

Static Shunt Compensators: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, Improvement of transient stability, Power Oscillation damping, SVC & STATCOM.

Static Series Compensators: Concept of series capacitive compensation, Improvement of transient stability, Power Oscillation damping, thyristor switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC).

Combined series and shunt Compensators: Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC).

Text Books:

1. K.R. Padiyar, "HVDC power transmissions systems: Technology and system interactions", Edition 2, New age International (P) Ltd., New Delhi, Eastern, 2011
2. N G Hingorani and L.Gyugyi, "Understanding FACTS devices", IEEE Press, 1999

Reference Books:

1. S.Kamakshiah, V.Kamaraju "HVDC Transmission", Edition-1, Tata Mc Graw-Hill Education, 2011
2. Song, Y.H and Johns, A.T, "Flexible A.C Transmission Systems (FACTS) IEEE Power Engineering Series 30, London, 1999

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SMART GRID TECHNOLOGIES

Mapping of the Course Outcomes with Student Outcomes

C.O.No.	Course outcome	PO/PSO	BTL
1	To understand the functioning of various devices in Smart Grids	5,7/1	2
2	To understand communication channels in Smart Grid.	5,7/1	2
3	To understand the concept of information security for the smart grid	5,7/1	2
4	To apply knowledge in smart metering	5,7/2	3

Syllabus:

Smart grid: Introduction – Necessity of smart grid – Definition – Early smart grid initiatives – overview of the technologies required for the smart grid-Information and communication technologies, Sensing measurement, control and automation technologies, Power electronics and energy storage.

Data communication: Introduction – dedicated and shared communication channels – switching techniques – communication channels- layered architecture and protocols; Communication technologies for the smart grid: Introduction –communication technologies – standards for information exchange.

Information Security for the smart grid: Introduction – Encryption and Decryption: Symmetric Key encryption, Public key encryption - Authentication – Digital signature: Secret key signature, Public key signature, Message digest – cyber security standards.

Smart metering and demand side integration: Introduction – smart metering – smart meters – Communication infra structure and protocols for smart metering - Demand side integration.

Smart grid applications: Introduction – voltage and VAR control and optimization – fault detection, isolation and restoration (FDIR) – Demand response (DR) – Distributed energy resources (DERs) – wide area monitoring, control and protection (WAMCP).

Text Books:

1. JanakaEkanayake ,KithsiriLiyanage , Jianzhong Wu , Nick Jenkins "Smart Grid: Technology and Applications" first Edition, John Wiley & sons Limited ; 2012.
2. Lars T. Berger and Krzysztof Iniewski "Smart Grid: Applications, communication and security" first Edition ,John Wiley & sons Limited; 2012.

Reference Books:

1. James Momoh "Smart grid: Fundamental of Design and analysis" ,John Wiley & sons Limited IEEE Press, 2012.

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RESTRUCTURED POWER SYSTEMS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the concept of deregulation market structure, market architecture and power system old vs new.	1 /1	2
2	Understand electricity sector structures different structure models, bilateral and pool markets and LMP based markets	1, 7/1	2
3	Analyze transmission pricing methods, congestion management methods and effect of congestion on LMPs.	1/2	4
4	Understand ancillary services system security in deregulation	1, 7/1	2

Syllabus:

Need and conditions for deregulation: Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts original cost of generation, least-cost operation, incremental cost of generation.

Power System Operation: Old vs. New. Electricity sector structures and Ownership /management, the forms of Ownership and management.Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Pricing: Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices. Transmission network and market power, Power wheeling transactions and marginal costing, transmission costing, Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices.

Ancillary Services: Ancillary Services and System Security in Deregulation, Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Text Books:

1. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder "Operation of restructured power systems", Kluwer's Power Electronics and Power Systems Series.
2. Steven Stoft, "Power System Economics: Designing markets for electricity" IEEE Computer Society Press.

Reference Books:

1. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 1996.

2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 2004, second Edition, Tata MCGraw Hill.

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18EE3231: ENERGY ACCOUNTING AND MANAGEMENT SYSTEMS

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the present power scenario in India.	PO1, PO2/ PSO1	2
CO2	Understand the duties and responsibilities of Engineer Distribution.	PO1, PO2/ PSO1	2
CO3	Analyze the energy accounting and billing.	PO2, PO3/ PSO1	4
CO4	Analyze the energy management system and demand side management implementation strategies.	PO2, PO3/ PSO1	4

Syllabus:

Introduction: Present power generation, transmission, and distribution scenario of India, Elements of power systems, transmission, distribution and generations, AT&C Loss, Calculation of Aggregate Technical and Commercial loss, Measures to reduce Technical and Commercial losses, Functions of power distribution companies, Power distribution from distribution substation to end consumers.

Organizational context: Organization structure of Distribution Company along with escalation matrix, Duties and responsibilities of Engineer Distribution, Relevant legislation, Electricity Act 2003, Central Electricity Regulatory Commission, State Electricity Regulatory Commission, Interpret Central Electricity Authority Regulations 2010. Roles and responsibilities of MSDC, MSDE and NSDA in power sectors.

Energy Accounting: Metering and Billing: Revenue management system in electrical distribution, Importance of Processes for Revenue Collection, Flow Chart of Revenue Collection, Energy Audit, Power purchase calculation and future demand, Long term and short-term agreement in power purchase, Management of supply demand gap, Laws and Regulation on withdrawal of Power from Grid Network, Categories of consumers, Process and documents needed for change in category of supply, Meter replacement and supply restoration.

Demand Side Management and Energy Management Systems: DSM Definition, various outcomes of DSM, Its benefits, Broad options and technology for Industrial DSM, Legal and policy frame work of DSM in India, Load Management, EMS in power systems, objectives, Functions and befits of EMS, EMS architecture, real time monitoring and control using SCADA-EMS.

Text books:

1. Participant handbook, Engineer – Distribution, PSS/Q7001, Version 1.0, NSQF Level 6.
2. Electric Power Distribution, A.S. Pabla, Tata McGraw-Hill Education, 2004.

Reference Books:

1. Integrated Resource Planning and Demand Side Management, Zhaoguang Hu, Xinyang Han, Quan Wen, Springer, 2013.
2. Demand Side Management, Jyothi Prakash, TMH Publishers.
3. Energy Management Systems, P.Giridhar Kini, Ramesh C. Bansal, Intech Open, 2011.

18EE3232: SUBSTATION PRACTICE

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of power distribution system.	PO1, PO2/ PSO1	2
CO2	Understand the substation erection and commissioning.	PO1, PO2/ PSO1	2
CO3	Analyze the protection of distribution system.	PO2, PO3/ PSO1	4
CO4	Understand the operation and maintenance of distribution system.	PO2/ PSO1	2

Syllabus:

Power Distribution Network: Circuit connections, voltage and current relationship in star & delta configuration, 3 phase and 1 phase supply, Types of distribution system, Concept of Load Flow Study in Power System, Components of Distribution System, schematic drawings, Layout of Plans for Erection and Commissioning, Preparation of Bill of Quantity (BOQ), procurement Processes in power distribution system, process for Installation of Equipment in distribution system as per the standards.

Substation Erection and Commissioning: Various types of Distribution Substation 33/11 and 11/433 kV, AIS, GIS etc., technical specifications of distribution substation equipment, different clearances required for the voltages, procedure for erection and commissioning of distribution substation, importance of capacitor bank, different mounting structures for the transformer, erection of Equipment in Distribution Substation, installation procedure of Switchgear, Power Factors Correction Panels and Control Panels, Substation Automation System (SAS) in Power Distribution Network.

Distribution System Protection: Various Distribution System Protections, surge voltages along with various surge protection devices, importance of Lightening Arrestor (LA) in distribution network, Earthing of Distribution System, different grounding systems.

Operation and Maintenance of Distribution System: Load Management, Grid Stability, Frequency, Load Dispatch, Feeder Loading etc. Monitor Remote Terminal Unit (RTU), Ring Main Unit (RMU) and Other Automation System, Standard Operating Procedures (SOPs) and Maintenance Schedules. Types of maintenance practices followed in distribution like preventive, regular maintenance etc. Underground and overhead maintenance work related to distribution system, Use of different equipment needed for locating the cable fault and fault rectification method.

Text Books:

1. Participant handbook, Engineer – Distribution, PSS/Q7001, Version 1.0, NSQF Level 6.

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18EE3242: BATTERY MODELLING FOR ELECTRIC VEHICLES

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the key components of Battery management systems	PO1, PO3/ PSO1	2
CO2	Understand the key functions of Battery management systems	PO1,PO5/ PSO2	2
CO3	Analyze the static battery models	PO7/ PSO1	4
CO4	Analyze the dynamic battery models	PO5/ PSO2	4

Gist:

a) Batteries (b) Electric Vehicles (c) (d) Battery management systems e) static modelling f) Dynamic modelling

Syllabus:

Components of battery-management systems

Lithium-ion cell terminology, major functions provided by a battery-management system and their purpose - Identify the major components of a lithium-ion cell and their purpose - Understand how a battery-management system "measures" current, temperature, and isolation.

Functions of battery-management systems

Identify electronic components that can provide protection and specify a minimum set of protections needed - Compute stored energy in a battery pack - List the manufacturing steps of different types of lithium-ion cells and possible failure modes.

Static Modelling of Battery

Static modelling of battery: static model parameters of the battery, lab test to determine the parameters of battery model, static equivalent circuit determination.

Dynamic Modelling of Battery

Dynamic modelling of battery, parameters affecting the dynamic model, lab test to determine the dynamic model parameters, dynamic equivalent circuit determination.

Text books:

1. **Battery management systems: Battery Modeling , Gregory L.Plett**, Artech house, 2015.
2. **Battery management systems: Equivalent circuit methods , Gregory L.Plett**, Artech house, 2015.

Reference books:

1. Hybrid Electric vehicles-Principles and Applications with practical perspectives, Chris Mi, M. AbdulMasrur and David Wenzhong Gao, Wiley Publications,1 edition 2011
2. Electric and Hybrid Vehicles power sources, models, sustainability, infrastructure and the market, Edited by Gianfranco Pistoia, Elsevier 1 edition 2010.
3. Electric and Hybrid Vehicles Design Fundamentals, by Iqbal Hussain, CRC Press2nd edition, 2010.

18EE3222: WIND AND MICRO ENERGY SOURCES

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of wind energy conversion and measurement system.	PO1,PO2/ PSO1	2
CO2	Apply the concepts of wind energy system to electric power grid.	PO1,PO2/ PSO2	3
CO3	Understand the concepts ofgeothermal energy systems.	PO1,PO5/ PSO1	2
CO4	Understand the concepts of tidal, ocean and bio-mass energy systems.	PO1,PO2/ PSO1	2

Syllabus

Wind Energy: Wind Energy Basics, Components of WECS, Power obtained from the wind, Factors influencing wind power, Wind data and Energy estimation, Wind Measurement & Analysis: Simple momentum theory, Power coefficient, Aerodynamics of WT, Betz's Limit, Blade Element Theory, Blade Design, Control Strategies: Power Regulation, yaw control, Pitch control, stall control, Schemes for Maximum Power Extraction. Wind Turbine Technology & Generators: HAWT, VAWT, Constant Speed constant frequency, Variable speed variable frequency, Modeling of DFIG, PMSG. Grid Connected Systems: Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

Geothermal Energy: Introduction to geothermal energy, structure of the earth interior, geothermal gradients, geothermal resources, geothermal power generation – liquid dominated and vapour dominated geothermal electric power plants.

Tidal Energy: Introduction to tidal energy, tidal characteristics, tidal range, tidal energy estimation, types of tidal power plants – single basin single effect plant, single basin double effect plant, double basin double effect plants.

Ocean Energy: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system.

Bio Mass Energy: Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, and power generation. Biomass energy conversion technologies, Biogas generation – classification of Biogas plants, Urban waste to energy conversion, Biomass energy programme in India.

Text books

1. Kalogirou .S.A., "Solar Energy Engineering: Processes and Systems", Academic Press, 2009.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, First edition

Reference books

1. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power"ISBN: Library of Congress Control Number: 2008929624_c Springer-VerlagBrerlin Heidelberg 2009.
2. John Twidell& Toney Weir: E&F.N. Spon, "Renewable Energy Sources", Taylor &Francis New York, 2nd edition.

18EE3223: ENERGY CONSERVATION AND AUDIT

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the energy auditing methods to meet the energy conservation and various tariffs	PO1/ PSO1	2
CO2	Apply the energy conservation techniques to power system elements	PO5/ PSO2	3
CO3	Understand the energy conservation opportunities in industrial motors and lighting systems	PO3/ PSO1	2
CO4	Understand the energy conservation opportunities incooling systems and cogeneration	PO2/ PSO1	2

Syllabus

Role of energy in economic development and social transformation, Energy Sources and Overall Energy demand and availability, Energy Conservation Act-2001 & 2003. Electricity Tariff.
Energy Audit: Need, Types, Methodology and Approach. Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, maximizing system efficiency.
Instruments Used in Energy Auditing, Energy Conservation opportunities in Transformers and cables. Energy Conservation opportunities in Transmission lines, P.F. improvements, Demand Side management (DSM), Variable speed drivers.

Electric Motors: Types, Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, Energy efficient motors and Soft starters. Energy conservation opportunities.

Illumination / Lighting Systems: Light source, choice of lighting, luminance requirements, electronic ballast, occupancy sensors, energy efficient lighting control. LED Lighting, Trends and Approaches.

Energy conservation opportunities in HVAC, Refrigeration and Air Conditioning systems, Energy Saving in Pumps & Pumping Systems.Energy Conservation Opportunities in Public and Private Buildings, Concepts of Cogeneration. Peak Demand controls- Methodologies.

Text books

1. Industrial Energy Management: Principles and Applications by Giovanni and Petrecca, The Kluwer international series-207 (1999)
2. Guide to Electric Load Management by Anthony J.Pansini, Kenneth D.Smalling, Pennwell pub (1988)

Reference books

1. Energy-Efficient Electric Motors and their applications by Howard E.Jordan, Plenum pub corp; 2nd ed. (1994).
2. Energy Management Hand book by Turner, Wayne C, Lilburn, The Fairmont press, 2001
3. Handbook of Energy Audits by Albert Thumann, Fairmont Pr; 5th edition (1998).
4. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.

18EE3241: INTRODUCTION TO ELECTRIC VEHICLE

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the History, Economics and environmental issues of Electric Vehicles	PO5/ PSO1	1
CO2	Analyze the power train components and dynamics of EV	PO7/ PSO1	4
CO3	Select and size the motor for power train of EV	PO7/ PSO1	3
CO4	Select and size the converter for EV	PO5/ PSO2	3

Gist:

(a) Electric Vehicles (b) Economic impact (c) electric vehicle dynamics

Syllabus:

HISTORY OF ELECTRIC VEHICLES

History of EV, Case studies on Economic and Environment aspects of EV,

ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE

EV markets – Supply and demand, Economical analysis with case study, Environmental impact analysis with case study. Impact of different transportation technologies on environment and energy supply.

CLASSIFICATION OF ELECTRIC VEHICLES Plug-in EV, ON-road and off-road EV's, Rail borne EV's, Air borne EV's, Sea borne EV's, Electric Rover and Spacecraft. Advantages and Disadvantages of different EV's.

INTRODUCTION TO EV DYNAMICS & POWER TRAIN COMPONENTS

Motion and dynamic equations of electric vehicles, difference between structures of EV two wheelers, three wheelers and four wheelers. Different materials used for EV chassis and power train. Basic EV calculations.

MOTOR SELECTION AND SIZING IN POWER TRAIN

Characteristic features of the Motors to be used in EV, evaluation of various motors for EV characteristics, sizing of the motor as per the power drive requirement

CONVERTER SELECTION AND SIZING IN POWER TRAIN

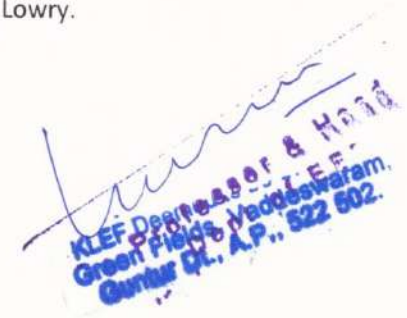
Characteristic features of the Converters to be used in EV, evaluation of various converters for EV characteristics, sizing of the converter as per the power drive requirement

Text books:

1. "A History of Electric Vehicles" by Nigel Burton, Edition -1, Crowood Publisher.
2. "Electric Cars: The Ultimate Guide for Understanding the Electric Car And What You Need to Know" by Brad Durant

Reference books:

1. "Electric Vehicle Technology Explained" by James Larminie and John Lowry.



18EE3221: SOLAR PV AND THERMAL TECHNOLOGIES

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the need of Solar PV and Solar Thermal systems	PO1,PO2 / PSO1	2
CO2	Understanding the applications of solar thermal energy systems	PO1,PO2 / PSO1	2
CO3	Understand the design aspects of Solar PV system	PO4 / PSO1	2
CO4	Understand the operational issues of grid connected and isolated solar PV system	PO5,PO7 / PSO1	2

Syllabus

Solar PV System: Overview of Indian Power Sector, Global Energy Scenario, Global and diffuse radiations, Solar spectrum, Terrestrial and extra terrestrial regions. Solar Irradiance and Insolation, Photovoltaic effects, PV cell characteristics, Effect of variation of temperature, Insulation level & Tilt Angle on the characteristics, Fabrication process. PV module data sheet and specifications.

Solar Thermal Systems: Principles of applied heat transfer, solar thermal collectors: Glazing, evacuation, selective surfaces, concentrators. Different types of solar thermal collectors, Solar power tower, Solar pond, solar desalination, solar space heating and cooling, Solar thermal cocker, Solar water heating system.

Solar PV System Design - Types, Selection criterion, MPPT issues, salient features, Grid - Connected Inverter: Functions of the inverter in PV systems, Classification of grid connected Inverter, Inverter Efficiency, Selection of Grid connected Inverter. DC cables and AC cables, Array Junction box / DC combiner box, Over Current protection device/circuit breakers, System protection, Energy meter, System monitoring, Marking and signage, Energy storage (Battery) types and their characteristics, Battery design parameters,

Isolated and Grid connected PV systems: Autonomous PV system; Grid Linked PV systems; Remote application of Photovoltaic's; System sizing; System Performance; Economics and future prospects. Jawaharlal Nehru National Solar Mission role, Site Selection factors.

Text books

1. H.P. Garg & J. Prakash, "Solar Energy - Fundamentals and Applications", Indian Edition - First Revised Edition, Mc Graw Hill Education.
2. S.P. Sukhatme& J.K. Nayak, "Solar Energy - Principles of Thermal Collection and Storage", Third Edition, Mc Graw Hill Education.

Reference books

1. Solar Photovoltaics, Fundamentals, Technologies and Applications, Second Edition, Chetan Singh Solanki, PHI Learning Private Limited (2012).
2. Hand Book of Fuel Cells - Fundamentals and Technology and Application, Wiley & Sons Publishers.
3. MichealBoxwell, "Solar Electricity Handbook", Green Stream publishing.
4. G.D.Rai, "Non conventional Energy", Khanna Publishers.

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18EE3243: CHARGING STATION FOR ELECTRIC VEHICLE

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Interpret Power electronic converters for electric vehicle charging	PO5 / PSO1	2
CO2	Develop control algorithms for various electric vehicle charging modes	PO5 / PSO1	3
CO3	Demonstrate charging station infrastructure	PO5 / PSO1	3
CO4	Demonstrate installation of charging station	PO7/ PSO2	2

Gist:

(a) Power Electronics for charging (b) Charging Modes and Topologies (c) Supply equipment (d) Installation

Syllabus:

Power Electronics for EV Battery Charging

Forward/ Flyback Converters, Half-Bridge DC–DC Converter, Full-Bridge DC–DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc-dc converter

Charger Topologies

Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, High power topologies, Multi-port Charger

Charging Modes

Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Float charge, Trickle Charge

Charging Infrastructure

Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001, Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock

Digital Communication between EV and Charging Station

Installation

Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947 part I,II, III and 61215

Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control

Text books:

1. Power Electronics by Daniel W.Hart
2. Power Electronics for Renewable Energy Systems, Transportation and industrial Applications by Haitham Abu-Rub, Mariusz Malinwoski, Kamal Al-Haddad

18EE3233: DISTRIBUTION SYSTEM TESTING AND SAFETY PRACTICES

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BT L
CO1	Apply the testing of the Equipment in Power Distribution	PO1, PO2/ PSO2	3
CO2	Understand the use of basic Health & Safety practices for power related work	PO1, PO2/ PSO1	2
CO3	Understand the documentation refers to the safety	PO2, PO3/ PSO1	2
CO4	Understand the rescue techniques during fire hazards.	PO2/ PSO1	2

Syllabus:

Testing of the Equipment in Power Distribution: Testing of distribution Transformer and associated components, routine test on the equipment, importance of Insulation Resistance testing, polarisation index and absorption index, importance of magnetic balance test of transformer, Test the earthing resistance in distribution system, various tests on Current Transformer, Capacitor Voltage Transformer, Lightning Arrestor, Circuit Breaker, Energy meter etc. to ensure their healthiness, Fault location methods for distribution systems lines and cables.

Use basic Health & Safety practices for power related work: Basic health and safety practices covering CEA safety regulations 2010, issue of permit to work etc. Uses of Personal Protective Equipment during at work site e.g. safety helmet, belt, shoes, protective glasses, earth rod, etc. **Documentation refers to safety:** Retrieve and point out documentation that refers to safety, health policy and standard, Inform relevant authority for any abnormal situation/ behaviour of any equipment's, good housekeeping practises and disposal of waste, common hazard, Storage of flammable materials and oils safely, possible causes of risk or accident, any abnormalities in system installed, alarms, noticing parameters, fire safety, causes and precautionary activities.

Rescue Techniques during fire hazards: Use of appropriate fire extinguishers on different types of fires, rescue techniques applied during fire hazard, correct method to move injured people during emergency, Arrange/ transport heavy objects and tools safely using correct procedures from storage to workplace and vice versa, Administer appropriate first aid to victims, bandaging heart attack, CPR, etc., how to free a person from electrocution, Respond promptly and appropriately to an accident situation or medical emergency in real or simulated environments, Inform relevant authority about any abnormal situation, Complete written accident report or dictate a report, send report to concern person responsible.

Text Books:

1. Participant handbook, Engineer – Distribution, PSS/Q7001, Version 1.0, NSQF Level 6.

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17TSS6003	Technical Skills -3	PR	**Introduction:**Review of Sensors, actuators and controllers. PLC Overview - PLC Selection - Number Systems & Codes - I/O Devices & Motor Controls - NO/NC & RLO Concept - Creating Relay Logic Diagrams. **PLC Programming** - Programming Logic Gate Functions - Ladder Logic – Relay type instructions - PLC Timer Instructions - PLC Counter Instructions - Math Instructions - – Data manipulation and math instructions – Programming Examples.Compare, Jump & MCR Instructions - Subroutine Functions - Logic & Bit Shift Instructions - Data Handling Instructions Communication architectures - PID modules - functions-PWM modules **PLC Based control systems:,** Temperature controller, Water-level control, conveyer control, elevator control, bottle filling system, traffic light controller, Motor control				100%
17EE3102	POWER SYSTEM PROTECTION AND CONTROL		**Power System Protection:** Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays &static relays. Introduction to Digital Protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings. Protection schemes- over current, differential and distance. **Protection against Over Voltages:** Causes of over voltages, ground wires, lightning arresters, **Neutral Grounding:** Necessity of earthling, step voltage, Types of neutral grounding. **Economic Dispatch:** Optimal operation of generators on a Bus Bar, optimal unit commitment, optimum generation schedulingwith and without constraints. **Automatic Generation Control & Automatic Voltage Regulator:** Load frequency control single area (Single area case), Load frequency control and economic dispatch control, Introduction to two area load frequency control, automatic voltage control,AVR block diagram, PV curves.				100%

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18EE2203: POWER SYSTEM PROTECTION & CONTROL

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the principle of protective relays & circuit breakers	5/1	2
2	Apply overcurrent, distance and differential protection schemes.	1, 2, 5/1	4
3	Analyze over voltage protection and economic operation of power system	1, 2/1	4
4	Analyse automatic generation control and voltage regulators	1, 2/1	4
5	Experimental verification of characteristics of differential relays and operation and control of power systems through programming /simulation.	5/2	3

Syllabus:

Power System Protection: Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays &static relays. Introduction to Digital Protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings. Protection schemes- over current, differential and distance.

Protection against Over Voltages: Causes of over voltages, ground wires, lightning arresters, **Neutral Grounding:** Necessity of earthling, step voltage, Types of neutral grounding.

Economic Dispatch: Optimal operation of generators on a Bus Bar, optimal unit commitment, optimum generation schedulingwith and without constraints.

Automatic Generation Control & Automatic Voltage Regulator: Load frequency control single area (Single area case), Load frequency control and economic dispatch control, Introduction to two area load frequency control, automatic voltage control,AVR block diagram, PV curves.

Text Books:

1. D. P. Kothari, I. J Nagrath, "Modern Power System Analysis", 3rd Edition, Tata Mc-Graw Hill Publications.
2. Badri Ram, D N Vishwakarma, "Power System Protection and Switchgear", Tata Mc-Graw Hill Publications.

Reference Books:

1. Jhon J Grainger, William D Stevenson Jr., "Power System Analysis", Tata Mc-Graw Hill Publications.
2. Sunil S Rao, "Switch Gear Protections", Khanna Publications.
3. C L Wadhwa, "Electrical Power Systems", New Age International (P) Ltd..
4. Van. C. Warrington A.R., "Protective Relays"Vol. 1 & 2, Chapman & Hall.

AGENDA ITEM-3

Syllabus revisions as per contemporary requirements for courses offered during A.Y 2018-19	**It is resolved to approve the course revisions of A.Y: 2018-2019 and same is recommended for academic council for approval from Y17 onwards**

- Dr. K. Sivakumar, Professor, IIT Hyderabad - suggested to include tutorial hours than lab hours for **Electrical circuits** course
- K Sarada recommended **Power System Protection and Control** course in view of gate, competitive exams.
- D.Kalyan proposed Technical Skill 3 & 4 courses on PLC
- V.Jayadhar Babu, Assistant R &D engineer, recommended to implement new specializations for Y17 admitted students.

To apply the changes made in professional electives to y17 batch as well(**Point 1 of Annexure-IV**)

AGENDA ITEM-4

Value added courses to be offered in AY 2018-19 for B.Tech EEE program	**BOS members approved the proposal for value added courses and recommender to academic council**

The syllabus of value-added courses is reviewed for mapping to employability or entrepreneurship or career progress. The courses are planned to be delivered by APSSDC. The reputation of the course delivering organizations and usefulness of the certificate were discussed and courses are approved by the BoS members.

- Mr. D Seshi Reddy recommended to incorporated PSSC syllabus in Curriculum for getting Global certificate to the students.
- N Naga Sai Koushik 150060064 has recommended a certification on IOT
- Dr.G.SUNITA SUNDARI, Professor in Physics Dept suggested to offer global certifications with industry tie-up

(Point 1 of Annexure-V)

AGENDA ITEM-5

Course Structure and Syllabi for 2018-2019 admitted batches for M.Tech (Power System) program as per the suggestions and feedback received from stakeholders and approved in DAC	**It is resolved to approve the curriculum of M.Tech (PS) 2018-2019 admitted batch and same is recommended for academic council for approval**

As per the contemporary requirements of local/global/national needs **EHVAC & HVDC Transmission** is introduced as new course .

- M Chaitanya Sai, Assistant Executive Engineer, APTRANSCO, India suggested to include **Digital Protection in Power Systems** curriculum
- Dr. S. Venu, Asst. prof., NIT Delhi- suggested to **offer Integration of Energy Sources** in M. tech program.

BOS members approved the curriculum of M.TECH (Power Systems) for the admitted students in 2018-2019 .
Point 1 of Annexure III

AGENDA ITEM-6

Course Structure and Syllabi for 2018-2019 admitted batches for M.Tech (Power Electronic Drives) program as per the suggestions and feedback	**It is resolved to approve the curriculum of M.Tech (PED) 2018-2019 admitted batch and same is**

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ENERGY STORAGE SYSTEMS

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BT L
CO1	Interpret the significance of energy storage systems	PO1, PO5/ PSO1	2
CO2	Demonstrate various devices for electrochemical, mechanical ,elastic and hydro storage systems	PO1, PO5/ PSO1	2
CO3	Demonstrate various electro-magnetic energy storage systems	PO1, PO5/ PSO1	2
CO4	Apply energy storage technologies for smart electrical energy consumption	PO2,PO5/ PSO2	3

Syllabus

Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable. Needs for Electrical Energy Storage: Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, the roles of electrical energy storage technologies, the roles from the viewpoint of a utility, the roles from the viewpoint of consumers, the roles from the viewpoint of generators of renewable energy.

Classification of EES systems, Mechanical storage systems, pumped hydro storage (PHS), Elastic energy storage, Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems: Introduction to batteries, elements and operation of electrochemical cells, theoretical cell voltage and capacity, losses in cells. Battery classification, factors effecting battery performance, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG). Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

Electromagnetic energy storage: Superconducting Magnetic Energy Storage. Super capacitor: Basic components of super capacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, aqueous and organic electrolytes. The disadvantages and advantages of super capacitors over battery systems and their applications in the aspects of energy density, power density, price and market.

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA-aggregation of many dispersed batteries. batteries for PV systems.

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Text books

1. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.
2. The Electrical Energy Storage by IEC Market Strategy Board.
3. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.
4. Johannes Jensen & Bent Sorensen ': "Fundamentals of Energy Storage", John Wiley & Sons, 1984.
5. S.Rao and Dr.P.P.Parulekar:"'Energy Technology", Khanna Pub., 1997.

Reference books

1. Collins: "Batteries Vo\. I & II'.
2. G.D.Rai: "Non-conventional Energy Sources", Khanna Publishers, 1989.
3. James Larminie: "Fuel Cell Systems Explained", John Wiley & Sons, 2005.
4. Tetsuya Osaka: "Energy Storage System for Electronics", Taylor & Francis Ltd., 2000.
5. ChethansinghSolanki "Solar Photovoltaics-Fudmentals, technologies and applications"-PHI II Edition -2012.

18EE4122: ENERGY MANAGEMENT SYSTEMS

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the need for energy management	PO1/ PSO1	2
CO2	Understand the Energy conservation building codes and energy conservation opportunities in different types of buildings.	PO5/ PSO1	2
CO3	Understand the energy conservation throughcogeneration plants	PO3/ PSO1	2
CO4	Understand the energy conservation opportunities inpumps and cooling systems	PO2/ PSO1	2

Syllabus

Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition.
Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources.
Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy.
Energy Efficiency in Buildings: Electrical Energy Conservation, Opportunities and Techniques for energy conservation in Buildings. Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture. Energy Conservation Building Code – 2007 (2008 Edition)
Energy Conservation Opportunities in Public and Private Buildings.
Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential.
Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.
Pumps, types and application, unit's assessment, Energy Saving in Pumps & Pumping Systems.
HVAC, Refrigeration and Air Conditioning: Vapor compressor refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance, Vapor absorption refrigeration systems: Working principle, type and comparison with vapor compressor system.
Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization.

Text books

1. Direct Energy Conversion: W.R.Corliss
2. Aspects of Energy Conversion: I.M.Blair and B.O.Jones
3. Principles of Energy Conversion: A.W.Culp (McGrawHill International
4. Principles of Refrigeration R.J. Dossat (Wiley Estern Limited.)

Reference books

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B. Smith (Pergamon Press).
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience publication)
5. Bureau of Energy Efficiency Publications-Rating System, Teri Publications – Griha Rating System, Leeds Publications

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SMART GRID COMMUNICATION AND CYBER SECURITY

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the communication technology and standards in smart grid	PO5, PO6/PSO1	2
CO2	Apply the knowledge of information security in smart grids.	PO5, PO6/PSO2	3
CO3	Understand the Interoperability and Standards.	PO5, PO6/PSO1	2
CO4	Understand the hacking techniques and cyber-security in smart grid.	PO5, PO6/PSO1	2

Syllabus

COMMUNICATION TECHNOLOGIES FOR THE SMART GRID: Different types of Communication technologies for the smart grid. Standards for information exchange, DNP3. Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network.

INFORMATION SECURITY FOR THE SMART GRID AND MEASUREMENT TECHNOLOGY

Introduction – Encryption and Decryption Authentication, Digital signature, Message digest, cyber security standards. Communication and Measurement - Monitoring, Advanced metering infrastructure-GIS and Google Mapping Tools, Multi Agent Systems (MAS) Technology for Smart Grid Implementations.

INTEROPERABILITY AND STANDARDS: Introduction-Benefits and Challenges Of Interoperability, Model For Smart Grid Network Interoperability, Approach to Smart Grid Interoperability Standards, IEC61850, GOOSE.

HACKING AND CYBER-SECURITY: Identifying a target-Vulnerability- Attack tools-Attack methods-Cyber security architecture • SGCG reference architecture - ISA-62443: zones and conduits and Smart Grids - Smartphone Security- Smartphone Security Guidelines- Communicating Securely (Through Voice and Messages) with a Smartphone- Secure Voice Communication- Sending Messages Securely

Text books

1. JanakaEkanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
2. James Momoh "Smart grid: Fundamental of Design and analysis" ,John Wiley & sons Limited IEEE Press (2012).

Reference books

1. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell.5.Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc.
4. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities", Island Press.

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SMART DISTRIBUTION SYSTEMS

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the evolution and various components of smart grids.	PO1, PO2/ PSO1	2
CO2	Understand the smart sub-station operation and applications in smart grids.	PO1, PO2/ PSO1	2
CO3	Analyze various load forecasting techniques in modern electrical power systems.	PO2, PO3/ PSO1	4
CO4	Understand the Volt/Var control techniques in smart grid.	PO2/ PSO1	2

Syllabus

Smart Grid and Distribution System Architecture - Introduction to Smart Grid - Evolution of Electric Grid- Definitions and Need for Smart Grid -Smart grid drivers, functions, opportunities, challenges and benefits- Initiatives for Smart Grid -Smart server - regional server -Smart appliances and smart meter -Advanced Distribution Management Systems -Outage Management.

Smart Sub-station -Intelligent Substation -Protection, Monitoring, and Control Devices (IEDs) -Sensors – SCADA- Sub-station location and rating -Protocol stacks -Interoperability and IEC 61850-Substation Design-Message exchange- Distribution Reconfiguration.

Load Forecasting-Distribution system modeling-Single-phase models for balanced three-phase distribution systems-Three-phase models for unbalanced three-phase distribution systems- State estimation-Weighted least square (WLS) estimators-Univariate Methods for Short-Term Load Forecasting-Application of the Weighted Nearest Neighbor Method to Power System Forecasting Problems.

Volt/VAr Control – Devices-Voltage drop and energy loss-Load Response-Benefits - Capacitorsin distribution systems-location-control equipment inside sub-station, feeder side implementation-FDIR control **frequency balance in smart-grid architecture** Frequency increase and drop operation - Message exchange in frequency operation.

Text books

1. StuartBorlase "Smart Grid – Infrastructure, Technology and Solutions" —CRC Press Taylor and Francis -2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley 2012.

Reference books

1. Mohamed E. El-Hawary, "Advances in Electric Power and Energy Systems", IEEE Press John Wiley & Sons, Inc, 2017
2. S. M. Muyeen; Saifur Rahman "Communication, Control and Security Challenges for the Smart Grid" – IET 2017

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POWER SYSTEMS DYNAMICS & CONTROL

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course outcome	PO/PSO	BTL
1	Understand Linear Dynamical system behavior	1, 2/1	2
2	Analyze the modeling of synchronous machines and their controllers	1, 2/1	4
3	Understand the modeling of transmission line and loads	1, 2/1	2
4	Analyze Angular stability and Frequency stability Analysis	1, 2/1	4

Syllabus:

Introduction to Power System Operations: Introduction to power system stability. Power System Operations and Control.Stability problems in Power System.Impact on Power System Operations and control.

Analysis of Linear Dynamical System and Numerical Methods: Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System.Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

Modeling of Synchronous Machines and Associated Controllers: Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model.D-Q Transformation.Model with Standard Parameters.Steady State Analysis of Synchronous Machine.Short Circuit Transient Analysis of a Synchronous Machine.Synchronization of Synchronous Machine to an Infinite Bus.Modeling of Excitation and Prime Mover Systems.Physical Characteristics and Models.Excitation System Control.Automatic Voltage Regulator.Prime Mover Control Systems. Speed Governors.

Modeling of other Power System Components: Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics.Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads.

Stability Analysis: Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

Enhancing System Stability: Planning Measures.Stabilizing Controllers (Power System Stabilizers).Operational Measures-Preventive Control.Emergency Control.

Text Books:

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2002.
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.

Reference Books

3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall.

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LINE COMMUTATED ACTIVE RECTIFIERS

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course outcome	PO/PSO	BTL
1	Understand the power quality problems posed by conventional Rectifiers	1/1	2
2	Analyze the operation of Multi-Pulse converter for improving power quality	4/1	4
3	Apply boost converter to improve supply pf of a rectifier	4,9/2	3
4	Apply dc-dc flyback converter to improve supply pf of a rectifier	4,9/2	3

Syllabus:

Diode rectifiers with passive filtering:

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Thyristor rectifiers with passive filtering:

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current wave-shape.

Multi-Pulse converter

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Single-phase ac-dc single-switch boost converter

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Ac-Dc bidirectional boost converter

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Isolated single-phase ac-dc flyback converter

Dc-dc flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure.

TEXTBOOKS/REFERENCES:

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics" , Addison-Wesley, 1991.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2001.

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MODERN POWER ELECTRONICS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand various advanced inverter topologies	1, 3, 4 /1	2
2	Analyze various PWM techniques to control inverter	1, 3, 4 /1	4
3	Analyze the performance of DC-DC converters	1, 3, 4/1	4
4	Understand the working of various resonant converter topologies	1, 3, 4/1	2

Syllabus:

Multilevel converters: Multilevel converter topologies- Diode-Clamped Multilevel Converters- Flying-Capacitor Multilevel Converters - Cascaded H-Bridge Multilevel Converters – circuit diagrams-principle of operation, waveforms – advantages and disadvantages of each converter topology –

Advanced PWM techniques - Third harmonic injection PWM (THPWM), Delta Modulation- - Selective Harmonic Elimination Technique- Current Controlled PWM (CCPWM) Technique– Sine PWM for 3 level inverter- space vector Modulation (SVM)for 2 and 3 level inverter

Switched mode power conversion: Non-isolated DC-DC converters: Buck-boost, Cuk, SEPIC, Zeta in DCM and CCM. Isolated dc-dc converters: Flyback, forward, Cuk, SEPIC, Zeta, half bridge, push-pull and bridge in DCM and CCM.

Resonant converters: Introduction – Need of resonant converters – examples -Series resonant converter - Parallel resonant converter - Zero current switching- Zero voltage switching – applications.

Text books:

1. Rashid, M H " Power electronics : circuits, devices, and applications", 2nd ed., Englewood Cliffs, N.J.Prentice Hall
2. Ned Mohan et.al "Power Electronic converters- converters, design and applications", Wiley

Reference books:

1. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2001.

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ELECTRICAL DRIVES

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course outcome	PO/PSO	BTL
1	Understand the dynamics of electrical drives	1,5 / 1	2
2	Apply phase and chopper control techniques to DC motor drive	1,5/2	3
3	Analyze stator and rotor side speed control of Induction motor drive	1,5/1	4
4	Apply various control techniques to synchronous motor drive	1,5/2	3

Syllabus:

Dynamics of electrical drives Fundamental torque equations, Modes of operation-Equivalent values of drive parameters: Load with rotational motion-Load with Translational motion, Measurement of moment of Inertia

Control of dc motors: Single and Three phase semi -Fully controlled converters fed DC motors drives –Speed-Torque Characteristics and expressions - Electric Braking - Four quadrant operation of D.C motors by dual converters - Control of DC motors by Choppers-Single quadrant, Two –quadrant and four quadrant chopper fed DC motors drives – DCM and CCM operation –Speed- torque expressions and characteristics – Closed loop operation of dc motor drives induction motor drives (Block Diagram Only)- Numerical problems.

Control of induction motors Stator voltage control : - Control of Induction Motor by AC Voltage Controllers – Stator Frequency control- Variable frequency control of induction motor by Voltage source and current source inverter - PWM control – Comparison of VSI and CSI operations - Closed loop operation of induction motor drives (Block Diagram Only)- Numerical problems.

Control of Induction motor of Rotor side: Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive –Problems.- Numerical problems.

Control of synchronous motors: Separate control &self control of synchronous motors – Operation of self controlled synchronous motors by VSI and CSI cyclo-converters. Load commutated CSI fed Synchronous Motor – Operation – Closed Loop control operation of synchronous motor drives (Block Diagram Only) - Numerical problems.

Text Books :

1. Ned Mohan, "First course on Power Electronics and Drives" Wiley Publications (2011).
2. G. K. Dubey, "Fundamentals of Electrical Drives" 2nd Edition, Narosa publications (2001).

Reference Books:

1. G. K. Dubey ,"Power Semiconductor controlled drives", Prentice Hall Inc., New Jersey(1989).
2. Vedam Subrahmanyam," Electrical Drives concepts and Applications", Tata McGraw Hill publishers (2008).
3. P.V.Rao, "Power semiconductor Drives", B. S.Publications (2007)
4. V. R. MOORTHI, "Power Electronics Devices, Circuits and Industrial Applications", Oxford University Press (2010)

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ADVANCED ELECTRICAL DRIVES

Mapping of the Course Outcomes with Student Outcomes

C.O. No:	CO	PO/PSO	BTL
1	Apply advanced control strategies to induction motor drives	1,5/2	3
2	Understand the operation and control strategies of stepper motor & SRM drive	1,5/1	2
3	Apply control strategies to PM BLDC drive	1,5/2	3
4	Understand the operation of special motors	1,5/1	2

Syllabus:

Control Strategies of Induction motor drives: Different transformations and reference frame theory, modelling of induction machines- vector control (FOC), direct torque and flux control(DTC).
Stepper motors: Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control Concept of lead angle - Applications.
Switched Reluctance Motor (SRM): Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Microprocessor – Based Control of SRM, Sensor less Control of SRM.
Permanent magnet brushless D.C. motors: Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Power Converter Circuits and their controllers - Characteristics and control- Applications.
SPECIAL MACHINES: Constructional features – Principle of operation and Characteristics of Hysteresis motor-Synchronous Reluctance Motor–Linear Induction motor-Flux Reversal machine (FRM) - Applications.

Text Books :

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. M.Ramamoorthy&O.Chandrasekhar, "Electrical Machines", PHI Publishers, 2017.

References Books:

1. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984
2. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008
3. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

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HYBRID ELECTRICAL VEHICLES

Mapping of the Course Outcomes with Student Outcomes

C.O. No:	CO	PO/PSO	BTL
1	Understand the basics of conventional vehicle and history of HEV	1,10/1	2
2	Discriminate various motors used for HEV	1,10/1	4
3	Identify various energy storage systems for HEV	1,10/1	2
4	Understand the function of EMS in HEV	1,10/1	2

Syllabus:

Introduction to Hybrid Electric Vehicles:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency
analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Energy Storage System: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. **Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

References Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.
3. Iqbal Hussain, CRC Press, Taylor & Francis Group, Second Edition (2011).

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FACTS CONTROLLER

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course outcome	PO/PSO	BTL
1	Understand the concepts of AC transmission system.	5,10/1	2
2	Understand the operational characteristics of shunt compensators.	5,10/1	2
3	Understand the operational characteristics of series compensators.	5,10/1	2
4	Understand the operational characteristics of combined FACTS devices	5,10/1	2

Syllabus:

FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATIONS: Transmission interconnections, Power Flow in AC system, Dynamic stability Considerations and the importance of the controllable parameters, Introduction to Facts devices, Basic types of FACTS Controllers, benefits from FACTS controllers.

STATIC SHUNT COMPENSATION: Objectives of shunt compensation, Methods of controllable VAR generation, variable impedance type static VAR generators (SVC): TCR, TSR, TSC, FC-TCR, TSC-TCR, switching converter type VAR generators: STATCOM, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement.

STATIC SERIES COMPENSATION: Objectives of series compensation, variable impedance type static series controllers: GCSC, TSSC, TCSC, switching converter type controller: SSSC, Operation and Control External system Control for series Compensator SSR and its damping – Static Voltage and Phase angle Regulators - TCVR and TCPAR – Operation and Control.

UPFC AND IPFC: The unified power flow Controller – Operation –Comparison with other FACTS devices – control of P and Q – dynamic performance – special Purpose FACTS controllers – Interline Power flow Controller – Operation and Control.

TEXT BOOKS:

1. N.G Hingorani&L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,2000
2. K.R.Padiyar "FACTS Controller in power Transmission and Distribution" New Age Int Publisher,2007

REFERENCE BOOKS:

1. Vijay K Sood "HVDC and FACTS Controllers" Kluwer Academic Publishers,2004.
2. Xiao-Ping Zhang, Christian Rehtanz, Bikash Pal, "Flexible AC Transmission Systems- modeling and control" Springer, 2005.

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STATE ESTIMATION & SYSTEM IDENTIFICATION

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Apply the probability theory to estimate system parameters	1,5/2	3
2	Apply the stochastic process to estimate system models	1,5/2	3
3	Analyze the optimal prediction and smoothing for discrete linear systems	1,5/1	4
4	Analyze the optimal estimation for continuous linear systems	1,5/1	4

Syllabus:

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties.

Stochastic processes and system models: Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non-sequence model, Gaussian white process.

Optimal prediction for discrete linear systems: problem statement, optimal filtering for discrete systems.

Optimal smoothing for discrete linear system, classification of smooth estimates, fixed interval smoothing, fixed point smoothing, fixed lag smoothing, single and double stage optimal smoothing.

Optimal estimation for continuous linear systems: problem formulation, optimal filtering and prediction, optimal fixed interval smoothing.

Text Books:

1. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company,1969.
2. Dan Simon, "Optimal State Estimation", Wiley Intersience,2006.

Reference Books:

1. K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989.
2. U. Mackenroth, Robust Control Systems Theory and Case Studies, Springer 2010.

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DIGITAL CONTROL SYSTEMS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand Z-transform and its properties.	1,11/1	2
2	Analyze systems in frequency domain using Z transform.	1,11/1	4
3	Analyze the basic compensators for discrete time systems .	1,11/1	4
4	Analyze the state controllers for discrete-data control systems.	1,11/1	4

Syllabus:

Introduction: sampling process, signal re-construction difference equations, Z–Transforms, inverse Z transform, properties of Z Transform, Z transformer function. Z transform analysis of sampled data control systems: Z Transfer function of OH, closed loop transfer function of discrete systems, Response of linear discrete systems. The Z and s-domain relationship, Stability analysis of discrete systems using Jury's method.

Compensation techniques of discrete system: Time domain technique of designing compensator. Frequency domain technique of designing compensator. Bilinear transformation: Root locus using bilinear transformation, Routh's criterion using bilinear transformation for discrete systems.

State variable methods in discrete time systems: state description of digital systems. Conversion of state variable models to Z Transform function, Eigen values and eigenvectors, solution of state difference equations, controllability and observability of discrete systems. Digital control systems with state feedback, state regulator design, design of state observers, reduced order observers, Compensator design by separation principle.

Text books:

1. M.Gopal, "Digital control and state variable methods", Tata McGraw Hill Publishers,2008.
2. B.C.Kuo, "Digital control systems" , Second edition,Oxford University Press, 2012.
3. Digital Control of Dynamic Systems, Gene F. Franklin, J. David Powell and Michael Workman, 3rd Edition., Ellis-Kagle Press, 1997.

Reference books:

1. Digital Control System Analysis and Design, 3rd ed., Phillips and Nagle, Pearson Publishers, 1994.
2. Digital Control of Dynamic Systems, 3rd ed., Franklin and Powell, Ellis-Kagle Press, 2006.

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PROGRAMMABLE LOGIC CONTROLLER

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the basics of Programmable Logic Controller	5,9/1	2
2	Apply the basic ladder programming for process control	5,9/2	3
3	Understand Registers and Functions of PLC	5,9/1	2
4	Understand data handling functions of PLC	5,9/1	2

Syllabus:

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.
Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

PLC Functions: Timer functions & Industrial applications, counter function & industrial applications, Arithmetic functions, Number comparison functions, number conversion functions

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

Text Books:

1. Programmable Logic Controllers by W. Bolton, 5th Edition, Elsevier, 2010.
2. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI.

Reference Books:

1. Programmable Logic Controllers- Programming Method and Applications –JR. Hackworth &F.D Hackworth Jr. –Pearson, 2004.

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DSP PROCESSORS

Mapping of Course Outcomes with Program Outcomes/ Program Specific Outcomes:

CO. No.	Course outcome	PO/PSO	BTL
1	Understand the basic concepts of Digital Signal Processing	1, 4/1	2
2	Understand various number systems	1, 4/1	2
3	Understand various architectures for programmable DSP devices	1, 4/1	2
4	Apply the Programming concepts of Digital Signal Processor to on chip/off chip peripherals	1, 4/2	3

Syllabus:

Digital signal processing: Introduction, Digital Signal processing system, sampling process, discrete time sequences. Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), linear time-invariant systems.

Numbering Systems: Floating, Integer and Fixed point Processors, IEEE-754 Floating-Point Format, Q-Format.

Architectures for programmable DSP devices: Architecture for two selected DSPs, Pipelining process of instructions, Read and write operations, Interrupts, Timers.

Programming for DSP processor (TMS320F28335/F2812): Code composer studio, implementation of small programs like Digital I/O, PID control, Digital Filters, Timer and interrupts, PWM signal generation, Analog to Digital Conversion

TEXTBOOKS:

1. Sanjit K Mitra , "Digital Signal Processing", Tata Mc-Graw Hill Publications.
2. J G Proakis, D G Manolokis, " Digital Signal Processing Principles, Algorithms, Applications", PHI.
3. TMS320F28335 Manuals

REFERENCE BOOKS:

1. A V Oppenhiem, R W Schafer , "Discrete-Time Signal Processing", Pearson Education.
2. Emmanuel C Ifeacher Barrie. W. Jervis, "DSP- A Practical Approach", Pearson Education.
2. S. M .Kay, "Modern spectral Estimation techniques", PHI, 1997

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OPTIMAL CONTROL SYSTEMS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the concepts of optimal control theory.	1,5/1	2
2	Understand the calculus of variations.	1,5/1	2
3	Apply dynamic programming principles for optimal control problem.	1,5/2	3
4	Applythe solution of Riccati equation to optimal control problem.	1,5/2	3

Syllabus:

Introduction: Formation of optimal control problem, Minimum time, Minimum Energy, Minimum fuel, state regulator problem, output regulator problem, tracking problem.

Calculus of variations: Minimization of functions, minimization of functional, Functional of a single function; Fixed end points problem, Terminal time t_1 specified, $x(t_1)$Free, Terminal time t_1 free, $x(t_1)$Specified. Both the terminal time t_1 and $x(t_1)$ free. Constrained minimization,formulation of variation calculus using Hamiltonian method. Minimum principle, Control variable inequality Constraints Control and state variable inequality constraints.

Dynamic Programming: principle of invariant imbedding, principle of optimality multistage decision process in continuous time.

Optimal feedback control:continuous time linear state regulator, Numerical solution of Riccati equation. Output regulator problem, tracking control scheme,proportional plus integral state feedback.Sub Optimal Linear regulators: Continuous time systems, Minimum time control linear invariant systems.

Text Books:

1. M.Gopal "Modern Control System Theory", New Age International Publishers,2005.
2. Anderson B.D.O and J.B Moore, "Optimal Control Linear Quadratic Methods", Prentice Hall Information and System Sciences Series,1989.

Reference Books:

1. A.P.Sage and C. C. White, III: Optimum Systems Control (2nd Ed.),Prentice Hall, 1977.
2. D.E.Kirk: Optimal Control Theory: AnIntroduction,Prentice Hall,1970

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AI APPLICATIONS IN ELECTRICAL ENGINEERING

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Comprehend the concepts of feed forward neural networks	5,9/1	2
2	Analyze the various feedback networks	5,9/1	4
3	Understand the concept of fuzzy systems	5,9/1	2
4	Understand the Rule base & defuzzification	5,9/1	2

Syllabus:

ARTIFICIAL NEURAL NETWORKS: Introduction, Biological Neuron, Artificial Neuron, Basic concepts of Neural Networks, Basic Models of ANN Connections, McCulloch-Pitts Model, Characteristics of ANN, Applications of ANN. Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

SUPERVISED LEARNING NETWORKS: Perceptron Network, Perceptron Learning Rule, Architecture, Perceptron Training Algorithm, ADALINE, MADALINE, Back Propagation Network, BP Learning Rule, Input Layer Computation, Hidden Layer Computation, Output Layer Computation, Radial Basis Function.

ASSOCIATIVE MEMORY NETWORK Training Algorithms for Pattern Association, Auto Associative Memory Network, Hetero Associative Memory Network, BAM, Hopfield Networks.

CLASSICAL & FUZZY SETS Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

FUZZY LOGIC SYSTEM COMPONENTS: Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Text Books:

1. Principles of – Soft Computing by S. N. Sivanandam and S. N. Deepa, Wiley India Edition.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publications.
3. Nureal networks by Satish Kumar , TMH, 2004. 4. Neuro Fuzzy and Soft Computing by J. S. R. Jang, C. T. Sun and E. Mizutani, Pearson Education.

Reference Books:

1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Fuzzy Logic with Engineering Applications by T. J. Ross, 2nd Edition , Wiley India Edition.
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.
5. Genetic Algorithms by D. E. Goldberg, Addison – Wisley, 1999

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ENERGY CONSERVATION & AUDIT

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the energy auditing methods and types of tariffs	1,8/1	2
2	Apply the energy conservation techniques to power system elements	1,8/2	3
3	Apply the energy conservation opportunities to air conditioning, refrigeration and air compressor systems	1,8/2	3
4	Apply the energy conservation opportunities to heating and cogeneration systems	1,8/2	3

Syllabus:

System approach and End use approach to efficient use of Electricity: Electricity tariff types; Energy auditing; Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models- Energy auditing of a typical industrial unit-case study

Electric motors- Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient / high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies-optimal selection and sizing – Optimal operation and storage; Case study

Transformer Loading/Efficiency analysis, feeder/cable loss evaluation, case study. Reactive power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-placement-Maintenance, case study; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study;

Lighting-Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study;

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study; Electric loads of Air conditioning & Refrigeration-Energy conservation measures-Cold storage, Types –Optimal operation –case study; Electric water heating-Gysers-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls-software's-EMS.

Text books:

1. Giovanni and Petrecca "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999)
2. Anthony J.Pansini, Kenneth D.Smalling "Guide to Electric Load Management", Pennwell pub (1988)

Reference books:

1. Howard E.Jordan "Energy-Efficient Electric Motors and their applications", Plenum pub corp; (1994)
2. Turner, Wayne C, Lilburn, "Energy Management Hand book" The Fairmont press, 2001
3. Albert Thumann "Handbook of Energy Audits ",5th edition, Fairmont Pr; (1998)
4. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.

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RENEWABLE ENERGY RESOURCES

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand the solar thermal applications and solar photovoltaic cells.	1, 8/1	2
2	Understand the operation and control of wind energy systems	1, 8/1	2
3	Understand the operation of ocean thermal energy conversion system	1, 8/1	2
4	Understand the operation of bio fuel system	1, 8/1	2

Syllabus:

Solar Energy System: Extra-terrestrial solar radiation, terrestrial solar radiation, solar thermal conversion,flat plate and concentrated solar thermal collectors, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models.

Wind Energy System: Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, yaw control, pitch control and stall control mechanisms, derivation of power coefficient.

Ocean Thermal Energy Conversion (OTEC) System: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system. Micro hydroelectric systems- different types of turbines.

Bio Fuel Systems: Origin and types, Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, power generation.

Biomass energy conversion technologies, Biogas generation – classification of Biogas plants.

Text books:

1. Godfrey Boyle "Renewable Energy", Oxford Publications, Second edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, First edition.

Reference books:

1. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power"ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg 2009.
2. John Twidell& Toney Weir: E&F.N. Spon, "Renewable Energy Sources", Taylor & Francis New York, 2nd edition.
3. John F.Walker&N.Jenkins, "Wind Energy Technology", John Willey and Sons Chichester, U.K – 1997

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HYBRID ELECTRICAL VEHICLES

Mapping of the Course Outcomes with Student Outcomes

C.O. No:	CO	PO/PSO	BTL
1	Understand the basics of conventional vehicle and history of HEV	1,10/1	2
2	Discriminate various motors used for HEV	1,10/1	4
3	Identify various energy storage systems for HEV	1,10/1	2
4	Understand the function of EMS in HEV	1,10/1	2

Syllabus:

Introduction to Hybrid Electric Vehicles:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency
analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Energy Storage System: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. **Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

References Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.
3. Iqbal Hussain, CRC Press, Taylor & Francis Group, Second Edition (2011).

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ENERGY STORAGE SYSTEMS

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Understand different types of batteries and their modelling	1, 2, 5/1	2
2	Understand the basics of fuel cell and their working principle, characteristics. It also introduces different types of fuel cell types	1, 2, 5/1	2
3	Understand different concepts of Ultra Capacitors and their developments	1, 2, 5/1	2
4	Understand the basic concept and operating principles of Fly Wheel energy storage systems and hybridization of energy storage	1, 2, 5/1	2

Syllabus:

Batteries: Introduction - Battery Parameters- Lead Acid Batteries - Nickel-based Batteries- Sodium-based Batteries - Lithium Batteries - Metal Air Batteries - Battery Charging - Battery Modelling.

Fuel cells: Basics Fuel cell definition, difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of Fuel Cells Fuel cell types: alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell.

Ultra-Capacitors: Background of Ultra-Capacitors- Electric Double-Layer Capacitors - Ultra-Capacitor Macro (Electric Circuit) Model - Ultra-Capacitor's Energy and Power- Ultra-Capacitor's Charge/Discharge Methods- Frequency Related Losses- Ultra-Capacitor's Thermal Aspects- Ultra-Capacitor High Power Modules- Ultra-Capacitor Trends and Future Development.

Hybridization of Energy Storages: Concept of Hybrid Energy Storage- Passive and Active Hybrid Energy Storage with Battery and Ultra-capacitor.

Flywheel energy storage: Operation Principles of Flywheels- Power Capacity of Flywheel Systems- Flywheel Technologies

Text Books:

1. MehrdadEhsani, Yimin Gao, Ali Emadi,"Modern Electric, Hybrid Electric and Fuel Cell Vehicles -Fundamentals, Theory and Design", II Edition, CRC Press, Taylor and Francis Group.
2. Hand Book of Fuel Cells - Fundamentals and Technology and Application, Wiley & Sons Publishers (2009).

Reference Books:

1. Petar J. Grbovi´c, "Ultra-Capacitors in Power Conversion Systems- applications, analysis and Design from theory to Practice", Wiley IEEE Press, 2014
2. James Larminie , John Lowry , "Electric Vehicle Technology Explained", John Wiley & sons, 2003.

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SYSTEM RELIABILITY CONCEPTS

Mapping of the Course Outcomes with Student Outcomes

CO No:	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
1	Understand the concepts of basic reliability theory.	1,5/1	2
2	Apply the network modeling for reliability evaluation.	1,5/2	3
3	Apply the concepts of time dependent probability for reliability measurements.	1,5/2	3
4	Apply concepts of discrete/continuous markov chains and process for limiting state probability evaluation.	1,5/2	3

SYLLABUS:

Basic Probability Theory: Basic concepts – Rules for combining Probabilities of events – Failure Density and Distribution functions – Bernoulli's trials – Binomial distribution – Expected value and standard deviation for binomial distribution – Examples.

Network Modeling and Reliability Evaluation: Basic concepts – Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability / Unreliability using conditional probability method – Paths based and Cutset based approach – complete event tree and reduced event tree methods - Examples.

Time Dependent Probability: Basic concepts – Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve – Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems - Partially redundant systems - Evaluation of reliability measure – MTTF for series and parallel systems – Examples.

Discrete Markov Chains & Continuous Markov Processes: Basic concepts – Stochastic transitional Probability matrix – time dependent probability evaluation – Limiting State Probability evaluation – Absorbing states – Markov Processes - Modelling concepts – State space diagrams – time dependent reliability evaluation of single component repairable model – Evaluation of Limiting State Probabilities of one, two component repairable models – Frequency and duration concepts – Frequency balance approach - Examples.

Text Books:

1. System Reliability Concepts by V.Sankar, Himalaya Publishing House, 2015.
2. 1. Reliability Evaluation of Engineering Systems by Roy Billiton and Ronald N. Allan, Reprinted in India B. S. Publications, 2007.

Reference Books:

1. Reliability Engineering by E.Balagurusamy, Tata McGraw Hill, 2003.
2. Reliability and Maintainability Engineering by Charles E. Ebeling, Tata McGraw Hill, 2000.
3. Probability concepts in Electric Power system – G.J.Anders- 1st edition –1990 – John wiley&sons.S

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UTILIZATION OF ELECTRICAL ENERGY

Mapping of the Course Outcomes with Student Outcomes

C.O. No.	Course outcome	PO/PSO	BTL
1	Identify the motor ratings for different applications	1, 8/2	3
2	Understand the concepts of electric heating & welding.	1, 8/1	2
3	Compare various illumination methods	1, 8/2	3
4	Apply electrical traction to different services	1, 8/2	3

Syllabus:

Selection of Motors : Choice of motor, type of electric drives, starting and running characteristics– Speed control–Temperature rise–Applications of electric drives–Types of industrial loads–continuous–Intermittent and variable loads–Load equalization.

Electric Heating: Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating.

Electric Welding: Electric welding–Resistance and arc welding–Electric welding equipment– Comparison between AC and DC Welding.

Illumination fundamentals: Introduction, terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter–Sources of light.

Various Illumination Methods: Discharge lamps, MV and SV lamps – Comparison between tungsten filament lamps and fluorescent tubes–Basic principles of light control– Types of lighting, flood lighting–LED lighting.

Electric Traction: System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. Calculations of tractive effort– power – Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion.

Text books:

1. H. Partab, "Art & Science of Utilisation of Electrical Energy", Dhanpat Rai & Co.(P) Ltd.2012.
2. C.L. Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International (P) Limited, Publishers,2011.

Reference books:

1. "Utilisation of Electric Energy", E. Openshaw Taylor, Orient Longman, 2006.
2. "A Text Book on Power System Engineering", M. L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd., 2001.

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IPR & PATENT LAWS

Mapping of Course out comes with student out comes:

CO No	Course Outcome	PO/PSO	B T L
CO 1	Acquire the knowledge of intellectual property rights	1,5/1	2
CO 2	Describe the principles and regulatory affairs	1,5/1	2
CO 3	Develop documentation ,Protocols and Case Studies on Patents	1,5/2	3
CO 4	Compare various Case Studies on Patents	1,5/2	3

SYLLABUS

Intellectual Property Rights Patents and intellectual property rights (IPR): Definition, History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures. **Principles, Scope and Functions Of GATT&WTO** GATT- Historical perspective, objectives and fundamental principles, impact on developing countries. WTO-Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India-tasks and challenges.

Regulatory Affairs Indian contest-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M,U & Y. Related quality systems-objectives and guidelines of USFDA,WHO & ICH; Introduction to ISO series.

Documentation and Protocols Documentation: Types related to pharmaceuticals Industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation.

Case Studies on Patents

Case Studies on - Patents (Basumati rice, turmeric, Neem, and related medicinal plants and byproducts)

Textbooks:

1. S. H. Willig, Good manufacturing practices for Pharmaceuticals, Informa Healthcare (Oct 2000).

Reference books:

1. Industrial Property Rights: Vol. III-4, Kogan Pate, Kogan Pate, Kogan Page (May 1998).

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ENVIRONMENTAL POLLUTION CONTROL METHODS

CO No	Course Outcome	PO/PSO	B T L
CO 1	To identify the sources of Air pollution, effects and control methods.	1,5,11/1	2
CO 2	To Identify the sources of water pollution, effects and control methods.	1,5,11/1	2
CO 3	To identify the sources of solid waste and disposal methods.	1,5,11/1	2
CO 4	To identify the sources of noise pollution, effects and control methods.	1,5,11/1	2

SYLLABUS:

Air pollution: Sources, Types, and effects and Fate of air pollutants. Meteorological factors and their impacts on pollutants dispersal.Sampling and measurement of air pollutants.Air quality standards.Air pollution control methods for particulates and gaseous pollutants.Emission Control equipment for particulate and gaseous matter.**Water pollution:** Sources, Types and Effects of Water pollutants. Measurement of pollution loads: DO, BOD, COD, TOC - Water quality and Effluent discharge standards. Role of Microorganisms in wastewater treatment.Bacterial population dynamics- growth kinetics.Pre-treatment, primary treatment, secondary and tertiary treatment of wastewater. Low cost treatment unit processes. **Solid waste:** Sources and types of Solid wastes – Disposal methods: Land filling - Composting - Incineration – Pyrolysis. Reclamation of polluted and degraded soil by Bioremediation- Phyto-remediation. Human acoustics, Sound and its general features- Noise and its measurement - Noise pollution hazards -Control methods.

Text Books:

1. Environmental Pollution Control Engineering by C.S.Rao (2006), New Age International (P)Limited Publishers, New Delhi.
2. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous(1985), Mc Graw-Hill International Editions, NewYork.

ReferenceBooks:

1. Sewage Disposal And Air pollution Engineering by S.K. Garg, Khanna publishers, New Delhi, 2010.
2. Waste water Engineering by M.N Rao and A.K Dutta, Oxford & IBH Publishing Co.Ltd, 2000.
3. Air Pollution by M.N Rao and H.V.N Rao, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000.
4. Environmental Engineering by Davis Cornvel, McGraw Hill Book Co., New York, 2000.
5. Waste Water Engineering by Met Calf &Eddy, McGraw Hill Book Co., New York, 2006.

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SOLID AND HAZARDOUS WASTE MANAGEMENT

CO No	Course Outcome	PO/PSO	B T L
CO 1	Understand the importance types, sources and disposal methods of Solid waste Management.	1,5/1	2
CO 2	To understand the importance of conversion and recycling of waste.	1,5/1	2
CO 3	Understand the types and Sources of Hazardous waste	1,5/1	2
CO 4	Understand the disposal methods of Hazardous waste	1,5/1	2

SYLLABUS

Solid wastes: Sources, Types, reasons for increase in generation, composition and properties of solid waste, Collection and on-site handling, Separation and processing. Solid waste disposal methods, Land filling, methods of land filling, Design of Landfills, gas production, Leachate and its control.

Conversion and recovery:Incineration, Pyrolysis, Composting methods, merits and demerits, Energy recovery, Bio methanation, use of refuse derived fuels (RDF).

Hazardous Waste, Definition, Sources, Classification, Hazardous wastes rules, and Nuclear waste, Biomedical wastes, Chemical wastes, disposal methods, Waste minimization. Treatment methods, Physico-chemical processes, Biological methods, Stabilization and Solidification, Thermal methods, Disposal methods Land disposal.Remedial technologies.

TEXT BOOKS:

1. Solid waste Engineering by P.AarneVesilind , William Worrell & Debra Reinhart, Cengage Learning India Pvt. Ltd, New Delhi
2. Environmental pollution control Engineering by C. S. Rao; New age International Publishers, New Delhi.

REFERENCE BOOKS:

1. Venkatappa Rao. G and Sasidhar. R.S.(2009), Solid waste management and Engineered Landfills, Sai Master Geoenvironmental Services Pvt.Ltd, Hyderabad
2. World Health Organization, Global Water Supply and Sanitation Assessment 2000 (Geneva2000).
3. Environment and Pollution Laws: Universal, Universal Law Publishing Co. Pvt.Ltd, Ed 2011.
4. Solid and hazardous waste management by M.N.Rao and Razia Sultana, BS Publications, Hyderabad.

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REMOTE SENSING AND GIS

CO No	Course Outcome	PO/PSO	B T L
CO 1	To get the Knowledge of Remote sensing Technology.	1,5/1	2
CO 2	Strong base of knowledge to Integrate the Remote sensing and GIS	1,5/1	2
CO 3	Design of Geospatial Information systems using RS	1,5/2	6
CO 4	Design of Geospatial Information systems using GIS in solving societal problems	1,5/2	6

SYLLABUS

Remote sensing basic definition and process, Passive and active remote sensing.Electromagnetic Spectrum, Resolution, Characteristics of Various sensors and satellites, Fundamentals of Image Processing. Map as a model, Spatial elements and terminology, Map scale, Spatial referencing system, Computers in map production, General software's in map production. Types of data products; Image interpretation strategy, Levels of interpretation keys; Topography, Types of Drainage Pattern and Texture, Erosion, ; Basic elements of image interpretation. Overview on visual image interpretation equipment. -

A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels/scales of measurement. The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing. Stages of GIS data modeling; Raster and Vector data representation, Spatial data models; Data editing, Detecting and correcting errors, Data reduction and generalization Edge matching and Rubber sheeting, Components of data quality, Sources of error in GIS.

Land use /Land cover studies, slope mapping, preparation of structures map, Ground water prospects mapping, Watershed management and Action plan, Water quality modeling, Salt Water intrusion models, pipeline alignment studies, Solid and hazardous waste disposal site selection, Landslides mapping, Urban planning and Management, GPS applications.

Text Books:

1. Remote Sensing and Image Interpretation- 5th Edition by Lillesand, Kiefer and Chipman, Published byJohn Wiley and Sons, Inc, New York, 20072.
2. Text book of Remote sensing and GIS – 3rd Edition by M. Anji Reddy, BS Publications, Hyderabad, 2010.

Reference Books:

1. Geoinformatics for Environmental management" by M. Anji Reddy, B.S Publications, Hyderabad
2. Remote Sensing and GIS- by B. Bhatia Published by Oxford University Press, 2009

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DISASTER MANAGEMENT

CO No	Course Outcome	PO/PSO	B T L
CO 1	Define and describe types of disasters, related hazards and the causes for disasters	1,5/1	2
CO 2	Know the effects, remedial measures, mitigation measures to be taken with respect to the kind of disaster that occur.	1,5/1	2
CO 3	To know about the disaster risk, reduction and the various organisations involved with related to disasters	1,5/1	2
CO 4	To know about the vulnerability and mitigations of various disasters with the help of case studies	1,5/1	2

SYLLABUS

Introduction and Concept of disasters and hazards related to Earthquakes, Tsunami, Volcanic eruption, Cyclones, Floods, Drought, Landslides, Forest fires, Avalanches and Pest infestation. Prediction and perception of hazards and adjustments to hazardous activities; Rates of natural cycles and residence time. Landslide: causes, prevention and correction. Landslide hazard mitigation. Earthquakes: intensity and magnitude of earthquakes; geographic distribution of earthquake zones; precursors to the earthquakes, seismic waves, travel-time and location of epicentre; nature of destruction; ground subsidence; protection from earthquake hazards; do's and don'ts during earthquake; Tsunamis causes and consequences. Floods: Causes, nature and frequency of flooding: nature and extent of flood hazard; urban floods, environmental effects of flooding; flood mitigation methods. Tropical cyclone- formation and consequences.Coastal erosion; sea level changes and its impact on coastal areas. Drought: Nature and effect on plant and animal systems. Study of pattern and mitigation of forest fires.Geological and environmental investigations for the construction of dams, bridges, highways and tunnels.Impact of major geotechnical projects on the environment. Disaster Management: Capability- Vulnerability- risk- preparedness and mitigation- Disaster management cycle; Disaster Risk Reduction and Resilience; Disaster Management Act and Policy. Disaster Management case studies.

Text books:

1. Environmental Hazards by Smith, K., Routledge, London,1992.
2. Geological Hazards by Bell, F.G., Routledge, London,1999.

Reference books:

1. Principles of Engineering Geology by Krynine, D.S. and Judd, W.R., CBS, New Delhi, 1998.
2. Natural Hazards by Bryant, E., Cambridge University Press. London, 1985.
3. Landslide Disaster – Assessment and Monitoring Nagarajan, R., Anmol Publications, New Delhi, 2001.
4. Environmental risks and hazards by Cutter, Susan L., Prentice Hall of India, New Delhi.1999.
5. Bill Mc Juire, Ian Mason and C. Killburn (2002) Natural hazards and Environmental change, Oxford University Press, New York.
6. Gupta, Harsh K. (2003) Disaster Management, Universities Press (India) Pvt. Ltd

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FUNDAMENTALS OF DBMS

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the fundamentals of DatabaseManagementSystems.	1/1	2
CO2	Construct database tables using SQL	4/2	3
CO3	Apply various Normalization techniques and develop procedures and functions in PL/SQL	3/2	3
CO4	Apply the file storage structures in the Database Management and Transaction processing.	9/2	3

SYLLABUS

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types, **Data Modelling:** ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. **SQL:** Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, Embedded SQL- Writing functions and procedures with PL/SQL, Relational Model, Relational Algebra, Operators in relational algebra. **Normalization:** Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4th and 5th normal forms. File storage, Index structures, Indexing and hashing (Basics) Query Processing: Issues in query processing **Transaction Processing:** Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log, Concurrency control techniques: binary locks, exclusive locks, Lock based techniques, Timestamp based techniques,.

TEXT BOOKS:

1. Elmasri and Navathe, 'Fundamentals of Database Systems', 2008, 4th edition, Pearson Education. '

REFERENCE BOOKS:

1. Silberschatz, Henry F Korth, S. Sudarshan, "Database System Concepts:, 2003, Fifth Edition, Tata MCGraw-Hill.
2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 2004, second Edition, Tata MCGraw Hill.

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FUNDAMENTALS OF SOFTWARE ENGINEERING

CO.NO.	Course outcomes	PO/PSO	BTL
CO1	Comprehend software development life cycleand prepare SRS document	2/2	3
CO2	Implementing software design and development techniques using UML	2/1	4
CO3	Identify verification and validation methods in a software engineering project	2/2	3
CO4	Optimize the development process using CMMI Levels	2/1	4

SYLLABUS

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, software engineering, software process, software engineering practice, software myths. Process Models: Generic process model, prescriptive process models, specialized process models, unified process, personal and team process models, product and process. Agile development: Agility, agile process, extreme programming. Design issues: Software architecture, architectural styles, architectural design. Use cases, Classes, Relationships, common Mechanisms and their diagrams. Interfaces, Modelling techniques for Class & Object Diagrams. Behavioural Modelling: Interaction diagrams. Activity Diagrams. Software testing: A strategic approach to software testing, strategic issues, test strategies for conventional software, Black-Box and White-Box testing, validation testing, system testing. Software Process Improvement, SPI, The SPI process, The CMMI.

Text Books:

1. Roger S.Pressman ,"Software Enginering – A Practitioner's Approach 7th Edition, Mc Graw Hill,(2010).
2. Ian Sommerville, 'Software Engineering', Sixth Edition,Pearson Education,(2001).
3. Jim Arlow, Ila Neustadt, "UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design", 2nd Edition, Pearson, (2005).

Reference Books:

1. Craig Larman, "Applying UML and Patterns: An introduction to OOAD and design and interface deployment", Pearson, (2002).
2. Alan Dix, Janet Finlay, Gregory d Abowd, Russel Bealel,"Human Computer Interaction", 3rd edition, Pearson education, (2008).
3. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited,(2007).

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FUNDAMENTALS OF INFORMATION TECHNOLOGY

CO.NO.	Course outcomes	PO/PSO	BTL
CO1	Understand the architectural design of a computer and various basic concepts of operating systems	4,3,9/1	2
CO2	Understand programming fundamentals Analyse various software development methodologies	4,5/1	2
CO3	Understanding of database design and Apply various SQL commands and Transaction Processing.	2,6,5/1	2
CO4	Apply OOP and model for different case studies using UML	2,7/2	3

SYLLABUS:

Fundamentals of Computers: Introduction, Architecture, organization of a small computer, center Processing Unit, Execution cycle, Instruction categories, measures of CPU performance, Memory, Input/output devices, BUS-addressing modes. **System Software:** Assemblers, Loaders and linkers, compilers and interpreters. **Operating System:** introduction, memory management schemes, Process management, scheduling, threads. **Programming Fundamentals:** Problem solving with algorithms, Programming styles, coding Standards and Best practices, Introduction to C Programming, Testing and Debugging. Code reviews. **System Development Methodologies:** Software development Models. **User Interface Design:** introduction, the process, Elements of UI design & reports. **RDBMS:** Introduction, Data processing, the database technology, Data models **ER Modeling:** Concept, Notations, Extended ER features, Logical database design **Normalization:** Functional Dependency, Normal Forms. **SQL:** DDL statements, DML statements, DCL statements, writing Simple queries. **SQL tuning techniques:** Embedded SQL, OLTP. **Object oriented concepts:** Object oriented programming, relationship, Inheritance, Abstract classes, polymorphism, UMI Diagrams, Object Oriented Design Methodology. **Rational Rose Tool:** Application of OOC using Rational Rose Tool.

TEXT BOOKS

1. Andrew S. Tanenbaum, Structured Computer Organization,PHI,3rd ed.,1991
2. Siberschatz and Galvin, Operating System Concepts, 4th ed., Addision-Wesley,1995
3. Dromey R.G., How to solve it by Computers PHI,1994
4. Kernighan, Ritchie, ANSI C language PHI,1992
5. Wilbert o.Galitz essential Guide to user interface design john,wiley,1997
6. Alex Berson, Client server Architecture, McGrew Hill International,1994

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IMAGE PROCESSING

CO No.	Course Outcomes	PO/PSO	BTL
CO1	Understand the fundamental concepts of a digital image processing system and transformation techniques	1/ 1	2
CO2	Analyze image enhancement techniques in spatial and frequency domains.	2 ,3/ 1	4
CO3	Explore image restoration and compression techniques.	3/1	2
CO4	Comprehendimage segmentation, representations and description	1/ 1	4

SYLLABUS:

INTRODUCTION: Origin of Digital Image Processing, Fields that uses Digital Image Processing, Fundamental steps in Digital Image Processing, Components of an Image Processing System. **DIGITAL IMAGE FUNDAMENTLS:** Elements of Visual perception, Image sampling and Quantization, Basic relationships between Pixels, Linear and Non-linear operations. **DIGITAL IMAGE TRANSFORMS:** Image Transforms – The Discrete Fourier Transform, The FFT, Walsh, Hadamard, Discrete Cosine Transform, The Haar Transform, And the Slant Transform, **IMAGE ENHANCEMENT IN SPATIAL DOMAIN:** Some basic Grey level transformations, histogram processing, enhancement using Arithmetic/Logic operations, Smoothing Spatial Filters, Sharpening Spatial Filters.

IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Introduction to Fourier Transform and the Frequency Domain, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters.

IMAGE RESTORATION: Noise models, Restoration in the presence of Noise, only Spatial Filtering, Periodic Noise reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Inverse Filtering, Wiener Filtering, Least mean square Filtering.

IMAGE COMPRESSION: Fundamentals – Image Compression models – Error Free Compression, Lossy Compression.

IMAGE SEGMENTATION: Detection of discontinuities, Thresholding, Edge based Segmentation and Region based Segmentation.

IMAGE REPRESENTATIONS AND DESCRIPTION: Representation schemes, Boundary Descriptors, Regional Descriptors

Text books:

1. Rafael C Gonzalez, Richard E Woods," Digital Image Processing", Second Edition, Pearson Education Asia, 2002. (Chapter 1, 3, 4, 5, 6, 7, 8, 9)
2. Jorg Arndt, " DSP Algorithms for Programmers"(Chapter 3)
3. Gonzalez. R & Woods B.E.," Digital Image Processing", Addison Wesley Longman Pearson Education, 2000.

Reference books:

1. MilanSonka, Vaclav Hlavac and Roger Boyle, Image Processing Analysis and Machine Vision, Thomson learning, SecondEdition, 2001.
2. William J Prati, "Digital Image Processing", John Wiley & sons
3. Tinku Acharya, Ajoy K Ray, "Image Processing Principles and Applications Principles and Applications", Wiley- Inter science.

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LINUX PROGRAMMING

CO No:	CO	PO/PSO	BTL
1.	Understand the fundamental LINUX operating system and utilities.	1/1	2
2.	Develop shell scripts for solving logical problems	3,4/2	3
3.	Analyze the file System, Processes and Signals concepts	5/1	4
4.	Develop programs using various IPC mechanisms	5/2	3

SYLLABUS

Linux Utilities-File handling utilities, Security by file permissions, Process utilities ,Disk utilities Text processing utilities, and Backup utilities Sed- scripts, operation, addresses, commands, applications, Awk execution, field and records , scripts, operation, patterns, actions functions using system commands in awk.

Working with Bourne again Shell (bash) responsibilities, here documents , running shell script, Shell as a programming language, shell meta characters, Control structures, arithmetic in shell, examples Interrupt processing, functions, debugging shell scripts.

Files : file Concept , File System Structure, I nodes, File Attributes, File types Library functions ,standard and formatted I/O in C, stream errors Kernel support for files ,System calls, file descriptors, low level file access File structure related system calls (FILE APIS), file and record locking File and directory management-Directory file APIS, Symbolic links and hard links

Process concept, Kernel support for process, process attributes, process creation , waiting for a process, Process termination ,Zombie process, orphan process, Process APIs Introduction to signals, signal generation and handling ,Kernel support for signals, signal function, unreliable signals , reliable signals Kill ,raise, alarm, pause, abort, sleep functions

Introduction to IPC, pipes, FIFOs- Introduction to three types of IPC-message queues, semaphores and shared memory -Kernel support for messages, Unix system V APIs for messages- Client /Server example

Text Books:

1. Unix and Shell Programming , B. A. Forouzan and R.F Gilberg, Cengage learning
2. Unix Concept and Applications, 4th edn. SumitabhadasTMH
3. Beginning Linux programming 4th edn. N. Matthew , R stones Wrox Wiley India edn.

Reference Books:

1. Linux system Programming , Robot Love, O;Reilly, SPD
2. Unix Network Programming , W.R. Stevens , PHI
3. Unix Internals , U Vahalia , Pearson Education
4. Unix and shell Programming, S.G.Kochanand P.Word3rd edn.PearsoEdn.

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E-COMMERCE

CO No	CO	PO/PSO	BTL
1.	Understand the E-Commerce revolution, infrastructure andAnalyse various E-Commerce Business Models	1/1	2
2.	Understand the E-Commerce payment systems, Buildingan E-commerce website and its online security	1/1	2
3.	Understand the Marketing communications and understandthe Ethical, Social and Political issues in E-Commerce	1,2/1	2
4.	Understand the supply chain management, Internet resourcesandapplications for E-Commerce	5/1	2

SYLLABUS

Electronic Commerce: Revolution. E-Commerce Business models and concepts: The Internet and World Wide Web: E-commerce infrastructure. Building an E-commerce web site, online Security and payment systems, E-Commerce Marketing concepts, , Ethical, Social and Political issues in E-Commerce, Retailing on the Web, Online Service industries, B2B E-Commerce: Supply chain management and collaborative commerce. E-Commerce Marketing communications, Internet Resources for Commerce: Technologies for Web Servers, Internet Applications for commerce, Internet Charges, Internet Access and Architecture, Searching the Internet

Text Books:

1. Kenneth C.Laudon, Carol G.Traver , E-Commerce, (Pearson Education)

Reference Books:

1. Daniel Minoli,EmmaMinoli,'Web Commerce Technology Handbook',(TMG)
2. Elias M.Awad'Electronic Commerce'(PHI)

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RENEWABLE ENERGY RESOURCES

Mapping of the Course Outcomes with Student Outcomes

CO No	Course Outcome (CO)	PO/PSO	BTL
CO1	Understand and analyze the solar thermal applications and solar photovoltaic cells	1,9/1	2
CO2	Analyze the performance of wind and tidal, wave and Ocean thermal energy conversion systems	2,5/1	4
CO3	Understand and analyze the operation of geothermal and bio energy conversion	1,9/1	2
CO4	Understand and analyze the Biogas digesters and bio power plants	1,9/1	2

SYLLABUS:

Solar Radiation: Extra-terrestrial solar radiation, terrestrial solar radiation, solar thermal conversion, flat plate and concentrated solar thermal collectors, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models.

Wind Energy: Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, yaw control, pitch control ans stall control mechanisms, derivation of power coefficient.

Energy from Oceans: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system. **Geothermal Energy:** Origin and types.

Energy from Bio mass: Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, and power generation, Biomass energy conversion technologies, Biogas generation – classification of Biogas plants, Micro hydro electric systems - different types of turbines.

TEXT BOOKS:

1. Godfrey Boyle "Renewable Energy", Oxford Publications, Second edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, First edition

REFERENCE BOOKS:

1. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power"ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg 2009.
2. John Twidell& Toney Weir: E&F.N. Spon, "Renewable Energy Sources", Taylor &Francis New York, 2nd edition.
3. John F.Walker&N.Jenkins, "Wind Energy Technology", John Willey and Sons Chichester, U.K –1997

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ENERGY ESTIMATION AND AUDIT

COURSE OUTCOMES (Cos):

CO No:	CO	PO/PSO	BTL
CO1	derstand the present power scenario in India and need for energy estimation and Audit.	PO2,PO10/ PSO1	2
CO2	derstand the operation of Induction motors and various energy conservation opportunities	PO2,PO10/ PSO1	2
CO3	Understand the basics of transformers, cables and their energy conservation opportunities.	PO2,PO10/ PSO1	2
CO4	Understand Lighting systems, pumping systems and their energy conservation opportunities.	PO2,PO10/ PSO1	2

SYLLABUS

Basics of Electrical Systems: Electrical power scenario in India, Structure of Electrical System, Energy billing, Electrical load management, Maximum demand control, Case studies on Domestic, Commercial and Industrial applications. **General Aspects of Energy Auditing**: Introduction - Types of Energy Auditing - Benefits of Energy Audit - Requirements to conduct Energy Audit - Methodology for Energy Audit - Energy Audit Report – Energy Conservation Building Code.

Induction Motors: Operation of Induction Motor - Special Design feature for high efficiency motor - Torque - Speed Characteristics - Operating parameters of motor - Losses - Measurement of efficiency - Determination of energy saving - determination of Load - Assessment of economic feasibility - choice of energy efficient motor - Effect of variation of voltage on the performance of motor - effect of load variations on efficiency and power factor - unbalanced phase voltage - insulation system.

Transformers and Cables: Transformers Introduction - Transformer Losses - Fixed Losses - Load Losses. Evaluation of Transformer Losses - Case Studies - reduction in Transformer Losses.Energy conservation opportunities in transformers. Cables: Introduction- Selection of Cable - Construction - Insulation - inner sheath - armouring - outer sheath - specifications - Tests- Installation. Energy conservation aspects.**Lighting**: Lighting terminology, Aspects of Lighting System Designing, Various means for Energy Saving - use of natural day light - reduction in light fixture - high efficiency lamps and luminaries – Constructional details of incandescent lamp, Construction and operation of Fluorescent tube light, Lighting energy audit.

Pumping Systems: Pumps classification, Pumping System characteristics, Pump curves - pump operating point - Factors affecting pump performance, Assessment of pumps, Energy Conservation Opportunities in Pumping Systems.

Text books:

1. Electrical Wiring, Estimating and Costing Dr.S.L.Uppal. Khanna Publishers.
2. Electrical Design Estimating and Costing.K.B.Raina&S.K.Battacharya. New age international (p) limited. Publishers.

Reference Books:

1. Energy Auditing in Electrical Utilities Rajiv Shankar. Viva Books First 2010.
2. Energy Engineering and Management AmlanChakrabarthi PHI Learning Pvt Ltd Second Printing 2011.

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ROBOTICS

CO No	Course Outcome (CO)	PO/PSO	BTL
CO1	Analyze the anatomy of existing robotic systems and their performance specifications, end effectors etc	PO3, PO5/1	4
CO2	alyze a robotic system with respect to the suitable sensors, actuators for its performance.	PO3/1	4
CO3	Understand manipulator kinematic analysis and joint trajectory plan for a given end effector.	PO3/1	2
CO4	Classification of Robot Languages, Comprehensive identification of suitable Robotic system for various applications.	PO5/1	4

SYLLABUS

Introduction to Robotics, Major components of a Robot, Robotic like devices, Classification of Robots – Classification by coordinate system and by control method, Specifications of Robots, Fixed versus flexible automation, economic analysis.

ROBOT END EFFECTORS: Introduction, End effectors, interfacing, types of End effectors, grippers and tools, considerations in the selection and design of remote centered devices.

ROBOTIC SENSORY DEVICES: Objective, Non-Optical position sensors – Potentiometers, Synchros, inductosyn, optical position sensors – opto interrupters, Optical encoders (absolute & incremental).

PROXIMITY SENSORS: Contact type, non-contact type – reflected light scanning laser sensors.

TOUCH & SLIP SENSORS: Touch sensors – proximity Rod & Photodetector sensors, Slip sensors – Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS: Objectives, homogeneous coordinates, basic transformation operations, forward solution – DenavitHartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution – problems involved, techniques.

Introduction to Trajectory Planning, the manipulator jacobian.

ROBOT APPLICATIONS: Industrial Applications – Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spray painting, grinding, Assembly and Inspection and Non-Industrial Applications.

ROBOT LANGUAGES: Introduction, AL, AML, VAL, RAIL

TEXT BOOKS

1. Robotic engineering by Richard D. Klafter, Prentice Hall India
2. Industrial robotics by MikellP.Groover, Mcgraw Hill Publications

REFERENCE BOOKS

1. Robotics – K.S. Fu, Gonzalez & Lee, Mcgraw Hill Publications
2. Robotics For Engineers by YoramKkoren, Mcgraw Hill Publications
3. Introduction to Robot Technology, - P.Coiffet and M.Chairenze / Kogam Page Ltd. 1983 London.

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OPERATIONS RESEARCH

CO No	Course Outcome (CO)	PO/PSO	(BTL)
1	odel and Solve for the optimum solutions using LPP	5/1	2
2	odel and Find the Optimized solutions for the problems in the field of Transportation and Management / Assignments.	5/1	2
3	odel and Optimize Game theory, Dynamic Part Programming, Queuing Theory , Inventory Control & Simulation Problems	5/1	2
4	Understand and solve the Concepts related to PERT/CPM	5/1	2

SYLLABUS

Introduction to Operation Research: Introduction, Modeling in Operations Research, Phases of OR study, Scope and application of OR. Linear Programming and its Applications: Linear Programming Problem – Graphical solution of LP Problem. Simplex method, Big M method, two phase methods, multiple solution, infeasible solution, unbounded solution, degeneracy, Dual Simplex method. Transportation: Introduction – Methods of basic feasible solution, Optimality test, Degeneracy in transportation problem, unbalanced transportation Problem, Assignment Problems: Hungarian method for assignment problem, Traveling salesman problem. Theory of Games: Introduction, to solve the rectangular two person zero sum games, solution of rectangular games in terms of mixed strategies, solution of 2x2 games without saddle point, solution of a two person zero sum 2Xn game, Graphical method for 2Xn and nX2 games.

Inventory Control: Introduction – EOQ with uniform rate of demand, Economic lot size with finite rate of replenishment, Quantity discounts, Deterministic model with Shortages, ABC analysis of inventory. Dynamic Programming: Introduction, Bellman's principle of optimality, application to shortest route problem, linear programming, tabular method. Queuing Theory: Introduction, single channel, Poisson arrival, exponential service time with finite population and infinite population, Simulation: Introduction, Monte-Carlo Simulation, Application to Inventory Control. Project Management by PERT/CPM: Introduction, simple network techniques, construction rules of drawing, Fulkerson's rule, Critical path method (CPM)- floats, critical path, project duration, PERT: Introduction, different Time estimates, expected time, variance, expected project duration and probability of completion. Crashing: Introduction, crashing of network, problem

Text Books:

1. Operations Research - HamdyTaha
2. Operations Research – Hiller &Liberman.

Reference Books:

1. Quantitative Techniques – A.P. Natarajan
2. Operations Research – S.D. Sarma

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NANO MATERIALS AND TECHNOLOGY

C.O. No.	Course outcome	PO/PSO	BTL
CO 1	Understand the essentials of nanomaterials and nanotechnology along with various methods used to fabricate nanomaterials. Also, recognize the several techniques used to characterize nanomaterials	1,5/1	2
CO 2	Understand the mechanical, optical & electrical properties of nanomaterials and also understand the concepts and applications of carbon based nanomaterials	1,5/1	2

SYLLABUS

Introduction : Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology-Definition, Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moore's law, Bottom up and top down approaches, challenges in Nanotechnology .

Nano materials : History of materials, Nanomaterials-Definition, Classification of Nanostructured materials, causes of interest in nanomaterials, some present and future applications of nanomaterials, Bio-Medical Applications-Drugs, Drug Delivery, Photodynamic therapy, Molecular motors, Neuro-Electronic Interfaces, Protein Engineering, Nanoluminescent tags.

Synthesis and processing of nanoparticles, thin films: Nanoparticles: Processes for producing ultrafine powders-mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Thin Films: Synthesis techniques- Physical Vapor Deposition: Evaporation, Molecular beam epitaxy, Sputtering. Comparison of evaporation and sputtering.

Special nanomaterials, characterization and tools: Carbon nanotubes, nano composites, carbon fullerenes-An overview over preparation, properties, applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Scanning Probe Microscopy– X ray Diffraction. MEMS: – Introduction, types of MEMS: - Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

TEXT BOOKS

1. Nano structures & Nano materials by Guozhongcao, Imperial college press.
2. Micro manufacturing and Nano Technology by N.P.Mahalik.

REFERENCE BOOKS

1. Nano Technology by Mark Ratner &Danier Ratner, Prentice Hall
2. Nano materials by A S Edelstein& R C Cammarata, Institute of physics publishing, Bristol and Philadelphia.

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SUB SEA ENGINEERING

CO No.	Course Outcome CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the subsea engineering, field development, distributions system used in subsea.	2/ 1	2
CO2	Understand the surface and subsurface equipment and control system in subsea	1/ 1	2
CO3	Understand the why normal conventional equipment is not utllized in subsea (well head, X trees, risers, pipelines)	2/ 1	2
CO4	Understand wax & asphaltenes management and remediation. Subsea Corrosion & Scale.	2/ 1	2

SYLLABUS

Overview of subsea engineering, subsea field development, distribution systems, subsea surveying positioning and foundation, installation of subsea equipment, subsea control, power supply, subsea hydraulics, subsea corrosion and scale, subsea connections and jumpers, subsea well heads and X-trees, subsea drilling risers, subsea production risers, subsea pipelines, subsea risk and reliability.

REFERENCE BOOKS:

1. Yong Bai, Qiang Bai, "Subsea engineering handbook", Gulf publishers, (2010)
2. Yong Bai, Qiang Bai, "Subsea pipeline and risers", Gulf publishers, (2005)
3. BoyunGuo, Shanhong Song, Jacob Chacko, Ali Ghalambor, "Offshore Pipeline", Gulf publishers, (2005)

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OIL AND GAS MANAGEMENT

CO No.	Course Outcome (CO)	PO/PSO	BTL
CO 1	Understand the global oil and gas market	6/1	2
CO 2	Understand the E&P activities, marketing and transportation of oil and gas	9/1	2
CO 3	Understand the refining activities, estimating the future of oil and gas industry	9/1	2
CO 4	Understand the marketing strategies of oil and gas products and exploration & production (E&P) policies of India	6,9/1	2

SYLLABUS

Global Oil and Gas: Value Chain and Geopolitics of Oil
The Upstream: Exploration, Development, and Production
The Midstream: Markets and Transportation
The Downstream: Refining and Marketing
The Future Oil and Gas Industry

REFERENCE BOOKS

1. Adedeji B. Badiru Samuel O. Osisanya, "Project Management for the Oil and Gas Industry", CRC Press, 2013.
2. Use Internet sources for present trends.

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SELF DEVELOPMENT

CO No.	Course outcome	PO/PSO	BTL
CO1	Illustrate and realign values based on goal.	1,5/2	3
CO2	Demonstrate various types of Yoga and identify commonalities of different religions.	1,5/1	2
CO3	Illustrate practices of different Schools of Meditation and self-motivated approach to pursue a balanced life	1,5/2	3
CO4	Demonstrate techniques of stress management and Self-management focused interest in a Spiritual Practice	1,5/1	2

SYLLABUS

Orientation, Discussion on Values : Understanding Values, Behavior and Attitudes, Application of Values and Universal Values, **Philosophy of Yoga :** God, Self and Ultimate goal of yoga, Brief Introduction to various types of yoga and Integration of values in Yoga, **Study of major Religions :** Identify commonality, condition of its origin or intention vs. current state, **Art of Meditation :** Observation, Introspection, Contemplation, Meditation and Concentration, Schools of Meditation, **Systematic Practice of Meditation:** Theories of life, Need for Meditation, Natural Path, Integration **Personal Responsibility:** Stress Management, Tips for Self-Management, Choices we make, Excellence.

TEXT BOOK

1. Self-development modules from Heartfulness Institute (www.heartfulness.org)

REFERENCE BOOKS

1. Complete works of Swami Vivekananda
2. Jonathan –Livingston - Seagull
3. The Monk Who Sold His Ferrari_Robin S. Sharma
4. You can win by shiv khera
5. Many lives Many Masters
6. The road less travelled – Scott Peck
7. As a man thinketh
8. Journey of the Soul
9. The Bhagavad-Gita
10. King James version of the Holy Bible
11. Holy-Quran

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EMOTIONALINTELLIGENCE

SYLLABUS

Course Objective: The main objective of the course is to enable the students understand meaning and importance of emotional intelligence.

Emotional Intelligence: The Concept, dimensions of emotions; Theories of Multiple intelligences; importance of emotions; emotions and the brain; The Role of Emotions in Organizations; Self-Awareness and Self-Control; Empathy; Social Expertness; Personal Influence.

Emotional Intelligence and Personality: relationship between EQ and IQ; human mind; consequences of low and high EQ; EQ development; Emotional Skills; emotional factors: Emotional Competency, Emotional Maturity, and Emotional Sensitivity.

Levels of EI: Models of Emotional Intelligence; emotional intelligence competencies; emotional intelligence and leadership behaviour; emotional intelligence and stress management; art of influencing people.

The Role of Emotional Intelligence in Professional Success: Emotional Intelligence and the Complexity of Work; Emotional Intelligence and High IQ Professions; Emotional Intelligence and Leadership; manage emotional upsets; Emotional 'Winner'.

EQ in the Indian Perspective; EQ and Managerial Effectiveness; the soft art of being a tough leader.

Textbooks:

1.Dalip Singh - Emotional Intelligence at Work: A Professional Guide – Response Books – 2006.

Reference Books:

1. Daniel Goleman, Emotional Intelligence, Bantam Books, 2006.
2. Moshe Zeidner, Gerald Matthews, and Richard D. Roberts, What We Know About Emotional Intelligence – How It Affects Learning, Work, Relationships, and Our Mental Health, The MIT Press, 2009.
3. James Bradford Terrell and Marcia Hughes, A Coach's Guide to Emotional Intelligence: Strategies for Developing Successful Leaders, Wiley, 2008.
4. Dr. Jeanne Segal, The Language of Emotional Intelligence, McGraw-Hill, 2008.

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PROFESSIONAL ETHICS AND VALUES

Syllabus:

Professional Ethics is the application of moral reasoning to established professions such as legal, medical, nursing, engineering, journalistic, and so on. Moral reasoning entails the search for values and principles that promote a good life and human flourishing. Professionals employ their expertise in ways that greatly affects the lives of others. It is critically important that professionals are thoughtful and reflective about the role of ethics in their work. Through successful completion of course readings andf assignments – and through active participation in class discussions – students will hopefully gain the tools to identify and analyze ethical issues.

Values in human society and types of values: Understanding of values; definition; culture and values; The wider applications of values; societal values; aesthetic values; organizational values; spiritual values;

Ethics and ethical values: Importance of values; value crisis at individual level, societal level, cultural level; social disorganization; value crisis management; Canons of ethics; types of ethics.

Professional ethics: Overview; ethics in engineering profession; code of professional ethics; organizational ethics; Violation of code of ethics: causes and consequences; Whistle blowing; Work place ethics, Women related issues; Industry and Industrialization: Problems of man-machine interaction; impact of assembly line and automation; industrial relations; ethics and industrial law.

Science, Technology and Engineering: Engineering as a profession; renewable and non-renewable resources; sustainable development; technology transfer; joint ventures of technology transfer and subsequent Indianization.

Environment and Eco-friendly technology: What is environment? Human development and environment; pollution and pollution control; Eco-friendly technologies, Green pactices.

Recommended Text Book(s):

1. Samita Manna and Suparna Chakraborti, 2010, **Values and Ethics in Business and Profession**, Published by Asoke K. Ghosh, PHI Learning Pvt. Ltd., M-97, Connaught Circus, New Delhi – 110001

Reference books:

1. William O' Donohue, Kyle Ferguson, 2003, **Handbook of Professional Ethics for Psychologists**, Sage Publications, Inc., California.
2. S. Dinesh Babu, 2007, **Professional Ethics and Human Values**, Laxmi Publications, Pvt. Ltd., 113, Golden House, Daryagunj, New Delhi-2.
3. Vaisali R. Khosla, Kavitha Bhagar, 2009, **Human Values and Professional Ethics,** first edition, Technical Publications, Pune.
4. R S Nagarazan, 2007, **A Text Book of Processional Ethics and Values**, New Age International.
5. A. Alavudeen, R. Kalil Rahman, M. Jayakumaran, 2008, **Professional Ethics and Human Values**, Laxmi Publications, Pvt. Ltd., 113, Golden House, Daryagunj, New Delhi

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BEHAVIORALSCIENCES

SYLLABUS

Introduction to BehaviouralScience;Foundations of Individual Behavior: Personality- Personality determinants; Personality traits: The Big Five Model, Major personality attributes influencing OB; Theories of personality; Values – Types of Values.

Learning- Theories of learning; Principles of learning; Attitudes – Source of attitudes; Types of Attitudes, Attitudes and consistency – Cognitive Dissonance theory.

Perception- Perceptual process; Factors influencing **Perception;** perceptual distortion; Linkage between perception and individual decision making; Motivation – Theories of Motivation – Hierarchy Needs Theory – Two-Factor Theory – Expectancy Theory; Applications of Motivation.

Foundations of Group Behavior: Groups – Nature of groups; Types of groups; Stages of Group Development; Group Cohesiveness; Teams vs Groups

Leadership – Nature; Leadership Styles; Theories of leadership: Trait Theories, Behavioral Theories and Contingency Theories.

Text Books:

1. Aswathappa, Organizational Behaviour, Himalaya Publishing House, 2010.

Reference books:

1. Robbins, Stephen, Timothy, A &Sanghi, S. Organizational Behavior, 13th Edn, Pearson Education. 2009.
2. Fred Luthans, Organizational Behaviour, Prentice Hall, 2007
3. UdaiPareek, Organizational Behavior, Oxford Publishers, New Delhi, 2008.

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PARADIGMS IN MANAGEMENT THOUGHT

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO.No	Course Outcome	PO/PSO	BTL
1	Understand the basic management concepts along with an insight into levels of management.	9/1	2
2	Understand the key contributions of classical approach to Management	12/1	2
3	Understand and apply Quantitative methods to improve Management performance.	9/1	2
4	Understand the key contributions of Behavioral and contemporary approaches to Management.	9,12/1	2

SYLLABUS:

Management Introduction - Early management thought - Management Concept – Nature - Management as art, science, profession - Scope and functions of Management - Levels of Management - Importance of management. **Classical Approach to Management: (a) Scientific Management-** The advent of Scientific Management – Frederick W Taylor's contributions, - Contribution by Henry L Gantt - Contribution by Frank, Lillian Gilberth. **General Administrative Approach**: Henry Fayol's contributions towards general management – Max Weber's Bureaucracy Approach. **Quantitative Approach:** Important contributions – TQM – implications in today's management – Six sigma.

Behavioral Approach: Organizational Behaviour – Contributions of Elton Mayo's – .Hawthorne studies – contributions of Mary Parker Follett – Chester Bernard.

Contemporary Approach: Systems Theory – Contingency Theory – Chao's Theory -Peter F Drucker Contributions – C K Prahlad's Contribution – Porter's theory – Worker Management – Employee Engagement – People Capability Maturity Model.

Recommended Text Book(s):

1. Management by Stephen P Robbins, Mary Coulter, Neeharika Vohra – Pearson – 10th edition

Reference Books:

1. Management by Stoner, Freeman, Gilbert – PHI – 7th edition.
2. Management A Global & Entrepreneurial Perspective – Weihrich, Cannice, Koontz – Mc Graw Hill – 13th Edition.
3. The evolution of management thought by Daniel A Wren, Arther G Bedeian : john wiley& sons

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INDIAN ECONOMY

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO.No	Course Outcome	PO/PSO	BTL
1	Understand the structure of Indian Economy	7/1	2
2	Understand the structural problems encountered by India	7/1	2
3	Develop a perspective approaches to economicplanning and development in India	7/2	3
4	Understand the role of the Indian Economy in the global context	7,12/1	2

SYLLABUS:

Economy: Meaning, types, problems and functions – Features of Indian Economy: Circular flow of economic activity: two sectors, three sector and four sector models. Sectoral distribution of the economy.Nature and features of Indian Economy; Sectoral contribution of National Income-Share of Public and Private Sectors in GDP. Agricultural Sector of India: importance and general problems; Land Reforms, Agricultural marketing problems and remedies. Industrial Sector of India: Types, Importance and general problems: Small Scale Sector: Importance and general problems. Tertiary Sector in India- Importance – Infrastructure Development – Transport – Roadways, Railways – Banking and Insurance –Communication – Science and Technology – Software. Personal Income distribution and causes of inequality - Unemployment causes and remedial measures; Poverty in India- Poverty Line – anti poverty programs. Human development: concept and measurement - Human Development Index. Economic Planning in India: Role of Planning Commission - Over all Objectives and achievements of various Five Year Plans. 12th Five Year Plan; Economic Liberalisation: LPG strategy-General Agreement on Tariffs and Trade (GATT) - Objectives of GATT and Evolution of WTO – WTO and the Indian Economy, NABARD and World Bank.

Recommended Text Book(s):

1. G.Dutt and K.P.M.Sundaram: Indian Economy (2011), S.Chand&Co., New Delhi.
2. S.K.Mishra and V.K.Puri: Indian Economy, 30th ed., Himalaya Publishing House, New Delhi.
3. M.L.Jingan: Macro Economics, 6th ed., Konark Publishing House.

Reference Books:

1. P.K.Dhar, Indian Economy-Its growing dimension, Kalyani Publishers.
2. Alok Ghosh, Indian Economy, Its Nature and Problem, World Press.
3. A.N.Agarawal, Indian Economy- Problems of Development and Planning, New Age

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MANAGING PERSONAL FINANCES

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO .No	Course Outcome	PO/PSO	BTL
1	Understand the need for effective financial planning	12/1	2
2	Analyze the basic concepts of money management, tax planning, consumer credit, housing and other consumer decisions, insurance, investments, retirement planning etc.	12/1	4
3	Evaluate various financial tax saving schemes to save money to get tax benefits.	12/1	5
4	Design savings and investment plans.	12/2	6

SYLLABUS

Financial planning process: Introduction-Importance of Financial Planning- Process of financial planning -The planning environment-Determinants of personal income- Financial statements and plans-Concept of Time value of money - Preparing a personal balance sheet - Preparing the income and expense statement-Using personal financial statements - Ratio Analysis. **Managing Taxes:** Introduction-Importance of tax planning-Basic concepts of income tax - Personal taxation -Income tax benefits on certain long term investments -Tax planning-Ethical consideration in tax planning. **Making decisions regarding houses and automobiles:** - Meeting housing needs-The rental option - The home buying process - Financing the housing transaction - Housing finance institutions in India - Housing schemes in India- Automobile purchase planning. **Planning for Investments:** - Types of investment vehicles-Factors considered in the choice of investments- Developing the investment strategy-Investing in Equities- Investment Process- Investing in Fixed Income Securities- Bond Market-Bond Investing Strategies-Types of Bonds-Bond Returns- Risks from Investing in Bonds.**Insurance& Mutual Funds**:-Insurance planning - Buying a life insurance - Life insurance products in India- Health Insurance-Need-Types and Sources of health care plans-Providers of Health care-Long term care insurance-Disability income insurance-Health Insurance in India; Mutual funds – Types of mutual fund products – Objectives of investing in Mutual funds.

Recommended Text Book(s):

1. Jack R Kapoor, "Personal Finance" Mc Graw Hill Publications, New Delhi, 2008.
2. KC Mishra and Steward Doss, "Basics of Personal Financial Planning" Cengage Learning, First Edition 2009.

Reference books:

1. Joehnk, Billingsley and Gitman "Planning Your Personal Finances" Cengage Learning India Private Limited, Delhi, 2012.
2. Mark Hirschey and John Nofsinger "Investments Analysis" and Behavior" Mc Graw Hill Publications, New Delhi, 2008.

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BASICS OF MARKETING FOR ENGINEERS

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO.No	Course Outcome	PO/PSO	BTL
1	Understand the concepts of marketing, factors influencing the consumer behavior, decision making process and strategic areas of 4Ps	1/1	2
2	Apply the insight earned about consumer psychology in improving the demand of the product in the market.	1/2	3
3	Analyze the markets and consumers, the changing environmental factors with special focus on technology products	1/1	4
4	Create an appropriate strategy for the marketing of high-tech products and services	1/2	6

SYLLABUS:

Introduction and Nature of Marketing: Evolution of Marketing Concept - Core concepts of marketing - Scope and Importance of Marketing. -Difference between Selling and Marketing - Marketing Myopia - Consumer Marketing Vs. Industrial Marketing.

Understanding Consumer Behaviour: nature, scope and importance of consumer behavior – Factors influencing Consumer Behavior - Buying decision making process - Market Segmentation, Targeting and Positioning (STP).

Marketing mix - Product definition, levels of product, product classification, difference between goods and services, Product Life Cycle, New Product Development – Technology and Product Management - Concept of Pricing – Factors influencing the pricing policy – Pricing strategies - Pricing Considerations in High-Tech Markets.

Promotion mix - Marketing Communication Tools for High-Tech Markets - Channels of distribution - Supply Chain Management in High-Tech Markets - Technology Marketing, Green Marketing, Introduction to market study.

BoS Approved Text books:

1. Philip Kotler and Gary Armstrong- Principles of Marketing- 15/e, Pearson Education.
2. Jakki J Mohr, Sanjit Sengupta and Stanley Slater, Marketing of High-Technology Products and Innovations, 3/e Pearson India.

BoS Approved Reference Books:

1. V.S. Ramaswamy and S. Namakumari – Marketing Management, 4/e, Mc Millan Publications, New Delhi.
2. Rajan Saxena, Marketing Management- 3/e, TMH, New Delhi.

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ORGANIZATION MANAGEMENT

Mapping of Course Outcomes to Program Outcomes: The students will be able to

CO.No	Course Outcome	PO/PSO	BTL
1	Understand the theories and approaches of organizational management	9/1	2
2	Understand the basics of organization structure	9/1	2
3	Understand the methods for motivating in competitive business environment.	9/1	2
4	Understand the basic modes of maintaining good industrial relations	9/1	2

SYLLABUS:

Development of Management thought – Introduction, Various theories; Functional approach, scientific management approach, human relations approach, latest management thoughts, organisation theory-classical organisation, neo-classical organisation theory, modern organisation theory. Organization Structure--Principles of organisation, organizational theories, departmentalism, authority, power, organizing, organizational effectiveness, structuring the organisation, organizational change, organisation charts; types of organisations—line , functional and line and staff relations, Organisational manuals. Motivation, Morale and behavioural science—Motivation: Characteristics, importance, Kinds of motivation. Thoughts of motivational philosophy: Gouglass Mc Gregore—X and Y theory; Herzberg's theory. Human needs, Incentive as motivators, Managing dissatisfaction and frustration. Morale, Absenteeism, Behavioural science, Group dynamics, Group behaviour.Leadership—Meaning, importance, styles, theories, leaders Vs managers. Management concept—Management, Administration, Organisation, Difference and Relationship between Management, Administration and Organisation, Importance of Management, Characteristics of management, Managerial Skills, Managerial Objectives, Harmonization of Objectives, Hierarchy of Objectives. Industrial Relations, Trade Union and Collective Bargaining—Industrial relations, Industrial Psychology, Industrial disputes, Conflict management, Views about conflict, Labor Policy. Workers grievances, Suggestion system.Trade Unions. Collective Bargaining, Negotiations, Industrial Safety—working conditions, Accidents, Preventive measures, Safety training.

Text books:

1. Stephen P. Robins, Organizational behavior, PHI / Pearson education, 11^{t} edition, 2008.
2. Koontz &Wehrich., Essentials of Management, 12th edition, Tata Mc Grawhill, 2007.

Reference books:

1. Banga&Sarma , Industrial Engineering Management including Productionmanagement, 11th edition, 2010.
2. O.P. Khanna, Industrial engineering management, Khanna publications, 2006.

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RESOURCE, SAFETY AND QUALITY MANAGEMENT

Mapping of Course Outcomes to Program Outcomes: The students will be able to

S.No	Course Outcome	PO/PSO	BTL
1	Understand the basics systems of man power and materials management	5/1	2
2	Understand the basics systems of machinery management	5/1	2
3	Understand the basics systems of safety management	6/1	2
4	Understand the basics systems of quality management	5/1	2

SYLLABUS

Resource Management (Man Power, Materials & Machinery): Introduction; Resource smoothing; Resource Levelling, Establishing workers productivity; Objectives of material management; Functions of material management department; ABC classification of materials; Inventory of materials; Material procurement; Storage management; Classification of construction equipment; Earth moving equipment; Excavation equipment; Hauling equipment; Earth compaction equipment; Hoisting equipment; Concrete plant and equipment; Time and motion study; Selection of equipment – Task consideration, cost consideration; Factors affecting the selection; Factors affecting cost owning and operating the equipment; Equipment maintenance.
Safety and Quality Management: Accident prevention program; Immediate attention in case of accident; Approaches to improve safety in construction; Safety benefits to employees, employees and customers; Prevention of fire in construction industries; Fault tree analysis; Safety information system; Safety budgeting; Importance of quality; Elements of quality; Organization for quality control; Quality assurance techniques; Documentation; Quality control circles; Total quality management; ISO 9000 – 2008.

TEXT BOOKS:

1. Construction Engineering and Management by S.Seetharaman; Umesh Publications, NaiSarakl, Delhi.
2. Fundamentals of PERT/CPM and Project Management by S.K.Bhattacharjee; Khanna Publishers, NaiSarak; Delhi.

REFERENCE BOOKS:

1. Construction Management and Planning by B.Sengupta and H.Guha; Tata Mc.Graw-Hill Publishing Co. Ltd., New Delhi.

Construction Planning, Equipment and Methods by Peurifoy R.L; MC Graw-Hill International Book Company

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Annexure-III

Course structure and Syllabus Revision for 2018-19 M.Tech-PS programs

I		Course Code	Course Title	L	T	P	Cr
1	PCC	18EE5101	Power System Dynamics & stability	3	1	0	4
2	PCC	18EE5102	Advanced Power System Analysis	3	1	2	5
3	PCC	18EE5103	Deregulated Operation of Power Systems	3	1	0	4
4	PCC	18EE5104	Modern Control Theory	3	1	0	4
5	PCC	18EE5205	Real Time Control of Power System	3	1	2	5
6	PCC	18EE5206	AI Techniques in Power Systems	3	1	0	4
7	PCC	18EE5207	Smart Grids Technologies	3	1	0	4
8	PCC	18EE5208	Digital Protection of Power Systems	3	1	0	4
9	PEC		Elective – 1	3	0	0	3
10	PEC		Elective - 2	3	0	0	3
11	PEC		Elective – 3	3	0	0	3
12	PEC		Elective - 4	3	0	0	3
13	PRI	18IE5149	Seminar	0	0	4	2
14	PRI	18IE5250	Term Paper	0	0	4	2
15	PRI	18IE6050	Dissertation	0	0	72	36
Total Credits							**86**
Professional Elective-1							
	1	18EE51A1	Reactive Power Compensation & Management	3	0	0	3
	2	18EE51A2	Distribution System Planning & Automation	3	0	0	3
	3	18EE51A3	Power System Reliability	3	0	0	3
Professional Elective-2							
	1	18EE51B1	Alternative Sources of Electrical Energy	3	0	0	3
	2	18EE51B2	Digital Signal Processors and Applications	3	0	0	3
	3	18EE51B3	Optimization Techniques	3	0	0	3
Professional Elective-3							
	1	18EE52C1	FACTS DEVICES	3	0	0	3
	2	18EE52C2	Energy Conservation & Audit	3	0	0	3
	3	18EE52C3	Adaptive Control Systems	3	0	0	3
Professional Elective-4							
	1	19EE52D1	EHVAC & HVDC Transmission	3	0	0	3
	2	18EE52D2	Power Quality	3	0	0	3
	3	18EE52D3	Integration of Energy Sources	3	0	0	3

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2. Course structure and Syllabus Revision for 2018-19 M.Tech-Power Systems

Sl	Course Code	Course Name	Cat	L	T	P	S	Cr	Pre-Requisite	New Course/Revised Course/ Retained Course	Changes Proposed by	Focused on Employability/ Entrepreneurship / Skill Development	Justification
1	18EE5101	Power System Dynamics & stability	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
2	18EE5102	Advanced Power System Analysis	PC	3	1	2	0	5	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
3	18EE5103	Deregulated Operation of Power Systems	PC	3	1	0	0	4	Nil	New	Contemporary	Employability	Covers the advanced topics which enable employability in the core sector and further study
4	18EE5104	Modern Control Theory	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
5	18EE5205	Real-Time Control of Power System	PC	3	1	2	0	5	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
6	18EE5206	AI Techniques in Power Systems	PC	3	1	0		4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
7	18EE5207	Smart Grids Technologies	PC	3	1	0		4	Nil	NEW	Contemporary	Employability	Covers the advanced topics which enable employability in the core sector and further study

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8	18EE5208	Digital Protection of Power Systems	PC	3	1	0		4	Nil	NEW	Industry expert	Employability	Covers the advanced topics which enable employability in the core sector and further study
9	18EE51A1	Reactive Power Compensation & Management	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
10	18EE51A2	Distribution System Planning &	PE	3	0	0	0	3	Nil	New	AcademicPeer	Employability	Covers the advanced topics which enable employability in the core sector and further study
11	18EE51A3	Power System Reliability	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
12	18EE51B1	Alternative Sources of Electrical Energy	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
13	18EE51B2	Digital Signal Processors and Applications	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
14	18EE51B3	Optimization Techniques		3	0	0			Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
15	18EE52C1	FACTS Devices	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
16	18EE52C2	Energy Conservation & Audit	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study

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17	18EE52C3	Adaptive Control Systems	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
18	18EE52D1	EHVAC & HVDC	PE	3	0	0	0	3	Nil	New	Industry Expert	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
19	18EE52D2	Power Quality	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
20	18EE52D3	Integration of Energy Sources	PE	3	0	0			Nil	New	Academic Peer	Employability	Covers the advanced topics which enable employability in the core sector and further study
21	18IE5149	Seminar	PRI	0	0	4		2	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
22	18IE5250	Term Paper	PRI	0	0	4		2	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
23	18IE6050	Dissertation	PRI	0	0	7		36	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving

Percentage of Courses focusing on Employability= 18/23=79.78.26%

Percentage of Courses focusing on Entrepreneurship= 2/23=0.086%

Percentage of Courses focusing on Skill Development = 3/23=13.043%

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3, Syllabus of NEW COURSE for Y18 M.Tech-Power System admitted students

Course Code	Course Name	Cat	New Syllabus	Topics Added/ Removed/ Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
18EE5103	Deregulated Operation of Power Systems	CORE	**Key Issues in Electric Utilities** Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion. Open Access Same-time Information System (OASIS) Structure of OASIS - Posting of Information – Transfer capability on OASIS. **Available Transfer Capability (ATC)** Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. **Electricity Pricing** Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Locational Marginal Pricing - Construction of Forward Price Curves – Short-time Price Forecasting. **Power System Operation in Competitive Environment** Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets Operational Planning Activities of a GENCO. **Market Power:** Introduction - Different types of market Power– **Exercising Market Power** - Examples, **Transmission Cost Allocation Methods:** Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.	--		Academic Peers	100%
18EE5207	Smart Grids Technologies		**Introduction to Smart Grid**: What is Smart Grid? Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid. **Smart Grid Architecture:** Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of a Smart Grid – Demand Response, Dispersed Loads, and Smart meters. **Tools and Techniques for Smart Grid:** Computational Techniques – Static and Dynamic Optimization Techniques – Computational Intelligence Techniques – Evolutionary Algorithms – Artificial Intelligence techniques. **Distribution Generation Technologies:** Introduction to Renewable Energy Technologies – Micro grids – Storage Technologies – Electric Vehicles and plug – in hybrids as ESS – Environmental impact and Climate Change – Economic Issues. **Communication Technologies and Smart Grid:** Introduction to Communication Technology – Synchro Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS). **Control of Smart Power Grid System**: Decentralized Secondary Control for frequency and voltage, Virtual inertia, Virtual impedance, Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.	--		Contemporary	100%

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18EE52D1	EHVAC & HVDC	ELECTIVE	**Introduction**: Need of EHV transmission, Limitations, EHV transmission, Comparison of EHV-AC & HVDC transmission, Interconnected Network and Role of Interconnecting Transmission Lines. **EHV-AC Transmission:** Parameters of EHV line, over-voltages due to switching, Ferro resonance, line insulator and clearance, corona, long-distance transmission with series & shunt compensations, principle of half wave transmission, flexible AC transmission. **HVDC Transmission:** Types of DC links, terminal equipment & their operations, HVDC system control, reactive power control, harmonics, multi-terminal DC (MTDC) system, AC/DC system analysis, protection of terminal equipment. **Insulation Requirement of EHV-AC and HVDC:** Classification, Insulation design aspect, Difference between Insulation Coordination-EHV-AC and HVDC, Insulation Coordination, Surge arrester protection in HVDC and EHV-AC Substation, Clearance for HVDC and EHV-AC. **Towers for (EHV-AC and HVDC):** Types and configuration of self-supporting and flexible towers, Foundation of towers, mechanical design of towers, Tower design based on switching surges and lightning strokes.			Industry Expert	100%
18EE52D3	Integration of Energy Sources	Elective	REVIEW OF CHARACTERISTICS OF POWER SOURCES: Basic review of power generation from wind - Solar PV - Thermal - Small hydro - Biomass power strategies in each of these energy conversion systems - Review of maximum power point tracking techniques in solar PV and wind (perturb & observe, hill climbs, incremental conductance). CONVERTER TOPOLOGIES: DC/DC converter (buck, boost, buck-boost) - DC/AC inverters (sine, triangular, PWM techniques) - Phase-locked loop for inverters. HYBRID SYSTEMS: Advantages of hybrid power systems - Importance of storage in hybrid power systems - Design of hybrid power system based on load curve - Sizing of hybrid power systems. ISOLATED SYSTEMS: Control issues for voltage and frequency in isolated systems – Small signal stability in isolated power systems - Importance of storage and dump load in isolated systems. ISSUES IN INTEGRATION OF RENEWABLE ENERGY SOURCES: Overview of challenges in integrating renewable sources to the grid - Impact of harmonics on power quality - Need to maintain voltage within a band and fluctuations in voltage because of renewable integration - Power inverter and converter technologies - Mechanism to synchronize power from renewable sources to the grid - Overview of challenges faced in designing power injection from offshore generation sources - Challenges in modelling intermittent nature of renewable power in a power system.			Academic Peer	100%
18EE5208	Digital Protection of Power Systems	core	**Protection of Power System Equipment** - summation transformer, phase-sequence current segregating network. Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing. **Digital Protection:** Developments in computer relaying – mathematical basis for protective relaying algorithms, Fourier Transforms – Discrete Fourier transforms – Walsh - Hadamard, Haar - wavelet transforms. **Microprocessor-based protection relays** – Working principles of µP based over current, directional, distance and current differential relays - digital relaying algorithms, various transform techniques employed like discrete Fourier, microprocessor implementation of digital distance relaying algorithms. New developments in relaying principles – fundamentals of travelling wave protection – principle of travelling wave distance relay – adaptive relaying – fault location algorithms			Academic Peers	100%

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POWER SYSTEM DYNAMICS & STABILITY

Course Code: 18EE5101

L	T	P	C
3	1	0	4

CO No:	CO	PO	BTL
1	Understand the modeling aspects of power system components and form the network matrices	PO-1	2
2	Apply mathematical methods for the solution of Power flow problem	PO-2	3
3	Analysis of power system with symmetrical and unsymmetrical faults	PO-3	4
4	Analyze the operation of power system under different contingencies	PO-2	4
5	Analysis of Power system problems using computer programming.	PO-5	4

SYNCHRONOUS MACHINE MODELING: Modeling of Synchronous Machine, Park's Transformation, Analysis of Steady State Performance, P. U. Quantities, Equivalent Circuit of Synchronous Machine, Vector diagrams in steady state and transient state, power angles curves of a salient pole machine. **POWER SYSTEM STABILITY:** Review of power system stability – classical model of a multi machines systems. **SMALL SIGNAL STABILITY:** Small signal stability of a single machine infinite bus system, Effects of excitation systems, Power system stabilizers, Sub Synchronous Resonance. **EXCITATION SYSTEMS:** Typical Excitations configurations and Automatic Voltage regulators, Effect of excitation on (a) Power limits, (b) Transient stability, (c) Dynamic stability, **VOLTAGE STABILITY:** Basic Concepts Related to Voltage Stability – Voltage Collapse – Voltage Stability Analysis – Prevention of Voltage Collapse. Introduction to Frequency Stability.

TEXT BOOKS:

1. Power System Stability and Control – Prabha Kundur, TATA McGRAW – HILL, 2006.
2. Power System Stability by Kimbark, Vol- I, II & III – 1968, Dover Publication Inc, Newyork-1968.

REFERENCE BOOKS:

1. Power System Dynamics Stability & Control – K.R.Padiyar, 2nd Edition, B.S. Publication 2002.
2. Power System Control and Stability – P. M. Anderson & A.A. Fouad , 2nd Edition, Wiley IEEE press-2002.

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ADVANCED POWER SYSTEM ANALYSIS

Course Code: 18EE5102

L	T	P	C
3	1	2	5

CO No:	CO	PO	BTL
1	Understand the modeling aspects of power system components and form the network matrices	PO-1	2
2	Apply mathematical methods for the solution of Power flow problem	PO-2	3
3	Analysis of power system with symmetrical and unsymmetrical faults	PO-3	4
4	Analyze the operation of power system under different contingencies	PO-2	4
5	Analysis of Power system problems using computer programming.	PO-5	4

Network Modeling-Single phase and three phase modeling of alternators, transformers and transmission lines, Conditioning of Y Matrix- Incidence matrix method, Method of successive elimination, Triangular factorization. **Load flow analysis**- Newton Raphson method, Fast decoupled method, AC-DC load flow-Single and three phase methods-Sequential solution techniques and extension to multiple and multi-terminal DC systems, Load flow with FACTS devices. **Fault studies**- 3-ϕ analysis of balanced and unbalanced faults-fault calculations-Short circuit faults-open circuit faults. **System Contingency Analysis** – Z_{bus} Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

TEXT BOOKS:

1. D. P. Kothari, I. J. Nagrath,' Modern Power System Analysis', Tata McGraw Hill-Education, New Delhi, 2003.
2. Arrillaga, J and Arnold, C. P., 'Computer analysis and power systems' John Wiley and Sons, New York, 1997

REFERENCE BOOKS:

1. Grainger, J. J. and Stevenson, W. D. 'Power System Analysis' Tata McGraw Hill, New Delhi, 2003.
2. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill, New Delhi, 2002.
3. Pai, M. A., 'Computer Techniques in Power System Analysis', Tata McGraw Hill, New Delhi, 2006.
4. P. Venkatesh,B V Manikandan,S Charles Raja and A Srinivasa Rao, "Electric Power System Analysis, Security & Deregulation", PHI, 2012.

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DEREGULATED OPERATION OF POWER SYSTEMS

Course Code: 18EE5103

L	T	P	C
3	1	0	4

CO No:	CO	PO	BTL
1	Understand the market operations in the electricity market under deregulated environment, Open Access Same-time Information System (OASIS) and Available Transfer Capability (ATC).	1,5	2
2	Analyze the concepts of Electricity Pricing.	1,5	4
3	Analyze the Power System Operation in Competitive Environment and Market Power.	1,5	4
4	Analyze the concepts of Transmission Pricing and Congestion pricing.	1,5	4

Key Issues in Electric Utilities Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion. Open Access Same-time Information System (OASIS) Structure of OASIS - Posting of Information – Transfer capability on OASIS. **Available Transfer Capability (ATC)** Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. **Electricity Pricing** Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Locational Marginal Pricing - Construction of Forward Price Curves – Short-time Price Forecasting. **Power System Operation in Competitive Environment** Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets

Operational Planning Activities of a GENCO. **Market Power :** Introduction - Different types of market Power– **Exercising Market Power** - Examples, **Transmission Cost Allocation Methods :** Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

TEXT BOOKS:

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd., England, 2001.
2. Kankar Bhattacharya, "Operation of Restructured Power System", Math H.J. Boller and Jaap E.Daalder Kulwer Academic Publishers, 2001.

REFERENCE BOOKS:

1. Mohammad Shahidehpour and Muwaffaq alomoush, "Restructured Electrical Power Systems", Marcel Dekker, Inc., 2001.
2. P. Venkatesh,B V Manikandan,S Charles Raja and A Srinivasa Rao, "Electric Power System Analysis, Security & Deregulation", PHI, 2012

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MODERN CONTROL THEORY

Course Code: 18EE5104

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand the basics of Z-Transforms and Digital control systems DCS components	PO1,PO5	2
CO2	Apply various stability analysis technics to digital control systems	PO1,PO5	3
CO3	Apply various stability analysis technics to non-linear control systems	PO1,PO5	3
CO4	Apply the basics of optimal control problem to state feedback controller design	PO1,PO5	3

Digital Control Systems: Review of Z and inverse Z-transforms sampling process and rigid reconstruction. Difference equations pulse transfer function, purpose of linear discrete systems, Z-transform analysis of sample data control system. Z and S domain relationship. Jury's stability method. Bilinear transformation compensation techniques. Controllability and observability of discrete systems. **Stability:** introduction – definitions of stability – stability in the sense of liapunov – stability of linear systems – transient response – behaviour of estimation – stability of non linear systems – generation of liapunov functions. **Optimal control:**formulation of the optimal control problem – method of calculus of variations – use of hamiltonian method – pontryagin's minimum principle - optimal control problem – hamilton – jacobi approach – continuous time linear state regulator matrix riccati equation – methods of solution – state variable feedback design.

TEXT BOOKS:

1. Discrete Time Control Systems-K.Ogata Pearson Education-2005.
2. Digital Control systems and State Variables methods by M.Gopal-2006.

REFERENCE BOOKS:

1. Modern Control System Theory by M. Gopal – New Age International – 2005
2. M. Gopal : Modern Control Systems Theory, Wiley Eastern Limited, New Delhi, 1996.
3. Modern Control Engineering by Ogata. K – Prentice Hall –2006
4. Optimal control by Kirck

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REAL TIME CONTROL OF POWER SYSTEMS

Course Code: 18EE5205

L	T	P	C
3	1	2	5

CO No	Course Outcome (CO)	PO	BTL
CO1	Analyze the load frequency control of power system	PO2	4
CO2	Analyze the economic operation of power system	PO3, PO4	4
CO3	Understand Computer control of power systems	PO3, PO5	2
CO4	Analyze the security control and state estimation	PO1	4

System optimization- strategy for two generator systems-generalized strategies-effect of transmission losses-Sensitivity of the objective function-Formulation of optimal power flow-solution by Gradient method-Newton's method - Unit Commitment, Hydro-Thermal Coordination. **Load frequency control** - AGC multi area system, static and dynamic response, Load frequency control of 2-area system, **Security control**-Security analysis and monitoring, generator and line outages by linear sensitivity factors, **State estimation**-Power system state estimation, Weighted least square state estimation, state estimation of AC network, Treatment of bad data – network observability and pseudo measurements.

TEXT BOOKS:

1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons, 1996.
2. I.J. Nagarath & D. P. Kothari , "Modern power system analysis" 3rd Edition, TMH, New Delhi, 2003.

REFERENCE BOOKS:

1. I. Elgard , "Electric Energy Systems Theory – An Introduction" TMH, 1983.
2. Abhijit Chakrabarti & Sunita Halder " Power System Analysis operation and Control " 1st edition, PHI, 2006.
3. Mahalanabis A.K., Kothari D.P. and Ahson S.I., "Computer aided power system analysis and control", 4th Edition, 2011, TMH.
4. J.J.Grainger, W.D.Stevenson JR, Power system analysis, Tata McGraw Hill N.D. 2007.
5. A. Handschin and E. Petroiaenu," Energy Management Systems, Operations and Control of Electric Energy Transmission Systems", Springer-Verlag, Berlin, Heidelberg, 1991.

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AI TECHNIQUES IN POWER SYSTEMS

Course Code: 18EE5206

L	T	P	C
3	1	0	4

CO No:	Course Outcome (CO)	PO	BTL
CO1	Able to Demonstrate the neural network, different architectures with different learning types and various algorithms for ANN to solve the load forecasting problems in Power systems.	PO 1,4	3
CO2	Use the fuzzy logic concept, fuzzy sets, with suitable membership function with proper de-fuzzification method to control the load frequency in power systems	PO 5,6	3
CO3	Understand the Genetic algorithm, encoding, Genetic operators, Reproduction operators, mutation operators, fitness functions, Genetic modeling	PO 1,4	2
CO4	Able to apply the different cross over methods and their elitism, convergence of algorithm and able to develop and analyze the algorithm to economic dispatch problem.	PO 5,6	3

Artificial Neural Networks: Introduction Models of Neuron Network – Architectures – Hebbian learning – Supervised learning – Unsupervised learning – Reinforcement learning. **ANN Paradigms:** Multi – layer perceptron using Back propagation Algorithm (BPA) – Radial Basis Function Network – Hopfield Network – Application to Load forecasting. **Fuzzy Logic:** Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Fuzzy Inference – Fuzzy Rule based system–Defuzzification methods – Application to Load Frequency Control. **Genetic Algorithms:** Introduction–Encoding – Fitness Function–Reproduction operators–Genetic Modeling – Genetic operators–Cross over – Single site cross over – Two point cross over – Multi point cross over – Uniform cross over – Mutation operator – Elitism - Generational cycle – convergence of Genetic Algorithm – Application to economic dispatch.

Text Books:

1. S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011

Reference Books:

1. James A freeman, David M Skapura, ' Neural Networks', Addison – Wesley, an imprint of Pearson Education, II Edition , 2000
2. S N Sivanandam, S sumathi, S. N deepa, ' Introduction to Neural Networks using Matlab 6.0, Tata Mc Graw Hill Publishing Company Private Limited, 2006
3. K Sundareswaran, 'Fuzzy Logic Systems', Jaico Publishing House, 2005

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SMART GRID TECHNOLOGIES

Course Code: 18EE5207

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand the basic concepts of smart grid, terminology, challenges and initiatives.	PO1	2
CO2	Identify various smart operations of power system structure, components, and monitoring techniques.	PO2, PO4	3
CO3	Apply smart metering and advanced metering infrastructure with monitoring, protection and measuring units.	PO2, PO4	3
CO4	Illustrate various communication protocols and cyber-security importance in smart grid.	PO4	2

Introduction to Smart Grid: What is Smart Grid? Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid.

Smart Grid Architecture: Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid – Demand Response, Dispersed Loads, Smart meters.

Tools and Techniques for Smart Grid: Computational Techniques – Static and Dynamic Optimization Techniques – Computational Intelligence Techniques – Evolutionary Algorithms – Artificial Intelligence techniques.

Distribution Generation Technologies: Introduction to Renewable Energy Technologies – Micro grids – Storage Technologies – Electric Vehicles and plug – in hybrids as ESS – Environmental impact and Climate Change – Economic Issues.

Communication Technologies and Smart Grid: Introduction to Communication Technology – Synchro Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS).

Control of Smart Power Grid System: Decentralized Secondary Control for frequency and voltage, Virtual inertia, Virtual impedance, Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

TEXT BOOKS:

1. Smart Grid Fundamentals of Design and Analysis, James Momoh, Wiley IEEE Press, Ed 2012.
2. Smart Grid Technology and Applications, Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, Wiley Press, Ed 2012.

REFERENCE BOOKS:

1. Control and Optimization Methods for Electric Smart Grids, Aranya Chakraborthy, Marija D Ilic Editor, Springer Publications.

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DIGITAL PROTECTION OF POWER SYSTEMS

Course Code: 18EE5208

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand the operation of protective equipment and adaptive protection	PO2,PO3	2
CO2	Apply various transforms for digital protection of power system	PO2, PO3	3
CO3	Analyze the microprocessor based relays for the protection of power system equipment	PO3, PO4	4
CO4	Analyze travelling wave, AI and FPGA based relays for the protection of power system equipment	PO4,PO5	4

Protection of Power System Equipment - summation transformer, phase-sequence current segregating network. Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing.

Digital Protection: Developments in computer relaying – mathematical basis for protective relaying algorithms, Fourier Transforms – Discrete Fourier transforms – Walsh - Hadamard, Haar - wavelet transforms. **Microprocessor based protection relays** – Working principles of µP based over current, directional, distance and current differential relays - digital relaying algorithms, various transform techniques employed like discrete Fourier, microprocessor implementation of digital distance relaying algorithms.

New developments in relaying principles – fundamentals of travelling wave protection – principle of travelling wave distance relay – adaptive relaying – fault location algorithms.

TEXT BOOKS:

1. Badri Ram & DN Viswakarma, "Power System Protection & Switch Gear", Tata McGraw Hill Publishing Company Limited, New Delhi (1995).
2. Power System Protection – Static relays T.S.MadhavaRao, TMH, 2010.
3. Digital Protection for Power Systems A.T.Johns and S.K.Salman, 1995.
4. Computer Relaying for power Systems A.G.Phake, James S.Thorp, John–Wiley and sons
5. Protective relaying principles and applications J.Lewis Blackburn, Marcel & Dekker

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REACTIVE POWER COMPENSATION AND MANAGEMENT (ELECTIVE1)

Course Code: 18EE51A1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads	PO1	2
CO2	Examine various compensation methods in transmission lines	PO2	2
CO3	Construct model for reactive power coordination	PO1	3
CO4	Distinguish demand side reactive power management & user side reactive power management	PO2	2

LOAD COMPENSATION: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- example.: Steady – state reactive power compensation in transmission system: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples. **TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS:** Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers –: Reactive power coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances-steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences. **DEMAND SIDE MANAGEMENT:** Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels: Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks . **USER SIDE REACTIVE POWER MANAGEMENT:** KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations. **REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES:** Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

TEXT BOOKS:

1. T.J.E.Miller, "Reactive power control in Electric power systems", John Wiley and sons, 1982.
2. D. M. Tagare, "Reactive power Management", Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. Hong Chen, "Practices of reactive power management and compensation", PJM Interconnection, Norristown, PA;
2. T E Miller, "Reactive Power Control in Power Systems", John Wiley, 1982.

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DISTRIBUTION SYSTEM PLANNING & AUTOMATION (ELECTIVE-1)

Course Code: 18EE51A2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand the power and its quality and system planning	PO2	2
CO2	Understand the design and operation of distribution feeders and loading of transformers.	PO2	2
CO3	Understand the consumer services in distribution system.	PO2	2
CO4	Understand the capacitor importance in distribution system and the SCADA with required components and its function.	PO2	2

Introduction: General Concepts, Distribution of Power, Quality of supply, System Study, Benchmarking, Electricity Reforms, Future of Distribution Systems.

System Planning: Planning Process, Planning Criteria and Standards, System Development, Dispersed Generation, Distribution System Economics and Finance, Mapping, Enterprise Resource Planning, Modelling, System Calculations, Introductory Methods, Network Elements, Load Flow, Automated Planning, Fault Studies, Effect of Abnormal Loads, Line Circuits, Urban Distribution, Outsourcing.

Design and Operation: Engineering Design, Operation Criteria and Standards, Sub Transmission, Sub Station and Feeder, Low Voltage three phase or single phase, Practices, Location of Sectionalizer, Voltage Control, Harmonics, Load Variations, Impact Loading of Transformers, Ferro resonance, System Losses, Energy Management, Model Distribution System.

Consumer Services: Supply Industry, Natural Monopoly, Regulations, Other Legal Provisions, Distribution Code, Consumer Care, Standards, Consumer Code Requirements, Consumer Factors, Least Cost of Supply, Revenue and Return, Load Management, Energy Audit, Theft of Electricity, Metering of Energy, Periodical Testing of Meters, Consumer Load Monitoring.

Power Capacitors: Reactive Power, Series and Shunt Capacitors, System Harmonics, HT Shunt Capacitors Installation Requirement, Size of Capacitators for power Factor Improvement, LT Capacitors, Construction Features, Failures.

Distribution Automation: Distribution Automation(DA), Project Planning, Definition, Communications, Sensors, Supervisory Control and Data Acquisition(SCADA), Consumer Information Service (CIS), Geographical Informational Systems (GIS), Automatic Meter Reading (AMR), Automation Systems.

Text Books:

1. Electrical Power Distribution Engineering by Turan Gonen, McGraw Hill, 1986.

Reference Books:

1. Electrical Power Distribution by A. S. Pabla, TMH, 5th Ed., 2004.
2. Electrical Power Distribution by V Kamaraju, TMH,2009

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POWER SYSTEM RELIABILITY (ELECTIVE-1)

Course Code: 18EE51A3

L	T	P	C
3	0	0	3

Co. No:	Course Outcomes	PO	BTL
CO 1	Understand the system reliability concepts	PO1, 5	2
CO 2	Apply the frequency and duration techniques for component repairable system.	PO 1,5	3
CO 3	Apply the network reliability concepts to generation system reliability analysis.	PO 1,5	3
CO 4	Apply the network reliability concepts to transmission and distribution system reliability analysis.	PO1,5	3

Network Modelling and Reliability Analysis: Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bath tub curve - reliability measures MTTF, MTTR, MTBF. **Frequency & Duration Techniques:** Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states. **Generation System Reliability Analysis:** Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. **Transmission System Reliability Analysis:** System and load point reliability indices – Weather effects on transmission lines – Weighted average rate and Markov model.: **Distribution System Reliability Analysis:** Basic Techniques – Radial networks – Evaluation of Basic reliability indices, performance indices - Load point and system reliability indices – Customer oriented, loss and energy-oriented indices – Examples. Parallel Configuration: Basic techniques – Inclusion of bus bar failures, scheduled maintenance – Temporary and transient failures – Weather effects –Evaluation of various indices – Examples.

Text Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Power systems" second edition, Springer.
2. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA Mc Graw - Hill – Edition.

Reference Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York.
2. Eodrenyi, J., "Reliability modelling in Electric Power System", John Wiley, 1980

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DIGITAL SIGNAL PROCESSORS AND APPLICATIONS (ELECTIVE-2)

Course Code: 18EE51B2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline components of digital signal processing	PO2	2
CO2	Demonstrate Architecture of TMS320C5X, TMS320C6X and ADSP-21XX processors	PO2	2
CO3	Demonstrate programming of functional units of TMS320C5X, TMS320C6X and ADSP-21XX	PO2	2
CO4	Develop Signal conditioning and PWM applications with TMS320C5X, TMS320C6X and ADSP-21XX processors	PO2,PO5	3

FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING: Review of DSP fundamentals. Issues involved in DSP processor design - speed, cost, accuracy, pipelining, parallelism, quantization error, etc. Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc.

TMS320C5X PROCESSOR 9 Architecture: Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

TMS320C6X PROCESSOR 9 Architecture: of the C6x Processor - Instruction Set - DSP Development System: Introduction– DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

ADSP PROCESSORS 9 Architecture of ADSP-21XX: and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions –

Software development tools: assembler, linker and simulator. Applications using DSP Processor - spectral analysis, FIR/IIR filter, linear-predictive coding, etc.

TEXT BOOKS:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012
2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture", TATA McGraw-Hill Education, 2002.

REFERENCES:

1. Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. NewDelhi, 2003.
2. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005 5. User guides Texas Instrumentation, Analog Devices, Motorola.

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OPTIMIZATION TECHNIQUES (ELECTIVE-2)

Course Code: 18EE51B3

L	T	P	C
3	0	0	3

CO No:	Course Outcome (CO)	PO	BTL
CO1	Understand classical optimization techniques, describe clearly the problems with and without constraints, identify its parts and analyze the individual functions, Feasibility study for solving an optimization problem.	4,5	2
CO2	Design and apply mathematical translation of the verbal formulation of an optimization problem and design algorithms of linear programming problems, the repetitive use of which will lead reliably to finding an approximate solution.	4,5	3
CO3	Evaluate and measure the performance of an algorithm of different methods to solve non-linear programming problems, study and solve optimization problems.	4,5	4
CO4	Analyze optimization techniques using algorithms. Investigate, study, develop, organize and promote innovative solutions for various applications.	4,5	4

Classical Optimization Techniques: Single variable optimization, multi-variable optimization with no constraints, with equality and inequality constraints, Karush- Kuhn- Tucker constraints **Linear Programming (LP):** Geometry of LP problem, graphical solution, simplex algorithm, two-phases of simplex algorithm, duality, dual simplex method, post-optimality analysis, quadratic programming. **Non-Linear Programming:** One-dimensional optimization – Fibonacci method, golden section method, quadratic and cubic interpolation methods, Newton's method.Unconstrained optimization - Steepest descent method, conjugate gradient method, Davidon-Fletcher-Powell method.Constrained Optimization - Methods of feasible directions, gradient projection method, generalized gradient method, penalty function methods, Augmented Legrangian multiplier method, Branch and bound method**Non-traditional Optimization Methods and Applications:**Genetic algorithms (G A), G A Operators, G A for constrained optimization, real –coded GAs.Particle swarm optimization.

Text Books:

1. S.S. Rao, ' Engineering Optimization : Theory andPractice.III Edition, New Age International (p) Limited Publications
2. Kalyanmoy Deb, ' Optimization for Engineering Design', PHI Learning Private Limited.

Reference Books:

1. PurnachandraBiswal, ' Optimization in Engineering', Scitech Publications (India) PVT Ltd

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FACTS DEVICES (ELECTIVE-3)

COURSE CODE: 18EE52C1

L	T	P	C
3	0	0	4

Co.No:	Course Outcomes	PO/PSO	BTL
CO 1	Interpret the significance of FACTS devices in power system	PO-1,2	2
CO 2	Demonstrate the operation and control of shunt compensation devices	PO-1,2	2
CO 3	Demonstrate the operation and control of series compensation devices	PO-1,2	2
CO 4	Demonstrate the operation and applications of special FACTS devices like UPFC and IPFC	PO-1,2	2

FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATIONS: Transmission interconnections, Power Flow in AC system, Dynamic stability Considerations and the importance of the controllable parameters, Introduction to Facts devices, Basic types of FACTS Controllers, benefits from FACTS controllers.**STATIC SHUNT COMPENSATION:** Objectives of shunt compensation, Methods of controllable VAR generation, variable impedance type static VAR generators (SVC): TCR, TSR, TSC, FC-TCR, TSC-TCR, switching converter type VAR generators: STATCOM, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement.**STATIC SERIES COMPENSATION: Objectives** of series compensation, variable impedance type static series controllers: GCSC, TSSC, TCSC, switching converter type controller: SSSC, Operation and Control External system Control for series Compensator SSR and its damping – Static Voltage and Phase angle Regulators - TCVR and TCPAR – Operation and Control.**UPFC AND IPFC:**The unified power flow Controller – Operation –Comparison with other FACTS devices – control of P and Q – dynamic performance – special Purpose FACTS controllers – Interline Power flow Controller – Operation and Control.

TEXT BOOKS:

1. N.G Hingorani&L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,2000
2. K.R.Padiyar "FACTS Controller in power Transmission and Distribution" New Age Int Publisher,2007

REFERENCE BOOKS:

3. Vijay K Sood "HVDC and FACTS Controllers" Kluwer Academic Publishers,2004.
4. Xiao-Ping Zhang, Christian Rehtanz,Bikash Pal, "Flexible AC Transmission Systems- modeling and control" Springer, 2005.

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ALTERNATIVE SOURCES OF ELECTRICAL ENERGY (ELECTIVE-2)

Course Code: 18EE51B1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	derstand the concept of Renewable energy resources, Distribution Generation and demand side management	PO2	2
CO2	Analyze the working of Photovoltaic Power Plants	PO3, PO4	4
CO3	Analyze the working of wind power plant and fule cells	PO3, PO4	4
CO4	Analyze the importance of energy storage systems in Distributed Generation	PO2	4

Introduction: Renewable Sources of Energy – Grid–Supplied Electricity – Distributed Generation – Renewable Energy Economics – Calculation of Electricity Generation Costs –Demand–Side Management Options – Supply–Side Management Options – Modern Electronic Controls of Power Systems.

Photovoltaic Power Plants: Solar Energy – Generation of Electricity by Photovoltaic Effect – Dependence of a PV Cell Characteristic on Temperature – Solar Cell Output Characteristics – Equivalent Models and Parameters for Photovoltaic Panels –Photovoltaic Systems – Applications of Photovoltaic Solar Energy – Economical Analysis of Solar Energy.

Wind Power Plants: Appropriate Location –Evaluation of Wind Intensity –Topography –Purpose of the Energy Generated –General Classification of Wind Turbines –Rotor Turbines –Multiple–Blade Turbines –Drag Turbines –Lifting Turbines –Generators and Speed Control Used in Wind Power Energy –Analysis of Small Generating Systems.

Fuel Cells: The Fuel Cell –Low – and High–Temperature Fuel Cells –Commercial and Manufacturing Issues –Constructional Features of Proton Exchange–Membrane Fuel Cells –Reformers – Electrolyzer Systems and Related Precautions –Advantages and Disadvantages of Fuel Cells – Fuel Cell Equivalent Circuit –Practical Determination of the Equivalent Model Parameters – Aspects of Hydrogen as Fuel.

Storage Systems: Energy Storage Parameters – Lead–Acid Batteries – Ultra capacitors –Flywheels – Superconducting Magnetic Storage System – Pumped Hydroelectric Energy Storage – Compressed Air Energy Storage –Storage Heat –Energy Storage as an Economic Resource

Text Books:

1. Felix A. Farret, M. Godoy Simo`es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.

2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004

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ENERGY CONSERVATION & AUDIT (ELECTIVE-3)

Course Code: 18EE52C2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	derstand the concept of Energy Audit and Energy Management	PO2	2
CO2	Analyze the various characteristics of energy efficient motors	PO3, PO4	4
CO3	Analyze the different energy instruments and importance of power factor improvement	PO3, PO4	4
CO4	Analyze the economic aspects of electrical energy	PO2	4

BASIC PRINCIPLES OF ENERGY AUDIT: Energy audit- definitions, concept, types of audit, energy index, cost index, pie-charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit. **ENERGY MANAGEMENT:**
Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting - Energy manger, Qualities and functions, language, Questionnaire - check list for top management. Demand side management. **ENERGY EFFICIENT MOTORS:** Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp- voltage van at ion-voltage unbalance- over motoring- motor energy audit. **POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS:** Power factor - methods of improvement, location of capacitors, PF with non linear loads, effect of harmonics on PF , PF motor controllers - Good lighting system design and practice, lighting control, lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's. **ECONOMIC ASPECTS AND ANALYSIS:** Economics Analysis - Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis - Energy efficient measures- calculation of simple payback method, net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

TEXT BOOKS:

1. W.C.Turner, "Energy management hand book", John wiley and sons Energy management and good lighting practice: fuel efficiency- book let 12-EEO
2. W.K. Murphy, G- Mckay Butier worth, "Energy management", Heine mann publications, 2007.

REFERENCE BOOKS:

1. Paulo Callaghan, "Energy management", Mc-graw Hill Book company, 1st edition, 1998
2. Giovanni and Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999)
3. Howard E.Jordan, "Energy-Efficient Electric Motors and their applications", Plenum pub corp; 2nd ed. (1994)

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ADAPTIVE CONTROL SYSTEMS (ELECTIVE-3)

Course Code: 18EE52C3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline elements of propbability and Stochastic processes	PO2	2
CO2	Demonstrate parametric and non-parmetric system models	PO2	2
CO3	Interpret adaptive control techniques to linear systems	PO2	2
CO4	Apply adaptive control process and asses stability of linear systems	PO2,PO5	3

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties.**Stochastic processes and system models:** Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non sequence model, Gaussian white process.**Non parametric methods & parametric methods:** Nonparametric methods: Transient analysis-frequency analysis-Correlation analysis-Spectral analysis.Liner Regression: The Lease square estimate-best liner unbiased estimation under linear constraints-Prediction error methods: Description of Prediction error methods-Optimal Prediction – relationships between Prediction error methods and other identification methods theoretical analysis.**Adaptive control schemes**Introduction – users- Definitions-auto tuning-types of adaptive control-gain scheduling controller-model reference adaptive control schemes – self tuning controller. MRAC and STC: Approaches – The Gradient approach – Lyapunov functions – Passivity theory – pole placement method Minimum variance control – Predictive control. **Adaptive control and application:** Stability – Convergence – Robustness – Application of adaptive control, direct model reference adaptive control. Introduction: Basic approaches to adaptive control. Applications of adaptive control. Identification: Error formulations linear in the parameters. Direct adaptive control: Linear error equations with dynamics. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions. Kalman-Yacubovitch-Popov lemma. Passivity theory.

TEXT BOOKS:

1. Dan Simon, "Optimal State Estimation", Wiley Intersience, 2006.
2. S. Sastry and M. Bodson, Adaptive Control: Stability, Convergence, and Robustness, Prentice-Hall, 1989.

REFERENCE BOOKS:

1. K.J. Astrom and B. Wittenmark, Adaptive Control, Addison-Wesley, 2nd edition, 1995.
2. I.D. Landau, R. Lozano, and M. M'Saad, Adaptive Control, Springer Verlag, London, 1998.
3. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, 1969.
4. K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989.
5. P.E. Wellstead& M.B. Zarrop, Self-Tuning Systems: Control and Signal Processing, J. Wiley & Sons, Chichester, England, 1991

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EHVAC & HVDC TRANSMISSION(ELECTIVE-4)

Course Code: 18EE52D1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline operational parameters of EHV-AC transmission	PO2	2
CO2	Demonstrate various HVDC links	PO2	2
CO3	Develop insulation design and coordination for HVDC system	PO2,PO-5	3
CO4	Demonstrate mechanical design of towers for HVDC and EHV-AC transmission	PO2	2

Introduction: Need of EHV transmission, Limitations, EHV transmission, Comparison of EHV-AC & HVDC transmission, Interconnected Network and Role of Interconnecting Transmission Lines.

EHV-AC Transmission: Parameters of EHV line, over-voltages due to switching, Ferro resonance, line insulator and clearance, corona, long distance transmission with series & shunt compensations, principle of half wave transmission, flexible AC transmission.

HVDC Transmission: Types of DC links, terminal equipment's& their operations, HVDC system control, reactive power control, harmonics, multi terminal DC (MTDC) system, AC/DC system analysis, protection of terminal equipment's.

Insulation Requirement of EHV-AC and HVDC: Classification, Insulation design aspect, Difference between Insulation Coordination-EHV-AC and HVDC, Insulation Coordination, Surge arrester protection in HVDC and EHV-AC Substation, Clearance for HVDC and EHV-AC.

Towers for (EHV-AC and HVDC): Types and configuration of self supporting and flexible towers, Foundation of towers, mechanical design of towers, Tower design based on switching surges and lightning strokes.

TEXT BOOKS:

1. K. R. Padiyar, HVDC Power Transmission System, Wiley Eastern Limited, 1990.
2. EHV-AC, HVDC Transmission and Distribution Engineering, S. Rao, Khanna Publishers, 2001.

REFERENCE BOOKS:

1. Rakesh Das Begmudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Limited, New Delhi – 1987
2. E.W.Kimbark, EHV-AC and HVDC Transmission Engineering &Practice, Khanna Publishers.

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POWER QUALITY (ELECTIVE-4)

Course Code: 18EE52D2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline basic power quality issues	PO2	2
CO2	Demonstrate conventional loop control for voltage and current balance	PO2	2
CO3	Demonstrate DSTATCOM for power quality restoration	PO2	2
CO4	Apply combined compensation techniques for power quality restoration	PO2,PO5	3

INTRODUCTION- Characterization of Electric Power Quality: Transients, short duration and longduration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations,Power frequency variation, Power acceptability curves – power quality problems: poor loadpower factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage,Disturbance in supply voltage – Power quality standards.Transients – origin and classifications – capacitor switching transient – lightning-load switching – impact on users – protection – mitigation. **CONVENTIONAL LOAD COMPENSATION METHODS** -Principle of Load compensation and Voltage regulation – Classical load balancing problem:Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction andvoltage sag reduction – Analysis of unbalance – instantaneous real and reactive powers –Extraction of fundamental sequence component **LOAD COMPENSATION USING DSTATCOM** - Compensating single phase loads – Ideal three phase shunt compensator structure –Generating reference currents using instantaneous PQ theory – Instantaneous symmetricalcomponents theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode. **SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM** Rectifier supported Dynamic Voltage Restorer – DC Capacitor supported DVR – DVRStructure – voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TEXT BOOKS:

1. ArindamGhosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2. R.C. Duggan, Mark.F.McGranaghan,SuryaSantoas and H.WayneBeaty, "Electrical Power System Quality", McGraw-Hill, 2004.
3. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publication, 1994.
4. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and Interruptions", Wiley-IEEE Press, 2000. Indian Reprint – 2013

REFERENCES

1. Jos Arrillaga and Neville R. Watson ," Power system harmonics",Wiley,2003.
2. Derek A. Paice , "Power Electronics Converter Harmonics :Multipulse Methods for CleanPower",Wiley,1999.
3. Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines, Elseveir academic press publications,2011.

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INTEGRATION OF ENERGY SOURCES

Course Code: 18EE52D3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Interpret characteristics of PV System	PO2	2
CO2	Interpret Power electronic converter topologies	PO2	2
CO3	Illustrate issues in isolated systems	PO2	2
CO4	Analyze the issues in integration of renewable energy sources	PO2	4

REVIEW OF CHARACTERISTICS OF POWER SOURCES: Basic review of power generation from wind - Solar PV - Thermal - Small hydro - Biomass power strategies in each of these energy conversion systems - Review of maximum power point tracking techniques in solar PV and wind (perturb & observe, hill climbs, incremental conductance).

CONVERTER TOPOLOGIES: DC/DC converter (buck, boost, buck boost) - DC/AC inverters (sine, triangular, PWM techniques) - Phase locked loop for inverters.

HYBRID SYSTEMS: Advantages of hybrid power systems - Importance of storage in hybrid power systems - Design of hybrid power system based on load curve - Sizing of hybrid power systems.

ISOLATED SYSTEMS: Control issues in isolated systems for voltage and frequency – Small signal stability in isolated power systems - Importance of storage and dump load in isolated systems.

ISSUES IN INTEGRATION OF RENEWABLE ENERGY SOURCES: Overview of challenges in integrating renewable sources to the grid - Impact of harmonics on power quality - Need to maintain voltage within a band and fluctuations in voltage because of renewable integration - Power inverter and converter technologies - Mechanism to synchronize power from renewable sources to the grid - Overview of challenges faced in designing power injection from offshore generation sources - Challenges in modeling intermittent nature of renewable power in a power system.

TEXT BOOKS:

1. Power Electronics, Converters, Applications and Design" by N. Mohan; T.M. Undeland;
2. W.P. Robbins. 1995, John Wiley and Sons.
3. Renewable Energy Integration Challenges and Solutions Series: Green Energy and
4. Technology Hossain, Jahangir,Mahmud, Apel (Eds.)
5. Integration of Alternative Sources of Energy Felix A. Farret, M. Godoy Simões,
6. December 2005, Wiley-IEEE Press

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1. Course structure for 2018-19 admitted M.Tech-PED program

I		Course Code	Course Title	L	T	P	Cr
1	PCC	18EE5109	Modeling and Analysis of Electrical Machines	3	1	0	4
2	PCC	18EE5110	Analysis of Power Converters	3	1	2	5
3	PCC	18EE5111	Power Electronic Control Of Drives	3	1	0	4
4	PCC	18EE5104	Modern Control Theory	3	1	0	4
5	PCC	18EE5113	Advanced Power Converters	3	1	2	5
6	PCC	18EE5114	Advanced Electrical Drives	3	1	0	4
7	PCC	18EE5207	Smart Grids Technologies	3	1	0	4
8	PCC	18EE5116	FPGA controllers and Applications	3	1	0	4
9	PEC		Elective – 1	3	0	0	3
10	PEC		Elective - 2	3	0	0	3
11	PEC		Elective – 3	3	0	0	3
12	PEC		Elective - 4	3	0	0	3
13	PRI	18IE5149	Seminar	0	0	4	2
14	PRI	18IE5150	Term Paper	0	0	4	2
15	PRI	18IE6050	Dissertation	0	0	72	36
			TOTAL				**86**
			Professional Elective-1				
	1	18EE51E1	Microcontrollers and Applications	3	0	0	3
	2	18EE51E2	Digital Simulation of Power Electronic Systems	3	0	0	3
	3	18EE51E3	Industrial Control Electronics	3	0	0	3
			Professional Elective-2				
	1	18EE51F1	Soft Computing Techniques	3	0	0	3
	2	18EE51B2	Digital Signal Processors and Applications	3	0	0	3
	3	18EE51B3	Optimization Techniques	3	0	0	3
			Professional Elective-3				
	1	18EE52C1	FACTS DEVICES	3	0	0	3
	2	18EE52H2	Electric and Hybrid Vehicles	3	0	0	3
	3	18EE52C3	Adaptive Control Systems	3	0	0	3
			Professional Elective-4				
	1	19EE52D1	EHVAC & HVDC Transmission	3	0	0	3
	2	18EE52D2	Power Quality	3	0	0	3
	3	18EE52D3	Power Electronics for Renewable Energy Systems	3	0	0	3

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5. Course structure and Syllabus Revision for 2018-19 M.Tech- PED programs

Sl	Course Code	Course Name	Cat	L	T	P	S	Cr	Pre- requisite	New Course/ Revise d Course/ Retained Course	Ch an ges Pro pos ed by	Focused on Employability/ Entrepreneurs hip / Skill Development	Justification
1	18EE5109	Modeling and Analysis of Electrical Machines	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
2	18EE5110	Analysis of Power Converters	PC	3	1	2	0	5	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
3	18EE5111	Power Electronic Control of Drives	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
4	18EE5104	Modern Control Theory	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
5	18EE5113	Advanced Power Converters	PC	3	1	2	0	5	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
6	18EE5114	Advanced Electrical Drives	PC	3	1	0	0	4	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
7	18EE5207	Smart Grids Technologies	PC	3	1	0	0	4	Nil	New	Academic Peer	Employability	Covers the advanced topics which enable employability in the core sector and further study

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8	18EE5116	FPGA controllers and Applications	PC	3	1	0	0	4	Nil	New	Industry Expert	Employability	Covers the advanced topics which enable employability in the core sector and further study
9	18EE51E1	Microcontrollers and Applications	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
10	18EE51E2	Digital Simulation of Power Electronic Systems	PE	3	0	0	0	3	Nil	New	Academic Peer	Employability	Covers the advanced topics which enable employability in the core sector and further study
11	18EE51E3	Industrial Control Electronics	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
12	18EE51F1	Soft Computing Techniques	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
13	18EE51B2	Digital Signal Processors and Applications	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
14	18EE51B3	Optimization Techniques	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
15	18EE52C1	FACTS Devices	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
16	18EE52H2	Electric and Hybrid Vehicles	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study

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17	18EE52C3	Adaptive Control Systems	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
18	18EE52D1	EHVAC & HVDC Transmission	PE	3	0	0	0	3	Nil	New	Industry Expert	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
19	18EE52D2	Power Quality	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
20	18EE52D3	Energy Management Systems	PE	3	0	0	0	3	Nil	Retained	No Changes Proposed	Employability	Covers the advanced topics which enable employability in the core sector and further study
21	18IE5149	Seminar	PRI	0	0	4	0	2	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
22	18IE5250	Term Paper	PRI	0	0	4	0	2	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
23	18IE6050	Dissertation	PRI	0	0	72	0	36	Nil	Retained	No Changes Proposed	Skill Development	Covers the practical knowledge of tools required for technical problem-solving

Percentage of Courses focusing on Employability= 18/23=79.78.26%

Percentage of Courses focusing on Entrepreneurship= 2/23=0.086%

Percentage of Courses focusing on Skill Development = 3/23=13.043%

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6. Syllabus of NEW COURSE for Y18 M.Tech-Power Electronic Drives admitted students

Course Code	Course Name	Cat	New Syllabus	Topics Added/ Removed / Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
18EE5116	FPGA controllers and Applications	Elective	Components of battery-management systems Lithium-ion cell technology Logical blocks, I/O blocks, Interconnects, Xilinx- XC9500, Cool Runner - XC5200, SPARTAN, Virtex - Altera MAX 7000. **ASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING** - System partition – FPGA partitioning – Partitioning methods- floor planning – placement- physical design flow – global routing – detailed routing – special routing- circuit extraction – DRC.**ANALOG VLSI DESIGN-** Introduction to analogue VLSI-Design of CMOS 2stage-3 stage Op-Amp –High Speed and High-frequency op-amps-Super MOS- Analog primitive cells-realization of neural networks. **LOGIC SYNTHESIS AND SIMULATION** -Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioural modelling, task & functions, Verilog and logic synthesis-simulation-WM pulse generations for converter applications.**MOTOR CONTROL USING FPGA:** Introduction to Motor Drives- Digital Block Diagram for Robot Axis Control - Position Loop - Speed Loop- Power Module -Case Studies for Motor Control - Stepper Motor Controller- Permanent Magnet DC Motor - Brushless DC Motor -Permanent Magnet Rotor (PMR) Synchronous Motor - Permanent Magnet Synchronous Motor (PMSM).	--		Industry expert	100%
18EE51E2	Digital Simulation of Power Electronic Systems	Elective	MODELING OF POWER ELECTRONIC DEVICES: General purpose circuit analysis software – Methods of analysis of power electronic systems - Transients and the time domain analysis with Pspice – Fourier series and harmonic components – Pspice modelling of diode, BJT, MOSFET, IGBT, SCR, TRIAC in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply.Modelling of SCR, TRIAC and IGBT, simulation of driver and snubber circuits.SIMULATION OF AC-DC CONVETERS USING PSPICE AND MATLAB SIMULINK: Modeling of single-phase and three-phase uncontrolled and controlled (SCR) rectifiers- simulation of converter fed DC drives-computation of performance parameters: harmonics, power factor, angle of overlap. SIMULATION OF DC-DC CONVERTERS USING PSPICE AND MATLAB SIMULINK: Modeling of Chopper circuits- Simulation of thyristor choppers with voltage, current and load commutation schemes-Simulation of chopper fed dc motor- computation of performance parameters.SIMULATION OF DC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK: Modeling of single and three-phase inverters circuits – Space vector representation- Pulse-width modulation methods for voltage control- Simulation of inverter fed induction motor drives. SIMULATION OF AC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK: Modeling of AC voltage controllers, and Cyclo-converters-Simulation of AC voltage controllers and Cyclo-converters feeding different loads- Computation of performance parameters.	--		Industry expert	100%

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MODELING AND ANALYSIS OF ELECTRICALMACHINES

COURSE CODE: 18EE5109	L	T	P	C
	3	1	0	4

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
CO1	ply the basic concepts of Electromagnetic Energy Conversion Principles to DC Machines	PO1	3
CO2	Understand the performance of electrical machines through mathematical modeling	PO2	2
CO3	Apply the dynamic behaviour of electrical machines under different operating conditions	PO1	3
CO4	Analysis of special machines	PO2	4

Basic Concepts and Dc machine: Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system. Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.**Induction machine:** Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames. **Synchronous Machine**: Determination of Synchronous Machine Dynamic Equivalent Circuit Parameters, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine. **Special Machines** - Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self controlled operation; Analysis of Switch Reluctance Motors

Reference Books:

1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, 'Electric Machinery', Tata McgrawHill, 5th Edition, 1992.
2. R. Krishnan, 'Electric Motor & Drives: Modeling, Analysis and Control', Prentice Hall of India, 2nd Edition, 2001.
3. Miller, T.J.E., 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, 1st Edition, 1989
4. P.S.Bhimra, "Generalized theory of electrical machinery", Khanna publications
5. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition 1995.

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ANALYSIS OF POWER CONVERTERS

COURSE CODE: 18EE5110	L	T	P	C
	3	1	2	5

CO No:	CO	PO	BTL
1	Analyze the various 3-phase controlled rectifiers and power factor correction converters with different load and	PO-1, PO-2	4
2	Analyze the performance of Switch-Mode PWM and different control techniques for Inverters	PO-1, PO-2	4
3	Analyze the performance of dc-dc switch regulators with CCM and DCM operation.	PO-1, PO-5	4
4	Understand the operations and performance of various ac-ac regulators with different loads and its.	PO-1, PO-2	2
5	Demonstrate and test basic power electronic converters by hardware realization and MATLAB software.	PO-3	4

3-PHASE AC-DC CONVERTERS - Analysis of power semiconductor switched circuits with R, L, RL, RC loads, d.c. motor load, battery charging circuit. Single-Phase and Three-Phase AC to DC converters-half controlled configurations- Reactive power considerations-Three phase dual converters-PWM control of 3-phase controlled rectifier - twelve pulse converters- numerical problems.Extinction angle control-symmetrical angle control.**POWER FACTOR CORRECTION CONVERTERS -** Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter. **SWITCH-MODE DC-AC INVERTERS -**Basic Concepts - Single Phase Inverters- PWM Principles- Sinusoidal Pulse Width Modulation in Single Phase Inverters-Choice of carrier frequency in SPWM- Spectral Content of output - Bipolar and Unipolar Switching in SPWM - Blanking Time Maximum Attainable DC Voltage Switch Utilization -Reverse Recovery Problem and Carrier Frequency Selection-Output Side Filter Requirements and Filter Design - Ripple in the Inverter Output - DC Side Current. – Three Phase Inverters -Three Phase Square Wave /Stepped Wave Inverters- Three Phase SPWM Inverters- Choice of Carrier Frequency in Three Phase SPWM Inverters - Effect of Blanking Time on Inverter Output Voltage. **DC-DC CONVERTERS** -Buck converter – Analysis and derivation of output voltage for continuous (CC) and discontinuous conduction mode (DCM).Boost converter – Analysis and derivation of output voltage for continuous (CC) and discontinuous conduction mode (DCM).BUCK-BOOST Converter - Analysis and derivation of output voltage for continuous (CC), Principle of operation of CUK and SEPIC Converter.**3- PHASE AC VOLTAGE REGULATORS -**Three Phase AC Voltage regulators-Analysis of 3-phase regulators with star and delta connected R and RL loads – Load voltage harmonic Analysis-numerical problems.

TEXTBOOKS

1. Ned Mohan et.al "Power electronics : converters, applications, and design" John Wiley and Sons, 2006
2. P.C. Sen "Power Electronics" Tata McGraw Hill, 2003.
3. Dewan&Straughen "Power Semiconductor Circuits" John Wiley &Sons., 1975 .
4. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
5. M.D.Singh&K.B. Khanchandani "Power Electronics" Tata McGraw Hill., 2007
6. B. K Bose Modern Power Electronics and AC Drives. Pearson Education (Asia)., 2007

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POWER ELECTRONIC CONTROL OF DRIVES

Course Code: 18EE5111

L	T	P	C
3	1	0	4

CO No:	CO	PO/PSO	BTL
CO1	alyze ac-dc and dc-dc converter fed DC motor drives	PO1	4
CO2	derstand converter fed stator side control of Induction Motor drives.	PO3	2
CO3	alyze rotor side control and slip power recovery scheme of 3-phase Induction Motor drives	PO2/PO3	4
CO4	alyze frequency control of Synchronous Motor drives for variable speed operation	PO2	4

Controlled Converter fed DC Motor Drives: Steady state analysis of the single and three phase fully controlled converter fed series and separately excited D.C motor drives: Continuous and discontinuous conduction mode, control of output voltage by sequence and sector control. **Chopper fed DC Motor Drives:** Four quadrant chopper circuit – Chopper for inversion – closed loop control of chopper fed dc drive –Steady state analysis of chopper controlled DC motor drives.**VSI and CSI fed Induction Motor Drives:** Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive. Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program.

Rotor Side Control of Induction Motor: Rotor resistance control- fixed resistance control, variable resistance control-converter controlled rotor resistance control, Slip power recovery schemes- Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation.**Synchronous Motors :**Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives.

TEXT BOOKS

1. Power Electronics and Motor Control – Shepherd, Hulley, Liang – II Edition, Cambridge University Press
2. R. Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
3. BimalK .Bose, 'Modern Power Electronics and AC Drives', Pearson Education Pvt. Ltd., New Delhi, 2003.

REFERENCES

1. Power Electronic Circuits, Devices and Applications – M. H. Rashid – PHI.
2. Control of Induction Motors - Andrzej M. Trzynadlowski
3. Fundamentals of Electric Drives – G. K. Dubey – Narosa Publications – 1995.
4. Power Semiconductor drives – G. K. Dubey.

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MODERN CONTROL THEORY

Course Code: 18EE5104

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand the basics of Z-Transforms and Digital control systems DCS components	PO1,PO5	2
CO2	Apply various stability analysis technics to digital control systems	PO1,PO5	3
CO3	Apply various stability analysis technics to non-linear control systems	PO1,PO5	3
CO4	Apply the basics of optimal control problem to state feedback controller design	PO1,PO5	3

Digital Control Systems: Review of Z and inverse Z-transforms sampling process and rigid reconstruction. Difference equations pulse transfer function, purpose of linear discrete systems, Z-transform analysis of sample data control system. Z and S domain relationship. Jury's stability method. Bilinear transformation compensation techniques. Controllability and observability of discrete systems.
Stability: introduction – definitions of stability – stability in the sense of liapunov – stability of linear systems – transient response – behaviour of estimation – stability of non linear systems – generation of liapunov functions.
Optimal control: formulation of the optimal control problem – method of calculus of variations – use of hamiltonian method – pontryagin's minimum principle - optimal control problem – hamilton – jacobi approach – continuous time linear state regulator matrix riccati equation – methods of solution – state variable feedback design.

TEXT BOOKS:

1. Discrete Time Control Systems-K.Ogata Pearson Education-2005.
2. Digital Control systems and State Variables methods by M.Gopal-2006.

REFERENCE BOOKS:

3. Modern Control System Theory by M. Gopal – New Age International – 2005
4. M. Gopal : Modern Control Systems Theory, Wiley Eastern Limited, New Delhi, 1996.
5. Modern Control Engineering by Ogata. K – Prentice Hall –2006
6. Optimal control by Kirck

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ADVANCED POWER CONVERTERS

Course Code: 18EE5113

L	T	P	C
3	1	2	6

CO No:	Course Outcome (CO)	PO	BTL
1	Analyze the concepts of Resonant switch Converters, L-type, M-type, Load resonant converters	1,2	4
2	Analyze the operation of soft switched isolated converter and Quasi resonant inverter	1,2	4
3	Analyze the concept of Z-source to inverter and analyze the concept of multi-level to inverters, Analysis and comparison of Multi level Inverters	1,2	4
4	Applydifferent PWM techniques for Multi-level inverters, Apply the Concept of Matrix converter for direct AC-AC conversion	1,2	3
5	Analyze the concepts of Advanced power converters through Lab experiments	1,2	4

Resonant Dc-Dc Converters: Switching loss, hard switching, and basic principles of soft switching-classification of resonant converters- load resonant converters – series and parallel – resonant switch converters – operation and analysis of ZVS, ZCS converters comparison of ZCS/ZVS Introduction to ZVT/ZCT PWM converters - Numerical problems. **Special Inverter Topologies**: Series Inverters -Switched Mode Rectifier - Single phase and three phase boost type APFC and control -Three phase utility inter phases and control Push-Pull and Forward Converter Topologies - Voltage Mode Control Half and Full Bridge Converters - Flyback Converter.

Soft Switching Converters: Resonant (Pulsating) DC Link Inverter -Active-clamped Resonant DC Link Inverter- Quasi-resonant Soft-switched Inverter - Numerical problems. **Multilevel Inverters- Multilevel & Boost Inverters -** Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase & Three phase Impedance source inverters -Introduction-Matrix converter circuit-Control strategies.

TEXT BOOKS:

1. N.Mohan, T.M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design", Wiley India Pvt. Ltd.-2013
2. Power Converter Circuits , William Shepherd and Li Zhang, CRC press ,Taylor & Francis -2004

REFERENCE BOOKS:

1. Gyugyi, L., B. R. Pelly, "Static Power Frequency Changers," Wiley, New York.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
3. Ali Emadi, Alireza Khaligh, Zhong Nie, Young Joo Lee, " Integrated Power Electronic Converters and Digital Control", CRC press
4. Simon Ang, Alejandro Oliva, "Power-Switching Converters, Second Edition, CRC Press, Taylor & Francis Group, 2010
5. Marian.K.Kazimierczuk and Dariusz Czarkowski, "Resonant Power Converters", John Wiley & Sons limited, 2011

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ADVANCED ELECTRICAL DRIVES

COURSE CODE: 18EE5114

L	T	P	C
3	1	0	4

CO No:	Course Outcomes(CO)	Mapped PO	BTL
1.	Understand the modeling of AC machines	PO1,PO2	2
2.	Contrast the speed control performance of 3-Phase induction and synchronous motor drive using vector control methods	PO1,PO2	4
3.	Analyze the dynamic behavior of SRM motor drives under various control methods	PO1,PO2	4
4.	Distinguish the performance of BLDC Motor drive using various control techniques	PO1,PO2	4

FIELD ORIENTED CONTROL OF INDUCTION MOTOR DRIVES - Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy. **SENSORLESS VECTOR CONTROL OF INDUCTION MOTOR**: Slip and Speed Estimation at Low performance, Rotor Angle and Flux-linkage Estimation at high performance -rotor Speed Estimation Scheme- estimators using rotor slot harmonics, Model Reference adaptive systems, Extended Kalman Filter. **CONTROL OF SYNCHRONOUS MOTOR DRIVES**: Self control-margin angle control-torque control-power factor control-Brushless excitation systems - SRM Structure-Stator Excitation-techniques of sensor less operation-convertor topologies-SRM Waveforms-SRM drive design factors-Torque controlled SRM-Torque Ripple-Instantaneous Torque control - using current controllers-flux controllers. **CONTROL OF BLDC MOTOR DRIVES**: principle of operation of BLDC Machine, Sensing and logic switching scheme, BLDM as Variable Speed Synchronous motor-methods of reducing Torque pulsations -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive.

TEXT BOOKS

1. Electric Motor Drives Modeling, Analysis & control -R. Krishnan- Pearson Education
2. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications
3. Sensorless Vector Direct Torque control –Peter Vas, Oxford University Press

REFERENCES BOOKS

1. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications-
2. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press -1st edition-1998
3. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992
4. VedamSubramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2002

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SMART GRID TECHNOLOGIES

Course Code: 18EE5207

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
CO1	Understand the basic concepts of smart grid, terminology, challenges and initiatives.	PO1	2
CO2	Identify various smart operations of power system structure, components, and monitoring techniques.	PO2, PO4	3
CO3	Apply smart metering and advanced metering infrastructure with monitoring, protection and measuring units.	PO2, PO4	3
CO4	Illustrate various communication protocols and cyber-security importance in smart grid.	PO4	2

INTRODUCTION TO SMART GRID - Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid. **SMART GRID TECHNOLOGIES** Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).**SMART METERS AND ADVANCED METERING INFRASTRUCTURE -** Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits ,AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection. High Performance Computing for Smart Grid Applications **COMMUNICATION SYSTEMS-**Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TEXT BOOKS

1. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions", CRC Press 2017.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley 2012.

REFERENCES BOOKS

1. Control and Optimization Methods for Electric Smart Grids, Aranya Chakraborthy, Marija D Ilic Editor, Springer Publications.
2. Smart Grid Fundamentals of Design and Analysis, James Momoh, Wiley IEEE Press, Ed 2012.
3. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids, vol. 14, 2012.

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FPGA CONTROLLERS AND APPLICATIONS

Course Code: 18EE5116

L	T	P	C
3	1	0	4

CO No	Course Outcome (CO)	PO/PSO	BTL
CO1	Apply basic digital program logics for programming CPLD and FPGA	PO1	3
CO2	Understanding ASIC physical design flow	PO1	2
CO3	Understanding Analog VLSI design	PO1	2
CO4	Analyse the control logics for motor application using VHDL program	PO2	4

PROGRAMABLE LOGIC DEVICES- Programming Techniques-Anti fuse-SRAM-EPROM and EEPROM technology Logical blocks, I/O blocks, Interconnects, Xilinx- XC9500,Cool Runner - XC5200, SPARTAN, Virtex - Altera MAX 7000. **ASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING -** System partition – FPGA partitioning – Partitioning methods- floor planning – placement- physical design flow – global routing – detailed routing – special routing- circuit extraction – DRC.**ANALOG VLSI DESIGN-** Introduction to analog VLSI- Design of CMOS 2stage-3 stage Op-Amp –High Speed and High frequency op-amps-Super MOS- Analog primitive cells-realization of neural networks. **LOGIC SYNTHESIS AND SIMULATION** -Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioural modelling, task & functions, Verilog and logic synthesis-simulation-WM pulse generations for converter applications.**MOTOR CONTROL USING FPGA:**Introduction to Motor Drives- Digital Block Diagram for Robot Axis Control - Position Loop - Speed Loop- Power Module - Case Studies for Motor Control - Stepper Motor Controller- Permanent Magnet DC Motor - Brushless DC Motor -Permanent Magnet Rotor (PMR) Synchronous Motor - Permanent Magnet Synchronous Motor (PMSM).

TEXT BOOKS

1. Kamran Eshraghian,DouglasA.Pucknell and SholeEshraghian," Essentials of VLSI circuits and system", Prentice Hall India,2005.
2. Wayne Wolf, " Modern VLSI design", Prentice Hall India,2006.
3. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays", 2009 Springer-Verlag London Limited

REFERENCE BOOKS

1. Mohamed Ismail,TerriFiez, "Analog VLSI Signal and information Processing", McGraw Hill International Editions,1994.
2. Samir Palnitkar, "Veri Log HDL, A Design guide to Digital and Synthesis" 2nd Ed, Pearson,2005.
2. Xilinx (2006) Spartan-3E Starter Kit Board User Guide. UG230 (v1.0) March 2006
3. Xilinx (2006) System Generator for DSP performing Hardware-in-the-loop with the SPARTAN-3E Starter Kit, December 2006

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MICROCONTROLLERS AND APPLICATIONS (ELECTIVE -1)

Course Code: 18EE51E1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO/PSO	BTL
CO1	Outline functional and operational features of PIC18C7X micro-controller	PO2/PSO1	2
CO2	Demonstrate programming of PIC18C7X	PO2,PO5/PSO1	2
CO3	Develop interfacing of PIC18C7X to analog and digital controller components	PO2,PO5/PSO1	3
CO4	Apply PIC18C7X programming to real time control applications	PO2,PO5/PSO1	3

PIC 18C7X MICROCONTROLLER- Architecture memory organization – Addressing modes – Instruction set – Programming techniques – simple programs-Timers – interrupts – I/O ports – I2C bus for peripheral chip access – A/D converter – UART.

MOTOR CONTROL SIGNAL PROCESSORS- Introduction- System configuration registers - Memory Addressing modes - Instruction set – Programming techniques – simple programs. General purpose Input/Output (GPIO) Functionality- Interrupts - A/D converter -PWM signal generation.

REAL TIME OPERATING SYSTEM FOR MICROCONTROLLERS: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers. ARM 32 Bit MCUs: Introduction to 18/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set –Development-tools. Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments – Robotics and Embedded control

TYPICAL APPLICATIONS–PWM pulse generation for converters- electric motor drives.

TEXT BOOKS:

1. Mazidi& Mc Kinley, " The 8051 Micro controller and Embedded Systems using Assembly and c", 2nd edition, published by Person Education, 2006
2. Rajkamal, "Embedded Systems Architecture, Programming and Design", TATA McGraw-Hill Publications, 2003.

REFERENCE BOOKS:

1. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004

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DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS (ELECTIVE 1)

Course Code: 18EE51E2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Understand Pspice modelling of power semiconductor devices and passive components behaviour with protection circuits.	PO1,PO2	2
CO2	Analyse performance of AC-DC controlled, uncontrolled converters and DC-DC converters using Pspice and MATLAB Simulink model.	PO1,PO2	4
CO3	Evaluate DC-AC converters performance using modern simulation tools.	PO1,PO2	5
CO4	Analyse AC voltage controller and cyclo-converter performance with programming and simulation tools.	PO1,PO2	4

MODELING OF POWER ELECTRONIC DEVICES: General purpose circuit analysis software – Methods of analysis of power electronic systems - Transients and the time domain analysis with Pspice – Fourier series and harmonic components – Pspice modeling of diode, BJT,MOSFET,IGBT, SCR,TRIAC in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply.Modeling of SCR, TRIAC and IGBT, simulation of driver and snubber circuits.**SIMULATION OF AC-DC CONVETERS USING PSPICE AND MATLAB SIMULINK:** Modeling of single phase and three-phase uncontrolled and controlled (SCR) rectifiers- simulation of converter fed DC drives-computation of performance parameters: harmonics, power factor, angle of overlap. **SIMULATION OF DC-DC CONVERTERS USING PSPICE AND MATLAB SIMULINK :** Modeling of Chopper circuits- Simulation of thyristor choppers with voltage, current and load commutation schemes- Simulation of chopper fed dc motor- computation of performance parameters.**SIMULATION OF DC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK**: Modeling of single and three phase inverters circuits – Space vector representation- Pulse-width modulation methods for voltage control- Simulation of inverter fed induction motor drives. **SIMULATION OF AC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK:** Modeling of AC voltage controllers, and Cyclo-converters- Simulation of AC voltage controllers and Cyclo-converters feeding different loads-Computation of performance parameters.

TEXT BOOKS:

1. Rashid, M., "Simulation of Power Electronic Circuits using PSPICE", Prentice Hall Inc., 2006
2. M. B. Patil, V. Ramnarayanan and V. T. Ranganathan., "Simulation of Power Electronic Converters", 1st Edition, Narosa Publishers, 2010.
3. John Keown., "Microsim, Pspice and circuit analysis"-Prentice Hall Inc., third edition, 1998.

REFERENCE BOOKS:

1. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.
2. IssaBatarseh, 'Power Electronic Circuits', John Wiley, 2004Simulink Reference Manual, Math works, USA.

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INDUSTRIAL CONTROL ELECTRONICS (ELECTIVE -1)

Course Code: 18EE51E3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline switch mode power supplies for Industry usage	PO2	2
CO2	Demonstrate Industrial control process electronic components	PO2	2
CO3	Identify opto-electronic applications to industrial processes	PO2,PO5	3
CO4	Apply control of servo-motor based industrial processes	PO2,PO5	3

Review of switching regulators and switch mode power supplies - Uninterrupted power supplies-offline and on-line topologies-Analysis of UPS topologies, solid state circuit breakers, solid-state tap changing of transformer.

Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers, derivative over run, integral windup, cascaded control, Feed forward control, Digital control schemes, control algorithms, programmable logic controllers - sensors for high voltage and current applications

Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding.

Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors; Fibre-optics; Bar code equipment, application of barcode in industry.

Stepper motors – types, operation, control and applications; servo motors- types, operation, control and applications – servo motor controllers – servo amplifiers – linear motor applications-selection of servo motor.

Reference Books:

1. Michael Jacob, 'Industrial Control Electronics – Applications and Design', Prentice Hall, 1995.
2. Thomas E. Kissell, 'Industrial Electronics', Prentice Hall India, 2003
3. James Maas, 'Industrial Electronics', Prentice Hall, 1995

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Annexure-VI

List of Certificate Courses to be offered by the Department of EEE for A.Y 2018-19

SNO	Name of the Course	Regulation	Course Level	Offered to Specializations	Organizing Institute	Focused on
1	Advanced IoT	Y16	2	PE, PS, CS, ES	APSSDC	Employability

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SOFT COMPUTING TECHNIQUES (ELECTIVE -2)

COURSE CODE: 18EE51F1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Demonstrate model, learning and training methods of Artificial Neural networks	PO2	2
CO2	Apply Genetic algorithms to engineering problems	PO2,PO5	3
CO3	Demonstrate characteristics of Fuzzy systems	PO2	2
CO4	Apply Neual netwotks and fuzzy logic to motor control s	PO2,PO5	3

INTRODUCTION: Introduction and motivation. Approaches to intelligent control.Architecture for intelligent control.Symbolic reasoning system, rule-based systems, the AI approach.Knowledge representation.**ARTIFICIAL NEURAL NETWORKS:** Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network.Networks: Hopfield network, Self-organizing network and Recurrent network.**GENETIC ALGORITHM:** Genetic Algorithm: Basic concept of Genetic algorithm: Mutation,Reproduction and cross over and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm, genetic algorithm as classifier and engineering applications.**FUZZY SYSTEMS:** Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system.Fuzzification, inference and defuzzification.Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control.**FUZZY LOGIC & NEURAL NETWORK APPLICATIONS TO DRIVESFuzzy logic applications:** Design of Fuzzy PI controller for speed control of DC motor- Flux programming efficiency improvement of three phase induction motor-Induction motor speed control. **Neural network applications:-**PWM Controller-Selected harmonic elimination PWM-Space vector PWM

TEXT BOOKS

1. Neural Networks: A comprehensive Foundation – Simon Haykins, Pearson Edition, 2003.
2. Fuzzy logic with Fuzzy Applications – T.J.Ross – Mc Graw Hill Inc, 1997.
3. Genetic Algorithms- David E Goldberg.
4. Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
5. Artificial Intelligent based Electrical Machines and Drives- Peter Vas, Oxford University Press

REFERENCE BOOKS

1. Neural Network Fundamentals with Graphs, Algorithms and Applications, N.K. Bose and P.Liang, Mc-Graw Hill, Inc. 1996.
2. Intelligent System- Modeling, Optimization and Control- Yung C. Shin and ChengyingXu,CRC Press, 2009.
3. Soft computing & Intelligent Systems- Theory & Applications – N.K.Sinha and ModanM Gupta. Indian Edition, Elsevier, 2007.
4. Fuzzy logic Intelligence, Control, and Information- John Yen and Reza Langari, Pearson Education, Indian Edition, 2003.

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DIGITAL SIGNAL PROCESSORS AND APPLICATIONS (ELECTIVE-2)

Course Code: 18EE51B2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline components of digital signal processing	PO2	2
CO2	Demonstrate Architecture of TMS320C5X, TMS320C6X and ADSP-21XXprocessors	PO2	2
CO3	Demonstrate programming of functional units of TMS320C5X, TMS320C6X and ADSP-21XX	PO2	2
CO4	Develop Signal conditioning and PWM applications with TMS320C5X, TMS320C6X and ADSP-21XX processors	PO2,PO5	3

FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING: Review of DSP fundamentals. Issues involved in DSP processor design - speed, cost, accuracy, pipelining, parallelism, quantization error, etc. Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc.**TMS320C5X PROCESSOR 9 Architecture**: Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.**TMS320C6X PROCESSOR 9 Architecture:** of the C6x Processor - Instruction Set - DSP Development System: Introduction– DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals. **ADSP PROCESSORS 9 Architecture of ADSP-21XX:** and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – **Software development tools:** assembler, linker and simulator. Applications using DSP Processor - spectral analysis, FIR/IIR filter, linear-predictive coding, etc.

TEXT BOOKS:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSPMicroprocessors with Examples from TMS320C54xx, cengage Learning India PrivateLimited, Delhi 2012

2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture", TATA McGraw-Hill Education, 2002.

REFERENCES:

1. Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. NewDelhi, 2003.

2. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005 5. User guides Texas Instrumentation, Analog Devices, Motorola.

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OPTIMIZATION TECHNIQUES (ELECTIVE-2)

Course Code: 18EE51B3

L	T	P	C
3	0	0	3

CO No:	Course Outcome (CO)	PO	BTL
CO1	Understand classical optimization techniques, describe clearly the problems with and without constraints, identify its parts and analyze the individual functions, Feasibility study for solving an optimization problem.	4,5	2
CO2	Design and apply mathematical translation of the verbal formulation of an optimization problem and design algorithms of linear programming problems, the repetitive use of which will lead reliably to finding an approximate solution.	4,5	3
CO3	Evaluate and measure the performance of an algorithm of different methods to solve non-linear programming problems, study and solve optimization problems.	4,5	4
CO4	Analyze optimization techniques using algorithms. Investigate, study, develop, organize and promote innovative solutions for various applications.	4,5	4

Classical Optimization Techniques: Single variable optimization, multi-variable optimization with no constraints, with equality and inequality constraints, Karush- Kuhn- Tucker constraints **Linear Programming (LP):** Geometry of LP problem, graphical solution, simplex algorithm, two-phases of simplex algorithm, duality, dual simplex method, post-optimality analysis, quadratic programming. **Non-Linear Programming:** One-dimensional optimization – Fibonacci method, golden section method, quadratic and cubic interpolation methods, Newton's method.Unconstrained optimization - Steepest descent method, conjugate gradient method, Davidon-Fletcher-Powell method.Constrained Optimization - Methods of feasible directions, gradient projection method, generalized gradient method, penalty function methods, Augmented Legrangian multiplier method, Branch and bound method**Non-traditional Optimization Methods and Applications:**Genetic algorithms (G A), G A Operators, G A for constrained optimization, real –coded GAs.Particle swarm optimization.

Text Books:

3. S.S. Rao, ' Engineering Optimization : Theory andPractice.III Edition, New Age International (p) Limited Publications
4. Kalyanmoy Deb, ' Optimization for Engineering Design', PHI Learning Private Limited.

Reference Books:

2. PurnachandraBiswal, ' Optimization in Engineering', Scitech Publications (India) PVT Ltd

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FACTS DEVICES (ELECTIVE-3)

COURSE CODE: 18EE52C1

L	T	P	C
3	0	0	4

Co.No:	Course Outcomes	PO/PSO	BTL
CO 1	Interpret the significance of FACTS devices in power system	PO-1,2	2
CO 2	Demonstrate the operation and control of shunt compensation devices	PO-1,2	2
CO 3	Demonstrate the operation and control of series compensation devices	PO-1,2	2
CO 4	Demonstrate the operation and applications of special FACTS devices like UPFC and IPFC	PO-1,2	2

FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATIONS: Transmission interconnections, Power Flow in AC system, Dynamic stability Considerations and the importance of the controllable parameters, Introduction to Facts devices, Basic types of FACTS Controllers, benefits from FACTS controllers.**STATIC SHUNT COMPENSATION:** Objectives of shunt compensation, Methods of controllable VAR generation, variable impedance type static VAR generators (SVC): TCR, TSR, TSC, FC-TCR, TSC-TCR, switching converter type VAR generators: STATCOM, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement.**STATIC SERIES COMPENSATION: Objectives** of series compensation, variable impedance type static series controllers: GCSC, TSSC, TCSC, switching converter type controller: SSSC, Operation and Control External system Control for series Compensator SSR and its damping – Static Voltage and Phase angle Regulators - TCVR and TCPAR – Operation and Control.**UPFC AND IPFC:**The unified power flow Controller – Operation –Comparison with other FACTS devices – control of P and Q – dynamic performance – special Purpose FACTS controllers – Interline Power flow Controller – Operation and Control.

TEXT BOOKS:

3. N.G Hingorani&L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,2000
4. K.R.Padiyar "FACTS Controller in power Transmission and Distribution" New Age Int Publisher,2007

REFERENCE BOOKS:

5. Vijay K Sood "HVDC and FACTS Controllers" Kluwer Academic Publishers,2004.
6. Xiao-Ping Zhang, Christian Rehtanz,Bikash Pal, "Flexible AC Transmission Systems- modeling and control" Springer, 2005.

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ELECTRIC AND HYBRID VEHICLES(ELECTIVE -3)

Course Code: 18EE52H2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Demonstrate Mechanics of Electric vehicle	PO2	2
CO2	Demonstrate Power train components of Electric vehicle	PO2	2
CO3	Apply controllers to electric vehicle drive system	PO2,PO5	3
CO4	Outline energy storage systems for Electric vehicles	PO2	2

ELECTRIC VEHICLES AND VEHICLE MECHANICS -Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

ARCHITECTURE OF EV's& HEV's AND POWER TRAIN COMPONENTS - Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes. Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

CONTROL OF DC AND AC DRIVES-DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and configuration and control of Permanent Magnet Motor drives – Switched reluctance motor (SRM) drives.

BATTERY ENERGY STORAGE SYSTEM- Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries.

ALTERNATIVE ENERGY STORAGE SYSTEMS- Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors-implementation issues of energy strategies.

TEXT BOOKS:

1. Iqbal Hussain, CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, Mehrdad Ehsani, John M.Miller "Vehicular Electric Power Systems" , Special Indian Edition, Marcel dekker, Inc 2010
3. Chris Mi, M. AbulMasrur .e.tal, "Hybrid Electric Vehicles Principles and Applications with Practical Perspectives", A John Wiley & Sons, Ltd., Publication 2011.
4. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric And Fuel Cell Vehicles", CRC Press LIC 2005.

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ADAPTIVE CONTROL SYSTEMS (ELECTIVE-3)

Course Code: 18EE52C3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline elements of propbability and Stochastic processes	PO2	2
CO2	Demonstrate parametric and non-parmetric system models	PO2	2
CO3	Interpret adaptive control techniques to linear systems	PO2	2
CO4	Apply adaptive control process and asses stability of linear systems	PO2,PO5	3

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties.**Stochastic processes and system models:** Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non sequence model, Gaussian white process.**Non parametric methods & parametric methods:** Nonparametric methods: Transient analysis-frequency analysis-Correlation analysis-Spectral analysis.Liner Regression: The Lease square estimate-best liner unbiased estimation under linear constraints-Prediction error methods: Description of Prediction error methods-Optimal Prediction –relationships between Prediction error methods and other identification methods theoretical analysis.**Adaptive control schemes**Introduction – users- Definitions-auto tuning-types of adaptive control-gain scheduling controller-model reference adaptive control schemes – self tuning controller. MRAC and STC: Approaches – The Gradient approach – Lyapunov functions – Passivity theory – pole placement method Minimum variance control – Predictive control. **Adaptive control and application:** Stability – Convergence – Robustness – Application of adaptive control, direct model reference adaptive control. Introduction: Basic approaches to adaptive control. Applications of adaptive control. Identification: Error formulations linear in the parameters. Direct adaptive control: Linear error equations with dynamics. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions. Kalman-Yacubovitch-Popov lemma. Passivity theory.

TEXT BOOKS:

3. Dan Simon, "Optimal State Estimation", Wiley Intersience, 2006.
4. S. Sastry and M. Bodson, Adaptive Control: Stability, Convergence, and Robustness, Prentice-Hall, 1989.

REFERENCE BOOKS:

6. K.J. Astrom and B. Wittenmark, Adaptive Control, Addison-Wesley, 2nd edition, 1995.
7. I.D. Landau, R. Lozano, and M. M'Saad, Adaptive Control, Springer Verlag, London, 1998.
8. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, 1969.
9. K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989.
10. P.E. Wellstead& M.B. Zarrop, Self-Tuning Systems: Control and Signal Processing, J. Wiley & Sons, Chichester, England, 1991

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EHVAC & HVDC TRANSMISSION(ELECTIVE-4)

Course Code: 18EE52D1

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline operational parameters of EHV-AC transmission	PO2	2
CO2	Demonstrate various HVDC links	PO2	2
CO3	Develop insulation design and coordination for HVDC system	PO2,PO-5	3
CO4	Demonstrate mechanical design of towers for HVDC and EHV-AC transmission	PO2	2

Introduction: Need of EHV transmission, Limitations, EHV transmission, Comparison of EHV-AC & HVDC transmission, Interconnected Network and Role of Interconnecting Transmission Lines.

EHV-AC Transmission: Parameters of EHV line, over-voltages due to switching, Ferro resonance, line insulator and clearance, corona, long distance transmission with series & shunt compensations, principle of half wave transmission, flexible AC transmission.

HVDC Transmission: Types of DC links, terminal equipment's& their operations, HVDC system control, reactive power control, harmonics, multi terminal DC (MTDC) system, AC/DC system analysis, protection of terminal equipment's.

Insulation Requirement of EHV-AC and HVDC: Classification, Insulation design aspect, Difference between Insulation Coordination-EHV-AC and HVDC, Insulation Coordination, Surge arrester protection in HVDC and EHV-AC Substation, Clearance for HVDC and EHV-AC.

Towers for (EHV-AC and HVDC): Types and configuration of self supporting and flexible towers, Foundation of towers, mechanical design of towers, Tower design based on switching surges and lightning strokes.

TEXT BOOKS:

3. K. R. Padiyar, HVDC Power Transmission System, Wiley Eastern Limited, 1990.
4. EHV-AC, HVDC Transmission and Distribution Engineering, S. Rao, Khanna Publishers, 2001.

REFERENCE BOOKS:

3. Rakesh Das Begmudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Limited, New Delhi – 1987
4. E.W.Kimbark, EHV-AC and HVDC Transmission Engineering &Practice, Khanna Publishers.

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POWER QUALITY (ELECTIVE-4)

Course Code: 18EE52D2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Outline basic power quality issues	PO2	2
CO2	Demonstrate conventional loop control for voltage and current balance	PO2	2
CO3	Demonstrate DSTATCOM for power quality restoration	PO2	2
CO4	Apply combined compensation techniques for power quality restoration	PO2,PO5	3

INTRODUCTION- Characterization of Electric Power Quality: Transients, short duration and longduration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations,Power frequency variation, Power acceptability curves – power quality problems: poor loadpower factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage,Disturbance in supply voltage – Power quality standards.Transients – origin and classifications – capacitor switching transient – lightning-load switching – impact on users – protection – mitigation. **CONVENTIONAL LOAD COMPENSATION METHODS** -Principle of Load compensation and Voltage regulation – Classical load balancing problem:Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction andvoltage sag reduction – Analysis of unbalance – instantaneous real and reactive powers –Extraction of fundamental sequence component **LOAD COMPENSATION USING DSTATCOM** - Compensating single phase loads – Ideal three phase shunt compensator structure –Generating reference currents using instantaneous PQ theory – Instantaneous symmetricalcomponents theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode. **SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM** Rectifier supported Dynamic Voltage Restorer – DC Capacitor supported DVR – DVRStructure – voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TEXT BOOKS:

5. ArindamGhosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
6. R.C. Duggan, Mark.F.McGranaghan,SuryaSantoas and H.WayneBeaty, "Electrical Power System Quality", McGraw-Hill, 2004.
7. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publication, 1994.
8. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press, 2000. Indian Reprint – 2013

REFERENCES

4. Jos Arrillaga and Neville R. Watson ," Power system harmonics",Wiley,2003.
5. Derek A. Paice , "Power Electronics Converter Harmonics :Multipulse Methods for CleanPower",Wiley,1999.
6. Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines, Elseveir academic press publications,2011.

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POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (ELECTIVE -4)

Course Code: 18EE52H3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	BTL
CO1	Interpret Power electronic power modulators for PV power utilization	PO2	2
CO2	Interpret Power electronic power modulators for wind power utilization	PO2	2
CO3	Illustrate hybrid PV-wind power integration to grid	PO2	2
CO4	Demonstrate model, sizing and interface of micro-grids	PO2	2

SOLAR POWER CONTROL- Introduction to PV-Cells, Array, Solar power extraction using PV-Cells, I-V Characteristics, PV-Inverters without D.C. to D.C. converters, Grid interfacing-with isolation, without isolation, Maximum power point tracking-Methods, PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation.

WIND POWER CONTROL-Fixed speed with capacitor bank, Rotor resistance control, DFIG, Synchronous Generator-external magnetized, Synchronous Generator-permanent magnets.

ANALYSIS OF WIND AND PV SYSTEMS-Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system.

INTRODUCTION TO MICRO-GRIDS - Types of micro-grids – autonomous and non-autonomous grids – Sizing of micro-grids- modeling & analysis- Micro-grids with multiple DGs – Micro- grids with power electronic interfacing units. Transients in micro-grids - Protection of micro-grids – Case studies.

TEXT BOOKS

1. FredeBlaabjergand Dan M. Ionel,"Renewable Energy Devices and Systems with Simulation", CRC Press-2017
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. .Integration of alternative sources of energy /Felix A. Farret, M. Godoy simoes
4. S.N.Bhadra, D. Kastha,& S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009
5. Li Fusheng, LiRuisheng and Zhou Fengquan, "Microgrid Technology and Engineering Application", Academic Press is an imprint of Elsevier -2016

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Annexure-IV

1. Syllabus of New Course for Y17 admitted students

Course Code	Course Name	Cat	New Syllabus	Topics Added/ Removed / Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
17EE3262	Battery Modelling for Electric Vehicles	PE	Components of battery-management systems Lithium-ion cell terminology, major functions provided by a battery-management system and their purpose - Identify the major components of a lithium-ion cell and their purpose - Understand how a battery-management system "measures" current, temperature, and isolation. Functions of battery-management systems Identify electronic components that can provide protection and specify a minimum set of protections needed - Compute stored energy in a battery pack - List the manufacturing steps of different types of lithium-ion cells and possible failure modes. Static Modelling of Battery Static modelling of battery: static model parameters of the battery, lab test to determine the parameters of battery model, static equivalent circuit determination. Dynamic Modelling of Battery Dynamic modelling of battery, parameters affecting the dynamic model, lab test to determine the dynamic model parameters, dynamic equivalent circuit determination.	--		Industry expert	100%
17EE3263	Charging Stations for Electric Vehicles	PE	Power Electronics for EV Battery Charging Forward/ Flyback Converters, Half-Bridge DC–DC Converter, Full-Bridge DC–DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc-dc converter Charger Topologies Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, High power topologies, Multi-port Charger Charging Modes Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Float charge, Trickle Charge Charging Infrastructure Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001 Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock Digital Communication between EV and Charging Station Installation Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947-Part I, II, III and 61215 Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control	--		Industry expert	100%

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17EE3271	Energy Accounting and Management Systems	PE	Introduction: Present power generation, transmission, and distribution scenario of India, Elements of power systems, transmission, distribution and generations, Functions of power distribution companies, and Power distribution from distribution substation to end consumers. Organizational context: Organization structure of Distribution Company along with escalation matrix, Duties and responsibilities of Engineer Distribution, Relevant legislation, Electricity Act 2003, Central Electricity Regulatory Commission, State Electricity Regulatory Commission, Interpret Central Electricity Authority Regulations 2010. Roles and responsibilities of MSDC, MSDE and NSDA in power sectors. Energy Accounting: Metering and Billing: Revenue management system in electrical distribution, Importance of Processes for Revenue Collection, Flow Chart of Revenue Collection, Energy Audit, Calculation of Aggregate Technical and Commercial loss, Measures to reduce Technical and Commercial losses, Power purchase calculation and future demand, Long term and short-term agreement in power purchase, Management of supply-demand gap, Laws and Regulation on withdrawal of Power from Grid Network, Process and documents needed for change in category of supply, Meter replacement and supply restoration. Energy Management Systems and Demand Side Management Work Contents of DSM Implementation by Power Grid Enterprises-Condition for Promoting Power Grid Enterprises to Actively Develop DSM Program- Experiences of Power Grid Enterprises in DSM Implementation-Load Management of Demand Side Management under Power Market Environment-Development Potential of Clean Development Mechanism Project of DSM.	--		Industry expert	100%
17EE3272	Substation practice	PE	Power Distribution Network: Circuit connections, voltage and current relationship in star & delta configuration, 3-phase and 1-phase supply, Types of distribution system, Concept of Load Flow Study in Power System, Components of Distribution System, schematic drawings, Layout of Plans for Erection and Commissioning, Preparation of Bill of Quantity (BOQ), procurement Processes in power distribution system, process for Installation of Equipment in distribution system as per the standards. Substation Erection and Commissioning: Various types of Distribution Substation 33/11 and 11/433 kV, AIS, GIS etc., technical specifications of distribution substation equipment, different clearances required for the voltages, procedure for erection and commissioning of distribution substation, importance of capacitor bank, different mounting structures for the transformer, erection of Equipment in Distribution Substation, installation procedure of Switchgear, Power Factors Correction Panels and Control Panels, Substation Automation System (SAS) in Power Distribution Network. Distribution System Protection: Various Distribution System Protections, surge voltages along with various surge protection devices, the importance of a lightning arrestor (LA) in the distribution network, Earthing of the Distribution System, and different grounding systems. Operation and Maintenance of Distribution System: Load Management, Grid Stability, Frequency, Load Dispatch, Feeder Loading etc. Monitor Remote Terminal Unit (RTU), Ring Main Unit (RMU) and Other Automation Systems, Standard Operating Procedures (SOPs) and Maintenance Schedules. Types of maintenance practices followed in distribution like preventive, regular maintenance etc. Underground and overhead maintenance work related to the distribution system, Use of different equipment needed for locating the cable fault and fault rectification method.	--		Industry expert	100%

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17EE3273	Distribution System Testing and Safety Practices	PE	SYLLABUS: Testing of the Equipment in Power Distribution: Testing of distribution Transformer and associated components, routine test on the equipment, the importance of Insulation Resistance testing, polarisation Index and absorption index, the importance of magnetic balance test of the transformer, Test the earthing resistance in distribution system, various tests on Current Transformer, Capacitor Voltage Transformer, Lightning Arrestor, Circuit Breaker, Energy meter etc. to ensure their healthiness, Fault location methods for distribution systems lines and cables Use basic Health & Safety practices for power related work: Basic health and safety practices covering CEA safety regulations 2010, issue of permit to work etc. Uses of Personal Protective Equipment during at work site e.g. safety helmet, belt, shoes, protective glasses, earth rod, etc. Documentation refers to safety: Retrieve and point out documentation that refers to safety, health policy and standards, Inform relevant authority of any abnormal situation/ behaviour of any equipment, good housekeeping practises and disposal of waste, common hazard, Storage of flammable materials and oils safely, possible causes of risk or accident, any abnormalities in system installed, alarms, noticing parameters, fire safety, causes and precautionary activities. Rescue techniques during fire hazards: Use of appropriate fire extinguishers on different types of fires, rescue techniques applied during fire hazards, correct method to move injured people during emergency, Arrange/ transport heavy objects and tools safely using correct procedures from storage to workplace and vice versa, Administer appropriate first aid to victims, bandaging heart attack, CPR, etc., how to free a person from electrocution, Respond promptly and appropriately to an accident situation or medical emergency in real or simulated environments, Inform relevant authority about any abnormal situation, Complete written accident report or dictate a report, send report to concern person responsible.	--		Industry expert	100%
17EE3281	Solar pv & thermal technologies	PE	Solar PV System: Overview of Indian Power Sector, Solar spectrum, Terrestrial and extraterrestrial regions. Solar Irradiance and Insolation, Photovoltaic effects, Economics and future prospects, Jawaharlal Nehru National Solar Mission role, Site Selection factors. PV cell characteristics, Effect of variation of temperature, Insulation level & Tilt Angle on the characteristics, Fabrication process. Solar Thermal Systems: Principles of applied heat transfer, Different types of solar thermal collectors, Solar power tower, Solar pond, solar desalination, solar space heating and cooling, Solar thermal cocker, Solar water heating system. Modeling and Sizing solar PV – Model of PV cell, short circuit, open circuit and peak power parameters, datasheet study, cell efficiency, fill factor, Solar PV system simulation, series, and parallel interconnection, Sizing of PV, Introduction to Auxiliary Battery system and its sizing, PV and Battery interfaces. Solar PV System Design - Types, Selection criterion, MPPT Schemes and different power conversions for MPPT achievement, salient features, Grid-Connected Inverter: Functions of the inverter in PV systems, Classification of grid-connected Inverter, Inverter Efficiency, Selection of Grid-connected Inverter. PV module datasheet and specifications. Energy meter selection. Isolated and Grid-connected PV systems: Autonomous PV system; Grid connection Principle, Grid Linked PV systems; Three-phase d-q controlled Grid connection DC-AC transformation and AC-DC transformations, PV- Grid interface example and Case study, Remote Applications of Solar PV.	--		Industry expert	100%

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17EE3282	Wind & micro energy systems	PE	Wind Energy: Wind Energy Basics, Components of WECS, Power obtained from the wind, Factors influencing wind power, Wind data and Energy estimation, Wind Measurement & Analysis: Simple momentum theory, Power coefficient, Aerodynamics of WT, Betz's Limit, Blade Element Theory, Blade Design, Control Strategies: Power Regulation, yaw control, Pitch control, stall control, Schemes for Maximum Power Extraction. Wind Turbine Technology & Generators: HAWT, VAWT, Constant Speed constant frequency, Variable speed variable frequency, Modeling of DFIG, PMSG. Grid Connected Systems: Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries. Geothermal Energy: Introduction to geothermal energy, structure of the earth interior, geothermal gradients, geothermal resources, geothermal power generation – liquid dominated and vapour dominated geothermal electric power plants. Tidal Energy: Introduction to tidal energy, tidal characteristics, tidal range, tidal energy estimation, types of tidal power plants – single basin single effect plant, single basin double effect plant, double basin double effect plants. Ocean Energy: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system. Biomass Energy: Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, and power generation. Biomass energy conversion technologies, Biogas generation – classification of Biogas plants, Urban waste to energy conversion, Biomass energy programme in India.	--		Industry expert	100%
17EE4162	Energy conservation & audit	PE	Role of energy in economic development and social transformation, Energy Sources and Overall Energy demand and availability, Energy Conservation Act-2001 & 2003. Electricity Tariff. Energy Audit: Need, Types, Methodology and Approach. Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, maximizing system efficiency. Instruments Used in Energy Auditing, Energy Conservation opportunities in Transformers and cables. Energy Conservation opportunities in Transmission lines, P.F. improvements, Demand Side management (DSM), Variable speed drivers. Electric Motors: Types, Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, Energy efficient motors and Soft starters. Energy conservation opportunities. Illumination / Lighting Systems: Light source, choice of lighting, luminance requirements, electronic ballast, occupancy sensors, energy efficient lighting control. LED Ligh ting, Trends and Approaches. Energy conservation opportunities in HVAC, Refrigeration and Air Conditioning systems, Energy Saving in Pumps & Pumping Systems. Energy Conservation Opportunities in Public and Private Buildings, Concepts of Cogeneration. Peak Demand controls- Methodologies.	--		Industry expert	100%

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17EE4161	Battery states estimation	PE	Importance of state estimation methods, Physical interpretation of battery terminology, Simple vs better estimation method, Limitations of voltage and current Measurement methods for estimating SOC, Advantages of model based estimation methods for SOC, sequential probabilistic inference and state estimation, combined uncertainty of two unknown quantities, time-varying uncertain quantities, Vector and matrix notations and cost function, Solution of state estimation through mechanism of sequential probabilistic inference, Derivation of three Kalman-filter prediction steps, Kalman filter to linear systems, Visualizing the Kalman filter with a linearized cell model, Introducion to Octave code to generate correlated random vectors, kalman filter algorithm and syntax in Octave, Octave code to implement KF for linearized cell model, Improvement of numeric robustness of Kalman filter, Automatic detection of bad measurements with a Kalman filter. Initialize and tune a Kalman filter, Introducing nonlinear variations to Kalman filters : Models for nonlinear Kalman filters Assumptions of EKF and its limitations. Deriving the three extended-Kalman-filter prediction steps, Deriving the three extended-Kalman-filter correction steps, Algorithm for EKF, Introducing a simple EKF example, with Octave code, Preparing to implement EKF on an ECM, Introducing Octave code to initialize and control EKF for SOC estimation, Introducing Octave code to update EKF for SOC estimation, Limitations of EKF for estimation of SOC of non-linear model, Problems with EKF that are improved with sigma-point methods, Approximating uncertain variables using sigma points, Deriving the six sigma-point-Kalman-filter steps, Introducing a simple SPKF example with Octave code, Algorithm for SPKF, Introducing Octave code to initialize and control SPKF for SOC estimation, Introducing Octave code to update SPKF for SOC estimation, Necessity of clever when estimating SOC for battery packs : Real-world issue: Current-sensor bias,	--		Industry expert	100%
17EE4182	Energy management system	PE	Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition. Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Energy Efficiency in Buildings: Electrical Energy Conservation, Opportunities and Techniques for energy conservation in Buildings. Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture. Energy Conservation Building Code – 2007 (2008 Edition) Energy Conservation Opportunities in Public and Private Buildings. Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential. Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices. Pumps, types and application, unit's assessment, Energy Saving in Pumps & Pumping Systems. HVAC, Refrigeration and Air Conditioning: Vapor compressor refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance, Vapor absorption refrigeration systems: Working principle, type and comparison with vapor compressor system. Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization.	--		Industry expert	100%

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17EE4172	Smart distribution system	PE	Smart Grid and Distribution System Architecture - Introduction to Smart Grid - Evolution of Electric Grid-Definitions and Need for Smart Grid -Smart grid drivers, functions, opportunities, challenges and benefits- Initiatives for Smart Grid -Smart server - regional server -Smart appliances and smart meter -Advanced Distribution Management Systems -Outage Management. Smart Sub-station -Intelligent Substation -Protection, Monitoring, and Control Devices (IEDs) -Sensors – SCADA- Sub-station location and rating -Protocol stacks -Interoperability and IEC 61850-Substation Design-Message exchange- Distribution Reconfiguration. Load Forecasting-Distribution system modeling-Single-phase models for balanced three-phase distribution systems-Three-phase models for unbalanced three-phase distribution systems- State estimation-Weighted least square (WLS) estimators-Univariate Methods for Short-Term Load Forecasting-Application of the Weighted Nearest Neighbor Method to Power System Forecasting Problems. Volt/VAr Control – Devices-Voltage drop and energy loss-Load Response-Benefits - Capacitors in distribution systems-location-control equipment inside sub-station, feeder side implementation-FDIR control frequency balance in smart-grid architecture Frequency increase and drop operation - Message exchange in frequency operation.	--			
17EE4163	Electric vehicle fault diagnosis and control	PE	Sensors and actuators Sensors: Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Motor speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Throttle plate angular position, and Air bag sensors, Actuators: Relays, Solenoids, motors and piezoelectric force generators, Chassis control systems , Automatic transmission control systems. Micro-controller functions PIC controller basics: Ports, Timer/Counters, Interrupts, Watchdog timers and PWM Development of control algorithms for different automotive subsystems: Look-up tables and maps, Need of maps, Procedure to generate maps, Fuel maps/tables, Ignition maps/tables, Motor calibration, Torque table, Dynamometer testing. Communication protocols and Infotainment systems Overview of automotive communication protocols, CAN, LIN , Flex Ray, MOST , Ethernet, D2B and DSI, Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packet radio service (GPRS). Fault Diagnosis Fundamentals of Diagnostics, Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system, Fault finding and corrective measures, Electronic transmission checks and Diagnosis, Diagnostic procedures and sequences, On-board and off-board diagnostics in Automobiles, OBDII, Concept of DTCs, DLC, MIL, Freeze Frames, History Memory, Diagnostic tools, Diagnostic protocols KWP2000 and UDS.	--			

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17EE4181	Energy storage systems	PE	Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable. Needs for Electrical Energy Storage: Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, the roles of electrical energy storage technologies, the roles from the viewpoint of a utility, the roles from the viewpoint of consumers, the roles from the viewpoint of generators of renewable energy. Classification of EES systems, Mechanical storage systems, pumped hydro storage (PHS), Elastic energy storage, Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems: Introduction to batteries, elements and operation of electrochemical cells, theoretical cell voltage and capacity, losses in cells. Battery classification, factors effecting battery performance, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG). Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies. Electromagnetic energy storage: Superconducting Magnetic Energy Storage. Super capacitor: Basic components of super capacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, aqueous and organic electrolytes. The disadvantages and advantages of super capacitors over battery systems and their applications in the aspects of energy density, power density, price and market. Applications: Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA-aggregation of many dispersed batteries. batteries for PV systems.	--		Industry expert	100%
17EE4171	Smart Grid Communication and Cyber Security	PE	COMMUNICATION TECHNOLOGIES FOR THE SMART GRID: Different types of Communication technologies for the smart grid. Standards for information exchange, DNP3. Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network. INFORMATION SECURITY FOR THE SMART GRID AND MEASUREMENT TECHNOLOGY Introduction – Encryption and Decryption Authentication, Digital signature, Message digest, cyber security standards. Communication and Measurement - Monitoring, Advanced metering infrastructure-GIS and Google Mapping Tools, Multi Agent Systems (MAS) Technology for Smart Grid Implementations. INTEROPERABILITY AND STANDARDS: Introduction-Benefits and Challenges Of Interoperability, Model For Smart Grid Network Interoperability, Approach to Smart Grid Interoperability Standards, IEC61850, GOOSE. HACKING AND CYBER-SECURITY: Identifying a target-Vulnerability- Attack tools-Attack methods-Cyber security architecture • SGCG reference architecture - ISA-62443: zones and conduits and Smart Grids - Smartphone Security- Smartphone Security Guidelines-Communicating Securely (Through Voice and Messages) with a Smartphone- Secure Voice Communication- Sending Messages Securely.	--		Industry expert	100%

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17EE3102	POWER SYSTEM PROTECTION AND CONTROL	co re	**Power System Protection:** Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays &static relays. Introduction to Digital Protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings. Protection schemes- over current, differential and distance. **Protection against Over Voltages:** Causes of over voltages, ground wires, lightning arresters, **Neutral Grounding:** Necessity of earthling, step voltage, Types of neutral grounding. **Economic Dispatch:** Optimal operation of generators on a Bus Bar, optimal unit commitment, optimum generation schedulingwith and without constraints. **Automatic Generation Control & Automatic Voltage Regulator:** Load frequency control single area (Single area case), Load frequency control and economic dispatch control, Introduction to two area load frequency control, automatic voltage control,AVR block diagram, PV curves.			Industry expert	100%
17EE3261	Introduction to Electric Vehicle	Elective	HISTORY OF ELECTRIC VEHICLES History of EV, Case studies on Economic and Environment aspects of EV, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE EV markets – Supply and demand, Economic analysis with case study, Environmental impact analysis with case study. Impact of different transportation technologies on environment and energy supply. CLASSIFICATION OF ELECTRIC VEHICLES Plug-in EVs, ON-road and off-road EVs, Rail borne EVs, Airborne EVs, Seaborne EVs, Electric Rover and Spacecraft. Advantages and Disadvantages of Different EVs. INTRODUCTION TO EV DYNAMICS & POWER TRAIN COMPONENTS Motion and dynamic equations of electric vehicles, the difference between structures of EV two wheelers, three wheelers and four wheelers. Different materials are used for EV chassis and power trains—basic EV calculations. MOTOR SELECTION AND SIZING IN POWER TRAIN Characteristic features of the Motors to be used in EV, evaluation of various motors for EV characteristics, sizing of the motor as per the power drive requirement	--	-	Faculty recommendation	100%

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Annexure-VI

List of Certificate Courses to be offered by the Department of EEE for A.Y 2018-19

SNO	Name of the Course	Regulation	Course Level	Offered to Specializations	Organizing Institute	Focused on
1	Advanced IoT	Y16	2	PE, PS, CS, ES	APSSDC	Employability

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