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XXVII meeting of the Academic Council (AC)-Annexure 3.5

Dt: 22-06-2019

Department of Electrical & Electronics Engineering

Minutes of the XXIII BOS Meeting

The Department BOS meeting is held on 22nd June 2019 from 2.00 pm-5.00 PM in Room No C323

The following members were present:

1. Dr. Praveen Singh Satvat, dean Academics, KLEF- Patron
2. Dr. K Narasimha Raju, Professor & HoD, Department of EEE, KLEF-Chairman
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, KLEF-Co-Opted 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

Member Not Attended: NIL

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Opening Remarks by Chair

1. Dr. K.Narasimha Raju, 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 and the Chairman then put forward the Agenda items before the Board.

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 of the BoS informed the members present about the Department Academic Committee (DAC) meeting held on 17th June 2019 (Agenda Item No: 1) and highlighted the major resolutions of discussion as brought to the notice of the DAC by the student members and the board unanimously resolved to approve the recommendations made by the DAC. (Annexure I: DAC Meeting minutes dt. 17/06/2019).

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 49 students registered for placements were successfully placed in various core and software companies.
47 students got multiple job offers, got more than 2 job offers
The highest salary package is 5.5 Lakhs per annum.

Research :

105 indexed papers were published in this academic year.

AGENDA ITEM-2

Proposed new courses for admitted students in B.Tech program in A. Y:2019-20	It is resolved to approve the courses introduced in B.Tech Program in A.Y 2019-2020 admitted batch and the same is recommended to the academic council for approval

The proposed new courses for Y19 admitted students in B.Tech program are shown in below table

SL	Course Code	Course Title	Course Type	Remarks
1	19EE2201	Industrial Applications of Electrical Machines	core	New course in place of Electrical machines-II)
2	19EE2102	Electrical Power Engineering	core	New Course -syllabus of EPGTD course and Economic Dispatch concepts of Power System Protection & Control course.
3	19EE2203	Computer Application in Power Systems	core	New Course -syllabus of PSAS course and Power System Protection & Control course.
4	19EE3101	AI Techniques in Electrical Engineering	core	New Course in place of Power System Protection & Control

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5	19EE3142	Battery State Estimation Algorithms For Electric Vehicles	Elective	New Course in Place of Battery State Estimation
6	19EE3241	AI and IoT for Electric Vehicles	Elective	A new Course in place of Electric Vehicle Fault Diagnosis and Control
7	19EE3242	Communication Protocols and Testing of Electric Vehicles	Elective	New Course in Place of Battery Modelling For Electric Vehicles
8	19EE3232	Internet Of Things And Smart Grid Analytics	Elective	New Course in Place of Smart Distribution Systems
9	19EE3112	Introduction to the Industrial Internet of Things	Flexi core	New Course added in the list of flexi core
10	19EE3111	Industrial Automation & Robotics	Flexi core	New Course added in the list of flexi core
11	19EE3222	Grid Integration of Renewable Energy Resources	Elective	New Course in Place of Energy Conservation & Audit
12	19EE3221	AI and IoT for Green Energy Integration	Elective	New Course in Place of Energy Storage Systems
13	19EE3106	Sensors and Internet of Things	Flexi core	New Course added in the list of flexi core
14	19EE3102	Electric Drives	Flexi core	New Course added in the list of flexi core
15	19PH1006	Materials & Measurements	Physics Elective	New Course added in the list of Physics elective

- Based on the discussions of Academic Peers feedback of Electrical Machines-I & Electrical Machines-II without inclusion of Electrical Drives for 4 credits with L-T-P-S structure 3-0-2-0, with a name Electrical machines and **Industrial Applications of Electrical Machines**.
- Dr. Praveen Dhamarcharla recommended **Electric Drives** course can be added as a skilling course or in a flexi core course.
- Rishika suggested having regular interaction in the form of active learning and provision to design their own ideas in the laboratory, BOS members agreed to include Design Thinking and Innovation Lab to be part of the curriculum for the 2019-20 batch students.
- Dr. J Somlal, Professor-EEE, KLEF, suggested Project based labs need to be defined for a particular course in the curriculum, Project based labs can be implemented for the DAC-identified and BoS-approved core courses and were forwarded to the academic council for approval.
- Dr. SVNL Lalitha- Professor-EEE, KLEF, suggested floating power systems generation, analysis, protection, control and stability in two courses, it is resolved to float **Electrical Power Engineering L-T-P-S:3-1-0-0 and Computer Application in Power Systems L-T-P-S:3-0-2-0** which covers all topics which are required.
- Dr. N. Jayaram, Asst. Prof., NIT, AP- suggested including applications of recent advantages like AI applications into the curriculum, it is resolved to add **AI Techniques in Electrical Engineering L-T-P-S:3-0-2-0** and forwarded to the academic council for approval
- N V N S Koushik, Alumni suggested that training on Coding skills be planned for Advanced learners, It is resolved Training on Coding skills is to be planned throughout the semester as a part of the curriculum.
- Mr.H.B.Shivuni - Sales & Mkt., Head-AMS electric mobility, suggested floating **Battery State Estimation Algorithms For Electric Vehicle, Charging Stations for Electric Vehicle, AI and IOT for Electric Vehicles**

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and Communication Protocols and testing Of Electric Vehicle in Electric Vehicle Technology specialization.

- Dr. P Srinivas Varma -Associate Professor-EEE, KLEF, recommended Grid **Integration of Renewable Energy Resources** and **AI and IOT for Green Energy Integration** in Green Energy Technology specialization.
- Mr. T Viiay Muni suggested including the **Internet Of Things And Smart Grid Analytics in Smart Grid** specialization, **Introduction to Industrial Internet of Things and Industrial Automation & Robotics** suggested as contemporary courses.
- D Kalyan suggested floating **machine-based Based Design and end-to-end Application Development** in skill-based courses.

On contemporary requirements **Sensors and Internet of Things L-T-P-S: 3-1-0-0, Materials and Measurements Engineering L-T-P-S: 3-0-2-0** as physics elective and **Technical Proficiency & Training-2 L-T-P-S: 0-0-0-4** is included in the curriculum.

Because of the feedback received, BOS members resolved to include all the recommendations in the curriculum. The finalized course structure for 2019-20 B.Tech-EEE is provided in Point 1 of Annexure II

The proposed new course syllabus is shown in Point 2 of Annexure II

AGENDA ITEM-3

Proposed to revise the Syllabus for the Y19 batch courses based on the feedback received from stakeholders	It is resolved to approve the course revisions of A.Y: 2019-2020 and the same is recommended for the academic council for approval from the Y19 batch onwards

The following course revision in the syllabus is done

SL	Course Code	Course Title	Course Type	Percentage of Revision	Remarks
1	19EE3103	Restructured power systems	Flexi Core	25%	Adding tutorial component in CO-1, 2, 3 & 4.
2	19EE3105	Power quality	Flexi Core	25%	Adding tutorial component in CO-1, 2, 3 & 4.
3	19EE3104	Utilization of Electrical Energy	Flexi Core	25%	Adding tutorial component in CO-1, 2, 3 & 4.
4	19EE2101	Electrical Circuits	Core	15%	Laboratory component is included.

- Rama Chandra Yerramsetti-Programmer Analyst, Cognizant, India - problem-solving to be given more weightage through core and programming subjects, Bos members suggested **Restructured power systems L-T-P-S:3-1-0-0, Power quality L-T-P-S:3-1-0-0, Utilization of electrical energy L-T-P-S:3-1-0-0** for problem-solving recommended to academic council approval.
- Dr. N. Viswanathan, Professor, NITW- suggested offering more flexible courses, **Restructured power systems and electric drives** are recommended to be offered and forwarded to the academic council for approval.

BOS members resolved that the course structure of **'Electrical Circuits"** is given higher weightage in the Y19 curriculum, with lab components included. The revisions proposed in the syllabus of the revised course are provided in Point 2 of Annexure IV

The detailed comparison of old and new syllabi is shown in point 2 in Annexure-II

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AGENDA ITEM-4

Value-added courses to be offered in AY: 2019-20 for B.Tech EEE program	It is resolved to recommend approval 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, ISIE India. The reputation of the course-delivering organizations and the usefulness of the certificate were discussed and courses were approved by the BoS members.

(Annexure-V)

AGENDA ITEM-5

Proposed new courses for admitted students in A.Y:2019-20 admitted M.Tech -POWER SYSTEMS and POWER ELECTRONIC DRIVES Programs.	It is resolved to approve the courses introduced in M.Tech for both programs in 2019-2020 admitted batch and the same is recommended for academic council approval

As per contemporary requirements of local/global/national needs following modifications as suggested by the BOS members.

SL	Course Code	Course Title	Course Type	Remarks
1	19EE2103	Energy Management Systems	core	New course (In place of Integration of Energy Sources Transmission)
2	19EE2201	Floating Solar & Off Shore Wind Technologies	core	New course (In place of EHVAC & HVDC Transmission)

- Instead of Integration of Energy Sources Transmission, **the "Energy Management Systems"** course is offered for PED & PS.
- Dr. A Pandian suggested that recent advancements like **Floating Solar & Off Shore Wind Technologies** should be included in the M.Tech curriculum course is offered for PED & PS, instead of EHVAC & HVDC Transmission

The structure and syllabus revision for 2019-20 M.Tech-PED and M.Tech-PS are approved by the BoS members and areshown in Point 1 and point 2 of Annexure-III
The proposed new courses syllabi is shown in Point 3 of Annexure-III

AGENDA ITEM-6

Review of Percentage of courses mapped to employability, entrepreneurship and skill development for 2019-2020 B.Tech EEE, M.Tech-PS, M.Tech-PED.	BOS members recommended for academic council approval

The finalized courses were reviewed by BoS members for mapping to employability, entrepreneurship, and skill development. The weightage of course mapping for each component is analyzed
(point 1 of Annexure-II, point 1 and point 2 of Annexure-III)

AGENDA ITEM-7

Approval of Program Development Document for 2019-2020 admitted B.Tech and M.Tech Programs.	BOS members recommended for academic council approval

All the BOS members reviewed the program development document for 2019-2020 B.Tech and M.Tech structures highlighting Local/Regional/National/ Global needs and Mapping to courses is presented to all the BoS members which is reviewed for significance to introduction or revision of courses.

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AGENDA ITEM-8

Approval of MOOC courses for A.Y:2019-2020	Bos members recommended MOOC courses to academic council approval

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

The list of MOOC courses are shown in Annexure-VI

AGENDA ITEM-9

List of Pre-PhD Courses for Y19 admitted Ph.D. course	BOS members approved

BoS members reviewed the proposed list of courses for pre-PhD examination for 2019 admitted PhD scholars and approved the same.

AGENDA ITEM-10

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 Academic Council

AGENDA ITEM-11

ANY other items

Bos members discussed the inculcate research culture among the interested students and counsel them.

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Annexure-I

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT ACADEMIC COMMITTEE (DAC) MEETING MINUTES

The department academic committee meeting was held from 10:00 A.M. on **17/06/2019** 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 2019 admitting batch
3. To modify the Curriculum & syllabus for M.Tech PS and PED, 2019 admitting batch
4. Discussion on MOOC courses offered for A.Y:2019-2020
5. Discussion on Value added courses offered for A.Y:2019-2020
6. Course Clouser minutes of CO-PO attainment of the previous semester.
7. 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

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

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

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

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

II. Up 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 they will be offered during the entire semester rather than for one week which is being done now.

III. Up on discussing the feedback from **Academic Peers and Faculty**, the following changes are to be suggested in the curriculum.

   a) In the Y19 curriculum, Electrical Machines- 1 & 2 in place of DC Machines & Transformer, AC Rotating Machines & Electrical Drives courses.

   b) In the Y19 Curriculum, Technical Skilling courses are to be merged along with the course itself.

IV. Up on the feedback received from the **Industry peers**, The DAC discussed and resolved the changes Up on the feedback received from the Faculty (course coordinators), The DAC discussed and resolved the changes as mentioned below.

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

V. Upon considering above mentioned feedback, it is resolved to propose the enclosed updated Program development documents and curriculum for the B.Tech-Electrical Engineering Program & M.Tech- PS & PED for 2019 curriculum for BOS approval.

VI. The chairman put forward CO-PO attainment in front of all DAC members and discussed course closer minutes.

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Stake Holders Feedback Summary for A.Y 2019-20

Feedback from different stakeholders has been collected concerning the curriculum offered for the academic year 2019-20

Serial Number	Type of Stakeholder	Number of feedbacks
1	Students	55
2	Parents	10
3	Alumni	12
4	Faculty	15
5	Academic peers	10
6	Industry persons	10
	Total	112

Serial Number	Recommendations	Action taken in BoS
Students Feedback		
1	Jaswanth recommended a certification in PLC	A certificate on PLC in association with APSSDC is proposed and recommended to BOS
2	Rishika suggested having regular interaction in the form of active learning and provision to design their own ideas in the laboratory	Design Thinking and Innovation Lab is made a part of the curriculum for 2019-20 batch students. So that they can acquire skills and laboratory to design their own
Faculty Feedback		
3	Dr. A Pandian suggested Faculty suggested that recent advancements like Floating Solar & Off Shore Wind Technologies should be included in the M.Tech curriculum.	A course on Floating Solar & Off Shore Wind Technologies is included in the 2019-20 M.Tech (PED and PS) and was forwarded to BOS for approval.
4	Dr. J Somlal suggested Project based labs need to be defined for a particular course in the curriculum	Project-based labs can be implemented for the DAC-identified and BoS-approved core courses and were forwarded to BOS for approval.
Academic peers and		
5	Dr. N. Viswanathan, Professor, NITW- suggested to offer more flexible courses	Restructured power systems and electric drives are recommended to be offered and forwarded to the academic council for approval.
6	Dr. N. Jayaram, Asst. Prof., NIT, AP- suggested including applications of recent advantages like AI applications into the curriculum	Added a course titled AI Applications in Electrical Engineering in 2019 and forwarded it to the academic council for approval
Industry Persons Feedback		
7	P KAVYA, ET, Power Grid corporate of India Limited, India- suggested including HEV concepts in EV specialization. As with dual source supplies adding additional classification of FUEL CELL EV. Fuel Cell EVs are generally Dual source EVs	These suggestions were not possible to incorporate into the 2019-20 curriculum. But will be considered for the 2020-21 curriculum.

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	that complement the Batteries or vice versa. Future reliable EVs will have dual source supplies, For Drive Train, involves more complexity in terms of charge and Load Distribution, Charge and Discharge pattern for Batteries, e.t.c Fault Diagnosis of EVs, Additionally, Adding Communication protocols or information about standards would give students an idea of what standards need to be considered when designing.	
8	N V N S Koushik suggested that training on Coding skills to be planned for Advanced learners	Training on Coding skills is to be planned throughout the semester as a part of the curriculum
9	Dr. Praveen Dhamarcharla recommended Electric Drives course can be added as a skilling course or in the Flexi core course	All the members agreed to float Electric Drives as a separate course.
Parents Feedback		
10	L Lakshmi Veera Rajesh suggested more books should be provided related to our syllabus	The department has raised demand from time to time for procurement of books in the University Central Library to provide more literature options to the students. The library section ensures the availability of books and journals even in digital form for greater accessibility of books to the students. The faculty members were also suggested to share possible eBooks of their courses with the students.
11	NERELLA RADHA KRISHNA 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 member agreed to put forward for BOS approval

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(Dr. K. Narasimha Raju)

Chairman, DAC

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Annexure-II

Course structure and Syllabus Revision for the 2019-20 B.Tech EEE program

1. Course structure for 2019-20 admitted BTech-EEE program

SNO	COURSE CODE	COURSE NAME	Category	L	T	P	S	Cr	Pre-requisites	New Course/Revised	Changes Proposed	Focused on Employability/ Entrepreneurship/ Skill Development	Justification
1	19UC1101	BASIC ENGLISH	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
2	19UC1202	ENGLISH PROFICIENCY	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
3	19UC2103	PROFESSIONAL COMMUNICATION SKILLS	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
4	19UC2204	APTITUDE BUILDER-I	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
5	19UC3105	APTITUDE BUILDER-II	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
6	19UC3206	CAMPUS TO CORPORATE	HSS	0	0	4	0	2	NIL	Retained	No Change	Employability	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment

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7	19UC0007	INDIAN HERITAGE AND CULTURE	HSS	2	0	0	0	0	NIL	Retained	No Change	Employability	Contemporary knowledge as required for entrance tests of PSU Graduate engineer trainees
8	19UC0008	INDIAN CONSTITUTION	HSS	2	0	0	0	0	NIL	Retained	No Change	Employability	Contemporary knowledge as required for entrance tests of PSU Graduate engineer trainees
9	19UC0009	ECOLOGY AND ENVIRONMENT	HSS	2	0	0	0	0	NIL	Retained	No Change	Employability	Contemporary knowledge as required for entrance tests of PSU Graduate engineer trainees
10	19UC0010	UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS	HSS	2	0	0	0	0	NIL	Retained	No Change	Employability	Covers essentials of entrepreneurship thinking
11	19GN1101	COUNSELLING	HSS	0	0	0	4	0	NIL	Retained	No Change	Employability	for career, personal and professional development
12	19MT1101	MATHEMATICS FOR COMPUTING	BS	3	1	0	4	5	NIL	Retained	No Change	Skill Development	Covers the applications of mathematics for computation in domain courses
13	19MT2102	MATHEMATICS FOR ENGINEERS	BS	3	0	0	0	3	NIL	Retained	No Change	Skill Development	Covers the soft, verbal and Quantitative reasoning skills Concepts which help the students attain better employment
14	19BT1001	BIOLOGY FOR ENGINEERS	BS	2	0	0	0	2	NIL	Retained	No Change	Employability	Enhances the general science knowledge of engineers

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15	19PH1006	MATERIALS & MEASUREMENTS	BS	3	0	2	0	4	NIL	New	Academic Peers	Employability	Enhances the general science knowledge of engineers
16	19CY1101	ENGINEERING CHEMISTRY	BS	3	0	2	0	4	NIL	Retained	No Change	Employability	Enhances the general science knowledge of engineers
17	19EE2101	ELECTRICAL CIRCUITS	BS	3	0	2	0	4	NIL	Revised	Academic Peers	Employability	Covers the knowledge required for materials and measurements necessary for electrical engineering
18	20UC1102	DESIGN THINKING AND INNOVATION-1	ES	1	0	0	4	2	NIL	New	Academic Peers	Entrepreneurship	Develops entrepreneurial thinking
19	20UC1203	DESIGN THINKING AND INNOVATION-2	ES	1	0	0	4	2	20UC1203	New	Academic Peers	Entrepreneurship	Develops entrepreneurial thinking
20	19SC1101	PROBLEM-SOLVING AND COMPUTER PROGRAMMING	ES	3	0	2	0	4	NIL	Retained	No Change	Employability	Covers the programming Concepts which help students attain better employment
21	19SC1202	DATA STRUCTURES	ES	3	0	2	3	5	NIL	Retained	No Change	Skill Development	Covers the programming Concepts which help students attain better employment
22	19ME1103	DESIGN TOOLS WORKSHOP - I	ES	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Covers the design tools workshop Concepts which helps the students attain better employment

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23	19SC1209	DESIGN TOOLS WORKSHOP - II	ES	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Covers the design tools and data structures required for advanced electrical applications
24	19SC1106	TECHNICAL SKILLS-1(CODING)	ES	0	0	0	6	2	NIL	Retained	No Change	Skill Development	Covers the design tools workshop Concepts which helps the students attain better employment
25	19SC1203	OBJECT-ORIENTED PROGRAMMING	ES	3	0	2	3	5	NIL	Retained	No Change	Employability	Develops modern programming structures
26	19EC1101	DIGITAL LOGIC & PROCESSORS	ES	3	0	2	0	4	NIL	Retained	No Change	Employability	Covers the hardware aspects of computer architecture which helps for employment in the semiconductor industry
27	19EC1213	BASIC ELECTRONIC CIRCUITS	ES	3	0	0	0	3	NIL	New	Academic Peers	Employability	Basic knowledge of electrical and electronic devices is very much an essential prerequisite for electrical core subjects
28	19EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	PC	2	0	0	0	2	19EC1101	Retained	No Change	Employability	Covers the hardware aspects of computer architecture which helps for employment in the semiconductor industry
29	19EC2103	ANALOG ELECTRONIC CIRCUIT DESIGN	PC	3	0	2	2	5	NIL	Retained	No Change	Employability	Covers the essential electronic circuits needed for building electrical & electronics engineering applications
30	19EC2106	EMBEDDED CONTROLLERS	PC	2	0	3	2	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies

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31	19EE2102	ELECTRICAL POWER ENGINEERING	PC	3	1	0	0	4	NIL	New	Academic Peers	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
32	19EE2103	ELECTRICAL MACHINES	PC	3	0	2	0	4	NIL	New	Industry Expert	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
33	19EE2201	INDUSTRIAL APPLICATION OF ELECTRICAL MACHINES	PC	3	0	2	0	4	19EE2103	New	Industry Expert	Entrepreneurship	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
34	19EE2202	POWER ELECTRONICS	PC	3	0	2	0	4	19EE2101	Retained	No Change	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
35	19EE2203	COMPUTER APPLICATION IN POWER SYSTEMS	PC	3	0	2	0	4	NIL	New	Alumni	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
36	19EE2204	CONTROL SYSTEMS	PC	3	0	2	0	4	NIL	Retained	No Change	Employability	Covers the core engineering Concepts which help the students attain better employment in EEE core companies
37	19EE3101	AI TECHNIQUES IN ELECTRICAL ENGINEERING	PC	3	0	2	0	4	19EE2203	New	Academic Peers	Entrepreneurship	Covers the advanced Concepts using AI Technologies in Electrical Engineering which helps the students attain better employment

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38	19EM3201	SIGNAL PROCESSING	PC	3	0	2	0	4	NIL	Retained	No Change	Skill Development	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
39	19EE3111	INDUSTRIAL AUTOMATION AND ROBOTICS	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
40	19EE3112	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
41	19EE3113	INDUSTRIAL DRIVES AND CONTROL	PE	3	0	0	0	3	NIL	Retained	No Change	Entrepreneurship	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
42	19EE3211	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
43	19EE3212	SMART SENSORS AND SMART NETWORKING	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
44	19EE3221	SOLAR AND MICRO ENERGY TECHNOLOGIES	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment

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45	19EE3122	WIND AND ENERGY STORAGE TECHNOLOGIES	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
46	19EE3123	ENERGY MANAGEMENT AND GREEN BUILDINGS	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
47	19EE3221	AI AND IOT FOR GREEN ENERGY INTEGRATION	PE	3	0	0	0	3	NIL	New		Entrepreneurship	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
48	19EE3222	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	PE	3	0	0	0	3	NIL	New		Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
49	19EE3131	DISTRIBUTION SYSTEM PRACTICES	PE	3	0	0	0	3	19EE2102	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
50	19EE3132	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
51	19EE3133	ENERGY MANAGEMENT SYSTEMS AND SCADA	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment

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52	19EE3231	SMART GRID COMMUNICATION AND CYBERSECURITY	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
53	19EE3232	INTERNET OF THINGS AND SMART GRID ANALYTICS	PE	3	0	0	0	3	NIL	New		Entrepreneurship	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
54	19EE3141	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
55	19EE3142	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	PE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
56	19EE3143	CHARGING STATIONS FOR ELECTRIC VEHICLES	PE	3	0	0	0	3	19EE2202	Retained	No Change	Entrepreneurship	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
57	19EE3241	AI AND IOT FOR ELECTRIC VEHICLE	PE	3	0	0	0	3	NIL	New		Entrepreneurship	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
58	19EE3242	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	PE	3	0	0	0	3	NIL	New		Employability	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment

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59	19EE3106	SENSORS & INTERNET OF THINGS	FC	3	0	2	0	4	NIL	New	Industry Expert	Entrepreneurship	Enables students to produce technical problem-solving in combination with an attached industry
60	19EE3102	ELECTRIC DRIVES	FC	3	0	2	0	4	19EE2202	New	Industry Expert	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
61	19EE3103	RESTRUCTURED POWER SYSTEMS	FC	3	1	0	0	4	NIL	Revised	Industry Expert	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
62	19EE3104	UTILISATION OF ELECTRICAL ENERGY	FC	3	1	0	0	4	NIL	Revised	Alumni	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
63	19EE3105	POWER QUALITY	FC	3	1	0	0	4	NIL	Revised	Alumni	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
64	18BT40A1	IPR & PATENT LAWS	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the practical knowledge of tools required for technical problem-solving
65	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
66	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

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67	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
69	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
70	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
71	18CE40A5	DISASTER MANAGEMENT	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
72	18EC40A9	IMAGE PROCESSING	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
73	18EC40C9	NANOELECTRONICS	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
74	18ME40B4	ROBOTICS	OE	3	0	0	0	3	NIL	Retained	No Change	Skill Development	Covers the contemporary interdisciplinary knowledge required for core domain students
75	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

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76	18OL40B3	INTRODUCTION TO SELF-DRIVING CARS	OE	2	0	0	0	2	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
77	18ME40B6	OPERATIONS RESEARCH	OE	3	0	0	0	3	NIL	Retained	No Change	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students
78	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
79	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
80	18FL3054	FRENCH 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
81	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
82	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
83	19EE3111	INDUSTRIAL AUTOMATION AND ROBOTICS	FC	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the contemporary interdisciplinary knowledge required for core domain students

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84	19EE3112	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	FC	3	0	0	0	3	NIL	New	Industry Expert	Employability	Covers the contemporary Interdisciplinary knowledge required for core domain students
85	19TS6001	SKILLING FOR ENGINEERS-1	PR	0	0	0	4	1	NIL	Retained	No Change	Skill Development	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
86	19TS6002	SKILLING FOR ENGINEERS-2	PR	0	0	0	4	1	NIL	Retained	No Change	Skill Development	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
87	19TS6003	SKILLING FOR ENGINEERS-3	PR	0	0	0	4	1	NIL	New	Faculty	Skill Development	Covers the advanced Concepts in renewable energy technologies which helps the students attain better employment
88	19TS6004	SKILLING FOR ENGINEERS-4	PR	0	0	0	4	1	NIL	New	Faculty	Skill Development	Covers the advanced Concepts in electric vehicle technologies which helps the students attain better employment
89	19TS6005	TECHNICAL PROFICIENCY & TRAINING-	PR	0	0	0	4	1	NIL	Retained	No Change	Skill Development	Covers the advanced Concepts in electric vehicle technologies which helps the students attain better employment
90	19TS6006	TECHNICAL PROFICIENCY & TRAINING-2	PR	0	0	0	4	1	NIL	New	Faculty	Skill Development	Covers the advanced Concepts in electric vehicle technologies which helps the students attain better employment
91	19IE2246	INDUSTRIAL TRAINING	PR	0	0	4	0	2	NIL	Retained	No Change	Employability	Enables students to produce technical problems solving industrial problems
92	19IE3247	TERM PAPER	PR	0	0	4	0	2	NIL	Retained	No Change	Skill Development	Covers the practical knowledge of tools required for technical problem-solving

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93	19IE4050	PRACTICE SCHOOL	PR	0	0	0	24	6	NIL	Retained	No Change	Employability	Covers the practical knowledge of tools required for technical problem-solving
94	19IE4051	INTERNSHIP	PR	0	0	0	24	6	NIL	Retained	No Change	Employability	Covers the advanced Concepts in industrial automation technologies which helps the students attain better employment
95	19IE4048	PROJECT (PART I)	PR	0	0	0	24	6	NIL	Retained	No Change	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
96	19IE4049	PROJECT (PART II)	PR	0	0	0	24	6	NIL	Retained	No Change	Skill Development	Covers the practical knowledge of tools required for technical problem-solving

Percentage of Courses focusing on Employability= 68/96=71%

Percentage of Courses focusing on Entrepreneurship= 11/96=11%

Percentage of Courses focusing on Skill Development = 17/96=18%

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2. Syllabus of New Course for Y19 admitted students

Course Code	Course Name	Cat	New Syllabus	Topics Added/ Removed / Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
19PH1006	Materials & Measurements	Basic Science	Crystallography: Bonding in materials, Space lattice, basis, unit cell, Seven Crystal systems, cubic structures, Bravais lattice system, Reciprocal lattice, Crystal directions, Miller Indices, problems, Diffraction of Crystals, Bragg's Law, XRD, powder XRD Technique, Problems. Electrical Properties: Band structures in Conductors, Semiconductors and Insulators, Electrical properties of conductors- Ohms, Matthiessen rule, conductivity, Mobility, Electrical properties of Semiconductors, Factors affecting the carrier concentration, Conductivity and Mobility of charge carriers, Di electrics Ferroelectricity and piezoelectricity. Materials for MEMS (Micro Electro Mechanical Systems) and Microsystems– Metals (Physical and chemical properties), Semiconductors(Electrical and chemical properties), ceramics, polymers and composites, Substrates and Wafers, Active Substrate materials(Si, Ge, GaAs and quartz), Silicon piezo resistors, Piezoelectric crystals. Introduction, types of measurements, generalized measurement system with examples, static & dynamic characteristics of a measurement system, types of Errors, error sources and remedies. Definition, representation and measurement methods of Displacement (Linear/Angular), Time, and Temperature. Speed, and Humidity. Measurement of Electrical parameters: Current, Voltage, Power, Energy, Power factor, Impedance	New	yes	As per Academic peers' feedback to introduce engineering materials in science elective	100

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19EE2102	ELECTRICAL POWER ENGINEERING	Core	**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, and 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 and 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, and bus bar arrangements.	New	Yes	Introduced to consolidate complete sectors of power systems	100
19EE2201	INDUSTRIAL APPLICATION OF ELECTRICAL MACHINES	Core	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 Motor- Operating principle, circuit model, phasor diagram, effect of load. Operating characteristics of synchronous machines, V-curves, and starting methods of synchronous motors. Salient pole Machine- Two reaction theories, analysis of phasor diagram, power angle characteristics, determination of Xd and Xq. DC Motors applications based on their characteristics- Stating methods, speed control methods- field control, armature control and Ward Leonard method. Special machines- Brushless DC motor, Permanent Magnet Synchronous Motor, Stepper motor, Reluctance motor and their applications.	New	Yes	Introduced as per the feedback from Industry peer	100

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19EE2203	COMPUTER APPLICATION IN POWER SYSTEMS	Core	Power System Analysis: Network model formulation, Formation of YBUS by Direct Inspection Method, Power flow problem formulation- NR Method (Polar Coordinate Approach), Symmetrical & Unsymmetrical Fault Analysis – Per Unit System, Calculation of symmetrical & Unsymmetrical short circuit currents for simple systems(unloaded). 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 earthing, step voltage, and Types of neutral grounding. 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.	New	Yes	Advanced topics as per industry peers' feedback	100
19EE3101	AI TECHNIQUES IN ELECTRICAL ENGINEERING	core	Artificial Neural Networks: Introduction Models of Neuron Network – Architectures – Hebbian learning – Supervised learning – Unsupervised learning – Reinforcement learning. ANN Paradigms: Multi–layer perceptron using Backpropagation Algorithm (BPA) – Radial Basis Function Network – Hopfield Network – Application to Load forecasting, Electrical Drives. 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, Electrical Drives. 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, Electrical Drives.	New	Yes	Advanced topics of AI techniques as per Academic peers' feedback	100

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19EE3111	INDUSTRIAL AUTOMATION AND ROBOTICS	Flexi Core	Introduction: Definition of industrial automation, Mechanization vs automation, advantages of automation, goals of automation, reasons for automation, social issues of automation, types of automation, current emphasis in automation, Controllers Employed in Automated Systems, Case Studies. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. Industrial automation and Case studies. Fundamentals of Industrial Robots-Specifications and Characteristics, Criteria for selection. Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks Robotic Control Systems-Robot Motions, Drives, Actuators, Robot controllers, and Power transmission systems. Robotic End Effectors and Sensors-Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, and force and torque sensing. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design. Robot Programming: Level of robot programming, Language-based programming, task-level programming, Robot programming synthesis, Industrial Applications and Case Studies			Faculty Expert	100
19EE3112	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	Flexi Core	Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems , Sensing & actuation, Communication, Networking types. Cyber Physical Systems and Next Generation Sensors: Collaborative Platform and Product Lifecycle Management. Basics of Industrial IIOT: Industrial Processes Industrial Sensing & Actuation, Industrial IIOT: Business Model and Reference Architecture, Industrial IIOT- Layers: IIIOT Sensing-Part I, Part II, IIIOT Processing, IIIOT Networking. Industrial IIOT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Industrial IIOT: Security and Fog Computing - Fog Computing in IIIOT, Security in IIIOT Industrial IIOT Application Domains: Healthcare, Power Systems, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case			Faculty Expert	100

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19EE3106	SENSORS & INTERNET OF THINGS	Flexi core	SENSORS / TRANSDUCERS/ACTUATORS: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization. -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors. Pneumatic and Hydraulic Actuation Systems, Servo and proportional control valves – Process control valves – Rotary actuators SMART SENSORS: Introduction – Primary Sensors, MEMS Sensors– Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface– The Automation. Introduction to Internet of Things (IoT)– Functional Characteristics – Recent Trends in the Adoption of IoT – Societal Benefits of IoT, Health Care — Machine to Machine (M2M) - Smart Transportation – Smart Living – Smart Cities- Smart Grid IoT ARCHITECTURE: Functional Requirements - Components of IoT: Sensors – Actuators – Embedded Computation Units – Communication Interfaces – Software Development COMMUNICATION PRINCIPLES: RFID – ZigBEE – Bluetooth – Internet Communication- IP Addresses - MAC Addresses - TCP and UDP – IEEE 802 Family of Protocols – Cellular-Introduction to EtherCAT. IOT PHYSICAL DEVICES & ENDPOINTS Exemplary Device Board-ARM AND CORTEX, Exception handling, interrupts programming, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption,	New	Yes	Advanced sensors for instrumentation requirements	100
19EE3221	AI AND IOT FOR GREEN ENERGY INTEGRATION	Professional Elective	AI for solar PV Power generation: Fuzzy logic-based PV MPP techniques, RMSE and MAPE analysis for short-term irradiance, solar energy and load forecasting, Machine learning algorithms for short-term irradiation and temperature forecasting, Day ahead power output forecasting for PV systems with regression, machine learning and deep learning techniques, Case studies AI for Wind and Hybrid Power generation: Frequency control of induction generator using genetic algorithm, stochastic wind generation and congestion management, Intelligent Energy Management System of Hybrid Solar/Wind/Battery Power Sources, Islanding detection, Case studies IoT Devices and Tools for Green Energy systems: Sensors-temperature, vibration, irradiance, wind speed, PIR, proximity, current, voltage Controllers, networking, Cloud computing, Data analytics IoT Applications for green energy systems: Cloud-based Real-time Monitoring systems: PV Power output, State of Health of Battery Storage, wind turbine vibration, M2M communication case study	New	Yes	As per alumni feedback to introduce AI into GET	100

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19EE3222	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	Professional Elective	PV Integration Technology: Photovoltaic (PV) inverter topologies- configurations and control strategies, Grid codes and technical regulations of Solar PV integration Wind Power Integration Technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control, Grid codes and technical regulations of Wind power integration Power quality management: THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, effects on system stability Challenges: Integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection.	New	Yes	Advanced course for higher studies	100
19EE3232	INTERNET OF THINGS AND SMART GRID ANALYTICS	Professional Elective	Networking Protocols and Standards for Internet of Things: Introduction, IoT Data Link Protocols, Network Layer Routing Protocols, Network Layer Encapsulation Protocols, Session Layer Protocols, IoT Management Protocols, Security in IoT Protocols, IoT Challenges. IoT Architecture: Introduction, Architectural Approaches, Business Architecture, Functional Architecture, Application Architecture, Data and Analytics Architecture, Technology Architecture, Security and Governance. Applications of IOT to Smart Grid: Energy monitoring, energy harvesting, smart parking, smart medium access in mobile IOT. Introduction to Big Data Analytics: Attributes of Big Data: Volume of data, velocity of data, variety of data; Overview of big data analytics, benefits of big data analytics, big data analytics for smart grids, big data analytics tools. Smart Grid Data Management and Applications: Smart Meter Data Management: Smart metering architecture, challenges and opportunities, smart meter data management, future trends and issues; PHEVs: Internet of Vehicles: Convergence of PHEVs and internet of vehicles, electric vehicles management, future trends and issues; Smart Buildings: Concept of smart buildings, challenges and opportunities, different approaches for establishing smart buildings, future trends and issues.	New	Yes	Analytics requirements as per alumni feedback	100

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19EE3241	AI AND IOT FOR ELECTRIC VEHICLE	Professional Elective	Data Engineering, Data types, Python Libraries (pandas, numpy, sci-kit Learn, Matplot Lib, Seaborn), data distributions, time-series, Feature Engineering (imputation, binning, encoding, and normalization) Amazon SageMaker, Amazon S3 Storage services, AWS Glue AWS Services and Algorithms Amazon SageMaker, Amazon S3 Storage services, AWS Kinesis Services, Basic Regression and Clustering ML Algorithms in AWS Program the ESP8266, ESP32, or Raspberry Pi 3 to send data to the AWS IoT Core Understand MQTT, JSON, IoT, and the AWS cloud, Place IoT data into Dynamo DB by creating a table and data fields, device-to-cloud communication, designing graphs and using analytics on IoT data, Use Node-Red to connect devices to AWS IoT AI and IOT Tools for EV Applications: Electric Vehicle Battery state estimation, health monitoring, SOL determination, Power management, Charging optimization and Electric Drive applications, Online vehicle Assistance	New	Yes	As per alumni feedback to introduce AI into EVT	100
19EE3242	COMMUNICATION PROTOCOLS AND TESTING OF ELECTRIC VEHICLE	Professional Elective	Introduction to serial communication protocols: SPI I2C CAN, CAN standard, CAN message: Arbitration, message types, valid frame, error checking CAN bus: Transceiver features, CAN physical layer, CAN connectors, Bit Timing, Error Handling, High Layer Protocols: IEC 61851, SAE J2601 Common Sensor modules used in EV: Air Bag, ABS, Window Mirror, Cruise Control, Transmission control, CAN Interface with Sensor Modules Power Distribution Box, Components like HVDC Relays connections, Insulation Monitoring Devices Fuses, BTMS, Driveline Cooling, Coolant tanks, Level Sensors, Vehicle Wiring, Terminals, Electrical Distribution Boards, Temperature Considerations for wiring, Cable selection, Instrument Panel, HVIL,24V converters, Junction boxes or Fuse Boxes, Fuses, derating, EMI and EMC. V cycle, reliability calculations, DFMEA/FMEA analysis, Design for manufacturing, servicing & data analytics, supply chain management	New	Yes	Industry peers	100
19EE3102	ELECTRIC DRIVES	Flexi Core	Electric Drive Basics: Elements of drive system, Drive characteristics, Dynamics of electric motor drives - steady-state stability, four quadrant drive operation DC Motor drives: Three Phase half & fully controlled rectifier fed drives - continuous and Discontinuous conduction, Chopper controlled drives- Duty-ratio control - current-limit control, Speed control of a separately excited DC drive with inner current loop and outer speed loop Induction Motor Drives: Equivalent circuits, terminal voltage control - fan & pump drives, frequency control of VSI fed motors – operation with constant ratio of terminal voltage to frequency - constant air gap flux and field-weakening, rotor resistance control, slip energy recovery Advanced Industrial Drives: Introduction to principles of vector control and direct toque control of Induction motor drives, Model of PMSM, Control of PMSM, BLDC drives, Introduction to vector control of BLDC drives	New		Advanced course for EVT as per feedback of Industry Expert	100

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3. Course wise Syllabus revision/ approved structure as mentioned in point 1

SNO	Course Code	Course Name	Course Category	Existing Syllabus	New Syllabus	Topics Added/Removed/ Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
1	19EE2101	ELECTRICAL CIRCUITS	Engineering Science	. 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: the 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.	Transient response of R-L, R-C, R-L-C circuits for different excitations, initial conditions, time domain and Laplace transform methods of solutions, introduction to two-port networks. AC Circuits- RMS and average values and form factor of different periodic waveforms steady-state analysis of R, L and C with sinusoidal excitation, the concept of power factor, Real and Reactive powers. Three phase circuits-phase sequence, Relation between line and phase quantities, Analysis of balanced and unbalanced 3 phase circuits, Introduction to network topology. Resonance: Resonance:-Series and parallel resonance, bandwidth, selectivity, Q factor, current locus diagrams. Magnetic circuits: concept of mutual inductance, dot convention, coefficient of coupling, Magnetic Circuits, Analysis of series and parallel magnetic circuits. Network Topologies: definitions, graph, tree, basic cut-set and basic tie set matrices for planar network, Loop and Nodal methods of analysis of networks Two-port Networks: one port and two port networks Two-port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships.	**Added:** AC Circuits- RMS and average values and form factor of different periodic waveforms. steady-state analysis of R, L and C with sinusoidal excitation, the concept of power factor, and Real and Reactive powers. **Removed**: . 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.	Co-2	On contemporary needs, the lab is introduced	25 %

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2	19EE3103	RESTRUCTURED POWER SYSTEMS	Flexi Core	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 models like the Monopoly model, Purchasing agency model, wholesale competition model, and 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.-	Need and conditions for deregulation: Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. different forms of Ownership and management. Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model, Reforms in Indian power sector, Availability based tariff Congestion management: Review of Concepts original cost of generation, Short-run and Long-run cost, Various costs of production, least-cost operation, incremental cost of generation, Definition of congestion, Reasons for transfer capability limitation, Calculation of ATC , ATC calculation using PTDF and LODF based on DC 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. effect of congestion on LMPs Transmission network and market power, Power wheeling transactions and marginal costing, transmission costing, transmission loss ,financial transmission rights 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. Load-generation balancing related services , Frequency regulation, Load following , Spinning reserve services.	Added : Tutorial component is added to exixting LTPS	no	Advanced course for GET & SGT as per the feedback of	25

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3	19EE3104	UTILISATION OF ELECTRICAL ENERGY	Flexi Core	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.	Motor power rating and selection: General considerations in selecting motor power rating. Selection of motor capacity for continuous duty. Equivalent current, torque and power methods, selection of capacity for short term and intermittent periodic duty. Heating and cooling of motors, load equalization, fly wheel equalization. Illumination: Introduction, Nature of radiation, terminology in illumination, Polar curve, Laws of illumination, Luminous efficacy, Photometry, Lumen or flux method of calculation, Types of Lamps, Types of Lighting, Flood Lightning, and calculations, Street lightning, Compact Fluorescent Lamp (CFL), Light Emitting Diode (LED) lightning, Lighting Characteristics, Design of choke and capacitor. Electric Traction: Introduction-General features, Traction motor, Locomotive, Characteristics and control of locomotives and motor coaches for track electrification, Tramways and Trolley buses, Track equipment and Collector gear, Diesel-Electric equipment, Train movement and Energy consumption, Braking, Requirements of braking system, Types of braking: Mechanical, Hydraulic and Electrical braking. Electrical Circuits used in Refrigeration, Air Conditioning and Water Coolers: Principle of air conditioning, Description of electrical circuits used in: Refrigerator, Air conditioner and Water cooler. Electrolytic Processes: Fundamental principles, Extraction and refining of metals, Electro deposition, Manufacture of chemicals, Power supply for electrolytic purposes. Electric Heating and Welding: Advantages of electrical heating, Design of heating elements, Heating methods: Resistance heating, Induction heating, Electric arc heating, Dielectric arc heating. Advantages of electric welding, Welding methods: Resistance welding, Electric arc welding, Atomic hydrogen welding, Modern welding techniques: Ultrasonic and Laser welding.	Added : Tutorial component is added to exixting LTPS	Yes	Advanced course for GET & SGT as per the feedback pf Alumni	25

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4	19EE3105	POWER QUALITY	Flexi Core	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, the origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, and 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.	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.	Added : Tutorial component is added to exixting LTPS		Advanced course for GET & SGT as per the feedback pf Alumni	25

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TECHNICAL COMMUNICATION SKILLS FOR ENGINEERS – I

Course code : 19UC1001
Pre-requisite : NIL
L-T-P-S : 0-0-4-0
Credits : 2

Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the practical knowledge of using action words in sentence construction.	PO1	3
CO2	Apply and analyze the right kind of pronunciation with regards to speech sounds and able to get different types of pronunciations.	PO10	3
CO3	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.	PO1	3
CO4	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.	PO5	4

Syllabus

Interactive Grammar: Action Words-Modifiers, Intensifiers, Connectives - 5 Passages- 5 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.

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TECHNICAL COMMUNICATION SKILLS FOR ENGINEERS – II

Course code : 19UC1202
Pre-requisite : NIL
L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concepts of accurate English while writing and become equally at ease in using good vocabulary and language skills.	PO8, PO9, PO10/PSO-1	3
CO2	Understand the importance of pronunciation and apply the same day to day conversation.	PO8, PO9, PO10/PSO-2	2
CO3	Apply the concepts of ratios, percentages, averages and analyze the given information on the basis of comparative analysis of the data in the form of tabulation, bar graphs, pie charts, line graphs.	PO1, PO4/PSO-1	3
CO4	Analyze the basic functionality of clocks and calendars to find the solutions for the problems. Analyze the given symbols to understand the hidden meaning of the given expression and find the solutions. Analyze the possible arrangements in linear & circular order.	PO1, PO5/PSO-1	4

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

Reference books

1. Dictionary of Technical Terms
2. Dr. Meenakshi Raman and Dr. SangeethaSarma: *Technical Communication*.Oxford University Press: Delhi.2016.
3. The Ultimate Verbal and Vocabulary Builder. Texas: Lighthouse Review.2000.
4. Rajeev Vasisth: *Interactive Vocabulary Drills*. New Delhi: Arihant Publications Limited. 2011.
5. Language LaboratoryTeacher Manual, KLEF

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PROFESSIONAL COMMUNICATION SKILLS

Course code : 19UC2103
Pre-requisite : NIL

L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	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.	PO9, PO10/PSO-1	3
CO2	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. Able to create a healthy work-environment and prove to be an asset or one of the most reliable resources to the organization.	PO8/PSO-1	4
CO3	Apply the concepts of time and work; 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.	PO1/PSO-1	3
CO4	Apply Venn diagrams to find out appropriate conclusions from the given statements. Apply the logical implications and also the negations of various connectives to find the solutions. Analyze the data and represent in the form of Venn diagrams to find relations between any given set of elements.	PO1, PO5/PSO-1	3

Syllabus

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.

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APTITUDE BUILDER –I(PROFESSIONAL ATTITUDE & ETIQUETTES)

Course code : 19UC2204
Pre-requisite : NIL
L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concept of Critical Reading and Analytical Reading and comprehend the key ideas 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.	PO5, PO6/PSO-2	3
CO2	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.	PO7, PO10/PSO-2	3
CO3	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.	PO1, PO5/PSO-1	3
CO4	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.	PO1, PO5/PSO-1	3

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-II (VERBAL & QUANTITATIVE REASONING)

Course code :19UC3105
Pre-requisite : NIL
L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the strategies and techniques for conversations in different contexts. Analyze the different parameters and formats of written technical communication and apply in everyday work and life.	PO8, PO10/PSO-1	3
CO2	Analyze the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.	PO8, PO10/PSO-1	4
CO3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest	PO1, PO5/PSO-1	3
CO4	Analyze the series of numbers or letters to predict the next number in the series or to find the analogy. Analyze the data to find the codes in the process of encoding and decoding. Apply the given set of conditions to select a team from a group of members.	PO1/PSO-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. SangeethaSarma: *Technical Communication*.Oxford University Press: Delhi.2016.
2. M. Ashraf Rizvi: *Effective Technical Communication*. New Delhi: McGraw Hill Education(India) Private Limited

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CAMPUS TO CORPORATE

Course code : 19UC3206
Pre-requisite : NIL

L-T-P-S : 0-0-4-0
Credits : 2

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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ECOLOGY AND ENVIRONMENT

Course code : 19UC0009
Pre-requisite : NIL

L-T-P-S : 2-0-0-0
Credits : 0

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the importance of Environmental education and conservation of natural resources.	PO6/PSO-2	2
CO2	Understand the importance of ecosystems and biodiversity.	PO12/PSO-1	2
CO3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	PO6/PSO-2	3
CO4	Understand the importance of Environmental education and conservation of natural resources.	PO6/PSO-1	2

Syllabus

The Multidisciplinary nature of Environmental Studies, Natural Resources, Forest resources, Mining and 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, and biomedical waste management
Disaster management, Environmental Legislation Environmental Impact Assessment Process.

Text books

1. AnubhaKaushik, 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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INDIAN CONSTITUTION

Course code : 19UC0008
Pre-requisite : NIL

L-T-P-S : 2-0-0-0
Credits : 0

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand Constitutional development after Independence	PO12/PSO-2	2
CO2	Understand the fundamental features of the Indian Constitution	PO12/PSO-1	2
CO3	Understand the powers and functions of Union and State Governments	PO12/PSO-2	2
CO4	Understand the basics of working of Indian Judiciary and the Election Commission	PO12/PSO-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 LokSabha and the RajyaSabha, 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 Court's – 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 SubhashKashyap
3. 'Indian Constitution' by D.D. Basu
4. 'Indian Administration' by Avasti and Avasti
5. 'Constitutional Law of India' by Seervai H.M.

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INDIAN HERITAGE AND CULTURE

Course code : 19UC0007
Pre-requisite : NIL

L-T-P-S : 2-0-0-0
Credits : 0

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	To familiarize with various aspects of the culture and heritage of India through ages.	PO1/PSO-1	2
CO2	To acquaint with the contributions of Indians in the areas of languages and literature, religion and philosophy	PO1/PSO-1	2
CO3	To understand the Social structure and the spread of Indian culture abroad	PO1/PSO-1	2
CO4	To know the development of Science and Technology in India through ages and to appreciate the contributions of some of the great Indian scientists	PO1/PSO-1	2

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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UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS

Course code : 19UC0010
Pre-requisite : NIL

L-T-P-S : 2-0-0-0
Credits : 0

Mapping of Course Outcomes with PO/PSO:

CO No:	CO	PO/PSO	BTL
CO1	Understand and identify the basic aspiration of human beings.	PO-8, PO-9/1	2
CO2	Understand the harmony in human being.	PO-8, PO-9/1	2
CO3	Understand the harmony in family, society and nature (existence).	PO-8, PO-9/1	2
CO4	Understand the profession and his role in this existence.	PO-8, PO-9/2	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 books

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

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MATHEMATICS FOR COMPUTING

Course code : 19MT1101
Pre-requisite : NIL
L-T-P-S : 3-1-0-4
Credits : 5

Course Outcomes (CO):

CO No:	Course out come	PO/PSO	BTL
CO1	Understand the basic Structures , relations and permutations & combinations , probability	PO1/PSO-1	2
CO2	Model and solve the relevant physical problems mathematically as a system of linear equations .	PO1/PSO-1	2
CO3	Apply the rules of Propositional logic to establish valid resultsof mathematical arguments, Induction and solve recurrence relations .	PO1/PSO-1	3
CO4	Understand the graphs and analyze different problems associated with computer , logic design.	PO1/PSO-1	2
CO5	Describe the Aptitude & Reasoning skills	PO1/PSO-1	2

Syllabus

Basic Structures: Sets, Functions, Sequences and Summations, Cardinality of Sets , Relations and their Properties, Equivalence Relations.

Permutations and combinations, Probability: Linear Permutation, Circular Permutation, Addition theorem, Conditional Probability, Multiplication Theorem.

Matrix Algebra: Introduction, Types of Matrices, Rank of matrix, Solutions of linear equations-Gauss elimination, Jacobi and Gauss Seidal, Eigen values, Eigen vectors

Game Theory: Pay of Matrix, Mini-Max criteria, Saddle points, Optimal Strategy , Mixed Strategy ,Value of a game

The Foundations: Logic and Proofs: Propositional Logic, Applications of Propositional, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference

Applications of Number theory: Fermat's theorem, Euclidean Algorithm

Counting Techniques: Recursive definitions, Solving Linear Recurrence Relations, Fibonacci series ,Divide-and-Conquer Algorithms, Generating Functions, Inclusion–Exclusion

Lattices: Introduction, Properties of Lattices, Sublattices, Partial order relation, Homomorphism and Isomorphism, Hasse diagrams.

Graphs & Trees: Terminology, Types of Graphs, Bipartite graphs, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path, Planar Graphs

Statistics: Curve fitting, Correlation, Linear Regression

Skilling:

LOGIC AND REASONING: Deductions, Logical Connectives, Linear and circular arrangements, Ordering and sequencing, Clocks, Calendars, Blood Relations, Cubes, Direction sense, Number and letter series, Number and letter Analogy, Odd man out, Coding and Decoding, Symbolic representations of given data, Binary Logic, Non Verbal reasoning.(20hrs)

Foundations in Arithmetic : Numbers, Ratio, Proportion, Variation, Averages, Percentages, Profit & loss, Time & Distance, Time & Work.(5hours)

Geometry: Lines, Triangles, Quadrilaterals, Polygons,Practical applications of common solids, irregular solids and their application in various engineering problems(5 hours)

Text books

1. Basic Engineering Mathematics, John Bird, sixth Edition, Elsevier, ISBN:978-1-1380-5382-3
2. Kenneth, K. R., Discrete Mathematics and its Applications, 7th Ed.,Tata McGraw Hill

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Reference books

1. Probability and Statistics for engineers and scientist, R.E.Walpole, R.H.Myers, S.L.Myes,K.E.Je, Pearson learning
2. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd
3. Tremblay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill.
4. A Modern Approach to Verbal and Non-verbal Reasoning, R. S. Agarwal, Schand Publications.

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MATHEMATICS FOR ENGINEERS

Course code : 19MT2102
Pre-requisite : NIL

L-T-P-S : 2-0-2-0
Credits : 3

Course Outcomes (CO):

CO No:	Course out come	PO/PSO	BTL
CO1	Apply differential and integral calculus to find maxima & minima of functions and evaluate the integrals	PO1/PSO-1	2
CO2	Model and solve the relevant phenomena as a differential equation	PO1/PSO-2	3
CO3	Demonstrate Fourier series and Analytic functions	PO1/PSO-1	2
CO4	Describe probability , Random Variables and Algebraic structures	PO1/PSO-1	2

Syllabus

Calculus:

Differential and Integral calculus: Taylors series for function of variables, Maxima and Minima for functions of two variables, Evaluation of double integrals – Change of order of Integration, Change of Variables , Polar coordinates

Vector calculus: Scalar and vector point functions, Gradient , Directional Derivative, Divergence and Curl, Evaluation of line integrals – Greens theorem.

Ordinary Differential Equations: Solution of first order equations and their applications- Newton law of cooling, Growth and decay , Solution of Second Order Differential equations.

Partial Differential Equations: Formation of PDE, Solution of first order linear equations – Lagrange's method, Solution of second order PDE by separation of variables.

Laplace Transforms: Laplace and Inverse Laplace transforms and their properties .

Fourier Series: Definition, Dirchelt conditions, Fourier series for simple functions

Complex Variables : Complex functions- Exponential, Logarithmic and Trigonometric functions ,Analytic function – Cauchy - Riemann equations - Milne Thomson method

Probability and Random Variables: Probability –Addition, Multiplication and Baye's theorem. Random variables – Probability distributions – Binomial, Poisson and Gaussian distributions, Markov process.

Algebraic Structures: Structure of Algebras, Semi groups, Monoids and Groups, Homomorphism's, Normal subgroups and congruence Relations, Rings

Text books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Willey& Sons, Inc, Newyork

Reference books

1. Probability and Statistics for engineers and scientist, R.E.Walpole, R.H.Myers, S.L.Myes,K.E.Je, Pearson learning
2. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd
3. Tremblay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill.

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BIOLOGY FOR ENGINEERS

Course code : 19BT1001
Pre-requisite : NIL

L-T-P-S : 2-0-0-0
Credits : 2

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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Engineering Materials and Measurements

COURSE CODE: 19PH1006 **L-T-P-S: 3-0-2-0**

Credits: 4

SYLLABUS:

Crystallography: Bonding in materials, Space lattice, basis, unit cell, Seven Crystal systems, cubic structures, Bravais lattice system, Reciprocal lattice, Crystal directions, Miller Indices, problems, Diffraction of Crystals, Bragg's Law, XRD, powder XRD Technique, Problems.

Electrical Properties: Band structures in Conductors, Semiconductors and Insulators, Electrical properties of conductors- Ohms, Matthiessen rule, conductivity, Mobility, Electrical properties of Semiconductors, Factors effecting the carrier concentration, Conductivity and Mobility of charge carriers, Di electrics Ferroelectricity and piezoelectricity.

Materials for MEMS (Micro Electro Mechanical Systems) and Microsystems– Metals (Physical and chemical properties), Semiconductors(Electrical and chemical properties), ceramics, polymers and composites, Substrates and Wafers, Active Substrate materials(Si,Ge,GaAs and quartz), Silicon piezoresistors, Piezoelectric crystals.

Introduction, types of measurements, generalized measurement system with examples, static & dynamic characteristics of measurement system, types of Errors, error sources and remedies. Definition, representation and measurement methods of Displacement (Linear/Angular), Time, Temperature. Speed, and Humidity. Measurement of Electrical parameters: Current, Voltage, Power, Energy, Power factor, Impedance

Text books & References:

1. William D. Callister,Jr. "Materials Science and Engineering: An Introduction" 6th edition, 2007, Wiley India Pvt.Ltd.
2. S. O. Pillai, "Solid state physics" Revised 6th edition, New Age International Publishers.
3. MEMS & MICROSYSTEMS Design and Manufacture – Tai-Ran Hsu, Mc Graw Hill Education
4.Microsensors, MEMS, and Smart Devices –Julian W. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Wiley India Pvt. Ltd.
5. Experimental methods for engineers - JP Holman McGraw Hill Ltd.
6. Electrical measurements - Martin U Reissland- New Age Int.
7. A course in Electrical, Electronic Measurement Instrumentation - AK Sawhney Dhanpat Rai &Co.and

Experiments:

1.Lattice constant by powder XRD
2.Determination of Hall coefficient of a semiconductor
3.Solar Cell characteristics
4.Energy band gap of a semiconducting diode
5.P-N Junction diode
6.Thermal conductivity of Bad conductor
7.Photoelectric effect- Planck's constant
8.Young's modulus-Uniform bending method
9. Measurement of Voltage
10. Measurement of Current

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ENGINEERING CHEMISTRY

Course code : 19CY1001
Pre-requisite : NIL

L-T-P-S : 3-0-2-0
Credits : 4

Course Code: 19CY1001

Energy and Chemistry: Energy use and the world economy, defining energy, energy transformation, and conservation of energy, heat capacity, calorimetry, enthalpy, Hess's law and heats of reaction, energy and stoichiometry. **Electrochemistry:** 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 & ITS CONTROL:** 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 Technology**: 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 reaction, rate laws and the concentration dependence of rates, integrated rate laws, temperature and kinetics, rate mechanisms, catalysis, insight into troposphere ozone.**Molecules and materials-** Types of polymerization-Plastics – Thermoplastic resins and Thermosetting resins - Compounding of plastics – Fabrication of plastics. Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde. **Conducting Polymers**: Polyacetylene, polyaniline, conduction, doping and applications. Carbon nanotubes and applications.

Text books:

1. Engineering Chemistry, Jain & Jain, Dhanpat Rai Publishing Company. New Delhi.
2. Engineering Chemistry, O G Palanna, The Tata McGraw Hill, New Delhi.

Reference Books:

1. Chemistry In Engineering and Technology, Volume 2, J C Kuriacose & J Rajaram, Tata McGraw Hill, New Delhi.
2. Chemistry for Engineers, Dr Rajesh Agnihotri, Wiley, New Delhi.
3. Engineering Chemistry, B. Sivasankar, The Tata McGraw Hill, New Delhi.
4. A text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co. New Delhi.
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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ELECTRICAL CIRCUITS

Course Code : 19EE2101
Credits : 4
L-T-P-S : 3-0-2-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the various elements of Electrical circuits and the techniques to simplify the complex networks	PO1, PO3/ PSO1	2
CO2	Analyze the single phase AC circuits and resonance.	PO1, PO2/ PSO1	4
CO3	Understand three-phase circuits and network topology.	PO1, PO3/ PSO1	2
CO4	Analyze transient behavior of DC & AC circuits and Two port networks.	PO1, PO3/ PSO1	4
CO5	Test the Electrical networks of AC & DC	PO1, PO3/ PSO1	4

Syllabus

Basic circuit concepts-Kirchhoff's Laws, Loop and Nodal methods of analysis of networks. Network theorems-: Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer, star/delta transformation.

AC Circuits- RMS and average values and form factor of different periodic wave forms steady state analysis of R, L and C with sinusoidal excitation, concept of power factor, Real and Reactive powers, Series and parallel resonance circuits.

Three phase circuits-phase sequence, Relation between line and phase quantities, Analysis of balanced and unbalanced 3 phase circuits, Introduction to network topology.

Transient response of R-L, R-C, R-L-C circuits for different excitations, initial conditions, time domain and Laplace transform methods of solutions, introduction to two port networks.

Text books

1. William Hayt and jack E. Kemmerly, "Engineering circuit analysis" Tata Mc Graw-Hill Companies, 8th edition 2012
2. John Bird "Electrical Circuit Theory and Technology" Routledge publishers, 6th edition, 2017.

Reference books

1. Charles K Alexander, Mathew N O Sadiku, "Fundamentals of Electric Circuits", Tata McGraw Hill Education Pvt. Ltd., 5th Edition 2013.

J. Edminister& M. Nahvi, "Electric circuits", Schaum's outlines Tata Mc GrawHill Publishing Company Ltd.,7th edition 2018.

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PROBLEM SOLVING & COMPUTER PROGRAMMING

Course code :19SC1101
Pre-Requisite: NIL

L-T-P-S : 3-0-2-0
Credits: 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Illustrate how problems are solved using computers and programming.	PO1, PO2, PO12/PSO-2	3
CO2	Illustrate and use Control Flow Statements in C.	PO1, PO2, PO12/PSO-2	3
CO3	Interpret & Illustrate user defined C functions and different operations on list of data.	PO1, PO2/PSO-2	3
CO4	Implement Linear Data Structures and compare them.	PO4/PSO-2	3
CO5	Apply the knowledge obtained by the course to solve real world problems.	PO1, PO2, PO4/PSO-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-Dimensional 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.

Text books

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice Hall/Pearson Education-2005.
2. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
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. E. Balagurusamy, "Programming in ANSI C", 4th ed., Tata McGraw-Hill Education, 2008.
3. Horowitz, Sahni, Anderson Freed, "Fundamentals of Data structures in C", 2nd Edition-2007.
4. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
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 code :19SC1202
Pre-Requisite: NIL

L-T-P-S : 3-0-2-0
Credits: 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply measures of efficiency on algorithms and Analyse different Sorting Algorithms.	PO1, PO2/PSO2	3
CO2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	PO1, PO/ PSO1	4
CO3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.	PO1, PO4/ PSO1	4
CO4	Analyse different representations, traversals, applications of Graphs and Heap organization.	PO2, PO4/ PSO1	4
CO5	Develop and Evaluate common practical applications for linear and non-linear data structures.	PO1, PO2/ PSO1	5

Syllabus

Algorithm Analysis: Mathematical Background, Model, Analyse, 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 data structures in C", Second Edition-2007.
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", Second Edition, Thomson India Edition, 2005.
4. Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, "Data Structures& Program Design in C", Fourth Edition-2007.

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List of Lab 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
    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
    a. Create
    b. Insert
    c. Display
    d. Delete
    e. 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 Circular Queue using Array
9. Develop a program to implement Binary Search Tree with Traversal Operations
10. Develop a program to perform following operations on AVL tree
    a. Insertion
    b. Deletion
11. Develop a program to implement the following
    a. Separate chaining for collision handling
    b. Open Addressing Technique
12. Develop a program to implement Heap sort
13. Develop a program to implement
    a. Breadth First Search
    b. Depth First Search
    c. Dijkstra's Algorithm
14. Program to implement Minimal Spanning by
    a. Prim's algorithm
    b. Kruskal's algorithm

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DESIGN TOOLS WORKSHOP –I

Course code : 19SC1108
Pre-requisite : NIL

L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Practice design thinking by developing artistic skills	PO-3/PSO-1	2
CO2	Visualize and practice innovative design by final drafting using photogrammetric and model the design using prototyping technique	PO-4/PSO-2	3
CO3	Apply the concept of AI & Data analytics & finalize the requirements to design his idea	PO-5/PSO-2	3
CO4	Draft a report of his project from the initial stage & make a report which include scope, time and cost management of his project	PO-4/PSO-2	3

Syllabus

Introduction to Design thinking: Design thinking, usage of visualization tool, Physics and preparation for Innovation, Idea generation and mind mapping, Strategic opportunities, Storytelling tool.**Photogrammetry:**Basic concepts of photogrammetry, types of photogrammetric techniques and measurements.**Prototyping:**Prototyping, including paper and tool-based prototyping,design principles and patterns, 3D Modeling, 360 Prototyping, 3DPrinting.**Engineering Project Management:** Scope, Time and Cost Management.**Data Analytics:** Introduction, Basics of Statistical Analysis System (SAS), Logistic regression using SAS.**Artificial Intelligence:** Introduction, Turing Test, Breadth first Search techniques, Depth first Search techniques using python.**Machine Learning:** Linear regression, Naive Bayes, gradient descent algorithms using python.

Text books

1. "Complete Design Thinking Guide for Successful Professionals" by Daniel Ling
2. "Project Management" by K.Nagarajan, 7th Edition, New Age International Publishers.
3. "Augmented Reality and Virtual reality" by Timothy Jung, M.ClaudiaTomDieck, Springer.
4. "Rapid Prototyping: Principles and Applications"by Chua C.K., Leong and Lim. C.S, 2nd Edition, World Scientific.
5. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, 3rd Edition, Prentice Hall.

Web References:

1. https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
2. https://www.coursera.org/learn/introduction-virtual-reality?specialization=virtual-reality
3. https://www.coursera.org/learn/scope-time-management-cost

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DESIGN TOOLS WORKSHOP –II

Course code : 19SC1209
Pre-requisite : NIL

L-T-P-S : 0-0-4-0
Credits : 2

Mapping of Course Outcomes with PO/PSO:

CO No.	Course Outcome	PO/PSO	BTL
CO1	Practice the design ideology by artistic skill	PO-3/PSO-1	2
CO2	Visualize the design ideology by using VR technology	PO-4/PSO-2	3
CO3	Visualize the design ideology by incorporating VR technique	PO-5/PSO-2	3
CO4	Visualize and present his design idea by applying AR technique	PO-4/PSO-2	3

Syllabus

Design Thinking in Modern Art &Ideas: Modern Art & Ideas, Transforming everyday objects, Abstract painting, clay modeling, poetry and literary.

Virtual Reality: Hardware and History, VR Applications, Psychology of VR: the three illusions, challenges in virtual reality, Future of Embodiment in VR, Realism, Graphics, Real-Time 3D Graphics in Games, Basic Concepts in 3D Computer Graphics, Realism Animation, Navigation, Nausea.

Room Scale VR, Holography, Mirror Reality: Setting up room scale VR, Simulation of virtual environment, Stereoscopic Vision, Perspective, Interference and Diffraction, Laser Viewable Holograms, Real and Virtual Images, Introduction to mirror reality.

Augmented Reality: Augmented Reality, characteristics of AR systems and main components of an AR architecture, Augmented Reality with Geolocation,Customizing an augmented reality game.

Text books

1. "Complete Design Thinking Guide for Successful Professionals" by Daniel Ling
2. "Project Management" by K. Nagarajan, 7th Edition, New Age International Publishers.
3. "Augmented Reality and Virtual reality" by Timothy Jung, M.ClaudiaTomDieck, Springer.
4. "Rapid Prototyping: Principles and Applications"by Chua C.K., Leong and Lim. C.S, 2nd Edition, World Scientific.
5. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, 3rd Edition, Prentice Hall.

Web References:

1. https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
2. https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
3. https://www.coursera.org/learn/modern-art-ideas?

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TECHNICAL SKILLS – 1 (CODING)

Course code : 19SC1106
Pre-requisite : NIL

L-T-P-S : 0-0-0-6
Credits : 1.5

Mapping of Course Outcomes (CO) to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	PO1,PO2/PSO2	3
CO2	Build solutions for problems on Numbers and array based problems , functions, recursion	PO1,PO2/PSO2	3
CO3	Solve problems solutions for character/string based problems and pointers	PO1,PO2/PSO2	3
CO4	Build solutions to programs on Data structures concepts.	PO1,PO2/PSO2	3

Syllabus

Basic problems, Pattern based problems, Number based problems, Array based problems (one dimensional and two dimensional), character and string based problems, functions and recursion (class and objects for java), pointer based problems, function pointers and array pointers (For C Users), linked lists, queues, stack problems.

Tools for References: http://hackerrank.com

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TECHNICAL SKILL - 2 (CODING)

Course code : 19SC1207
Pre-requisite : NIL
L-T-P-S : 0-0-0-6
Credits : 1.5

Mapping of Course Outcomes (CO) to Program outcomes:

CO #	Course Outcomes (CO)	PO/PSO	BTL
CO1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	PO1,PO2/ PSO2	3
CO2	Build solutions for problems on Numbers and array based problems , functions, recursion	PO1,PO2/ PSO2	3
CO3	Solve problems solutions for character/string based problems and pointers	PO1,PO2/ PSO2	3
CO4	Build solutions to programs on Data structures concepts.	PO1,PO2/ PSO2	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. Guldo 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.

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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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OBJECT ORIENTED PROGRAMMING

Course code : 19SC1201
Pre-requisite : NIL

L-T-P-S : 3-0-2-0
Credits : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand basic Concepts of OOP, fundamentals of java and apply the concepts of classes and objects through Java Language. Apply constructors, Overloading, parameter passing.	PO3, PO5/PSO1	2
CO2	Apply access control, Inheritance, Packages.	PO3, PO5/ PSO2	3
CO3	Apply Interfaces, Exception Handling, multi- threading, I/o.	PO3, PO5/ PSO2	3
CO4	Apply collection framework and event driven programming.	PO3, PO5/ PSO2	3
CO5	Apply object-oriented programming concepts to write programs and Analyses requirements and design to implement lab-based project with SDLC in a group of students.	PO7, PO9, PO10/ PSO1	4

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, String handling functions.

Packages and Interfaces: Packages, Class path, Importing packages, differences between classes and interfaces, Implementing & Applying interface.

Exception Handling: Exception Handling fundamentals, Collections Framework.

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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List of Lab Experiments:

1. Every student must complete minimum 12 experiments and one Lab based Project.
2. Java program to implement nested if
3. Java program to generate a multiplication table using for- loop
4. Java program to find out second largest number
5. Java program on array – bubble sort
6. Java program on constructor over loading
7. Java program on method overloading
8. Java program on inheritance and method overriding
9. Java program on access specifiers
10. Java program on packages
11. Java program with two interfaces
12. Java program on exception handling
13. java programs on collection Frame work-1
14. java programs on collection Frame work-2

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DIGITAL LOGIC AND PROCESSORS

Course code : 19EC1101
Pre-requisite : NIL

L-T-P-S: 3-0-2-0
Credits: 4

CO#	Course Outcome	PO/PSO	BTL
CO1	Describe the concepts of number systems wit h 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. Code conversions and digital IC's realization with respect to data sheets	PO1/PSO-1	2
CO2	Employ combinational logic crcuits with minimization techniques and logical verification through hardware description language	PO5/PSO2	3
CO3	Substantiation of sequential logic circuits and logical verification through hardware description language	PO5/ PSO2	3
CO4	Implementation of digital circuits using PAL, PLA and FPGA. Discriminate the operations of ALU and execution of microinstructions.	PO5/PSO-1	4
CO5	Analyse the digital IC logic for combinational and sequential circuits implementation	PO6/PSO-1	4

Syllabus

Basics of Logic Design: Number systems: Binary, Octal and Hexa decimal; Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Karnaugh map, Digital waveform characteristics; Codes:BCD, ASCII, Parity and Alphanumeric; Code Conversion, Logic Gates TTL and CMOS ICs, IC Data sheet parameters, Clock Buffer (7440) and level shifter (CD 4504)

Combinational Logic design: Half Adder/Subtractor (7486, 7408 and 7404); Full adder using 7483, Full Subtractor using simple gates, Decoders (74HC238,74LS154), Encoders(CD4532,74184), Multiplexers/Demultiplexers (4051, 4052, 4053), Magnitude Comparators (4585 , 7485), Parity Generators and Checkers (74180), BCD to seven segment decoder (74LS47), Verilog HDL design for Combinational Logic Functions.

Sequential Logic design: NAND/NOR Latches Gated Latches (4011/4001), JK (7476/4027) and D Flip-flops (7474/4013), Shift registers (SISO, SIPO, PISO,PIPO), Design of Synchronous counters (7476, 7490, 7493) and Asynchronous Counters (4013), Up-down counters (74193/CD4510),Ring and Johnson counters, Digital Clock design, Verilog HDL design for Sequential Logic Functions

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

Processors: Block diagram of generic processors, ALU, Instruction register, Instruction decoder, execution of micro instructions (Adding two HEXA Numbers).

Text Books

1. Digital Principles and Logic Design by ArijitSaha and NilotpalMannaISBN: 978-1-934015-03-2 Jones & Bartlett Publishers 2007

Web References

1. https://onlinecourses.nptel.ac.in/
2. https://onlinecourses.nptel.ac.in/noc18_ee33/previe
3. https://drive.google.com/file/d/1IpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

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4. https://www.youtube.com/watch?v=qqeRUgAvmzQ
5. https://www.youtube.com/watch?v=o1-hj6GKaFY
6. https://www.youtube.com/watch?v=2gl3aC5blfA

List of Experiments

1. Realization of Boolean Function using Logic Gates
2. Realization of Half Adder/Subtractor (7486, 7408 and 7404) , Full adder using 7483 , Full Subtractor using simple gates & Decoders (74HC238, 74LS154).
3. Realization of Priority Encoding using CD 4532 and BCD / Binary decoder 74184)
4. Implementation of Multiplexers / Demultiplexers (4051, 4052, 4053)
5. Implementation of BCD to Seven Segment decoder (74LS47)
6. Realization of Decade Counter Using JK Flip flop (7476 and 4027)
7. Implementation of Up down counter with LED display using 74193
8. Analysis of BCD to Excess 3 & Binary to Gray Codes.
9. Summing &Subtractor of ALU Using discret IC's

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BASIC ELECTRONIC CIRCUITS

Course Code: 19EC1213
Pre-requisite: Nil

L- T- P : 2-0-0-0
Credits : 2

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic electronic components.	PO1/ PSO1	2
CO2	Understanding of junction diode, I-V characteristics and applications of diodes.	PO1/ PSO1	2
CO3	Understanding the design and working of power supply and regulators using zener diodes.	PO1/ PSO1	2
CO4	Understand the working of BJT and study of data sheets, analog and digital IC's.	PO5/ PSO1	2

Syllabus:

Introduction to Electronic Components: Components, types of components, color coding, types of resistors, types of capacitors, types of inductors, switches, diodes, transistors, Induction coils, transformers.

Introduction to Circuit Theory: Mesh analysis, Nodal Analysis, Thevenin's theorem, Norton's theorem, Super position theorem, Maximum power transfer theorem.

Diodes: P-type and N-type semiconductors (brief discussion), P-N junction, forward bias and reverse bias, V-I characteristics, ideal and practical diodes, approximate model, diode data sheet, types of diodes and variants (Introductory level only).

Applications of diodes: Clippers, Clampers, Rectifiers - HWR, FWR, BR with and without capacitive filters.

POWER SUPPLY & TRANSISTER BASICS:

Power supply: Power supply with ripple reduction and regulation.

Zener Diode: Difference between ordinary diode and zener diode, zener diode as a voltage regulator, Avalanche and Zener breakdown, Zener characteristics, Applications.

BJTs: Types of transistors (PNP and NPN), switching transistors, power transistors (low, medium and large power), key parameter from data sheet. (Gain, Bandwidth, β,α...etc.

Analog & Digital ICs: 7805,7905,IC 741, IC 555, LM 339, LM723.

Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell

Reference Books

1. Integrated Electronics by Millman & Halkias

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SKILLING FOR ENGINEERS-1 (IT CODING / HARDWARE CODING)

Course Code : 19TS201 L-T-P-S : 0-0-0-6

Pre-requisites : NIL Credits : 1.5

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction to GSD and Lab VIEW Environment such as Front Panel, Controls Palette, Controls and Indicators, Block Diagram Terminals, Functions Palette, Data Type, Boolean Operations, String Operations.	PO1,PO3/ PSO1	2
CO2	Introduction to Loop Concept, Nested Loop, Feedback, Arrays, Cluster, Plotting Data using chart and Graph, Tunnel Concept, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes using Lab VIEW	PO1,PO3/ PSO1	2
CO3	Introduction to Case structures, Case Control using Enumerated data type, Introduction to Flat Sequence, Create New Sub VI, Input and Output Sub VI Connectors, Error handling and Debugging Techniques, Introduction to File I/O operations, Event Structure and operations, Design Technique, Introduction to Architecture, Synchronization and Communication using Lab VIEW.	PO3,PO5/ PSO1	2
CO4	Simulation Using MultiSim Instruments such as Multimeter, Function Generator, Wattmeter, Bode plotter, Introduction to Measurement Probe and Current Probe in MultiSim, Operations on Simulation Analysis such as AC analysis, DC operating Point, Fourier Analysis, Noise Analysis, Distortion Analysis, Parameter Sweep, Transfer Function, Worst case Execution using MultiSim	PO3,PO5/ PSO2	3

Syllabus:

Introduction To LabVIEW: Introduction to graphical system design (GSD), working on GSD platform, Benefits of GSD, Text based programming Vs LabVIEW, Introduction to LabVIEW Environment, Front Panel Window Toolbar, Block Diagram Window Toolbar, Introduction to VIs, Data types, Data Representation, Coercion dot, Selecting a Tool, Shortcut Keys, Basic debugging techniques, Introduction to Digital Electronics, Boolean operations , Digital Circuit design, string operations, Various Display Types (Normal, code, Password, HEX display), Exploring string functions

Graphical Programming using LabVIEW: Introduction to loop concept, Type of Loops, For loop, Nested For loop, While loop(Stop if true and Continue if True), hybrid nested loop, Feedback Node, Shift Register and Stack Shift register, Introduction to tunnel and its type, Auto-Indexing, Last Value, Concatenating, Introduction to Arrays, operations of Array Functions, 1-D Array, 2-D Array, Introduction to Clusters, Cluster Function, Difference between Array and Cluster, Chart, Graph, Difference between Chart and Graph by Execution Exercise, Signal Generation and Plotting, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes,

Structures Using LabVIEW: Introduction to Case structures, Case Control using Enumerated data type, Enum with type definition, Introduction to Flat Sequence, Create New Sub VI from Scratch, Input and Output Sub VI Connectors, Icon Editor, Making Sub VI from existing VI, Using Sub VIs Exercises, Finding Errors, Error handling and Debugging Techniques. File I/O: Introduction to File I/O, Reading a Data from file, Writing a Data to file, Understanding File I/O using RefNum, File I/O Function Pallet, Introduction to Event Structure and operations, Design Technique, Introduction to Architecture, State machine Architecture. Synchronization and Communication: producer and consumer (Multiple Loops/Parallel programming), Master Slave Architecture Exercises, Difference between Producer Consumer and Master Slave Architecture.

MultiSim: Simulation Using MultiSim, Using various instruments like Multimeter, Function Generator, Oscilloscope, Wattmeter, Bode plotter, IV analyzer using MultiSim, using Measurement Probe and Current Probe in MultiSim. Introduction to Simulation Analysis Using MultiSim, AC analysis, DC operating Point, Fourier Analysis,

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Transient Analysis, Noise Analysis, Distortion Analysis, DC Sweep, Parameter Sweep using MultiSim. Software Tool: NI LabVIEW, NI MultiSim.

Text Books: "Hands-On Introduction to LabVIEW for Scientist and Engineers", John Essick, OXFORD University Press, Second Edition. "Circuit Analysis with MultiSim" DavidBaez-Lopez & Felix E. Guerrero- Castro, Morgan & Claypool Publisher.

Reference Books: "LabVIEW for Everyone", J. Travis &Jim Kring, PRENTICE Hall , Third Edition. "Introduction to MultiSim", Nilsson& Riedel, 9th Edition Reference

Videos:

http://www.ni.com/academic/students/learn-labview/ https://www.youtube.com/playlist?list=PLmdbvGjzIE-EOLHC-RHeUmO1W7v_YuKAX C

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SKILLING FOR ENGINEERS-2 (IT CODING / HARDWARE CODING)

Course Code :19TS202
Pre-requisites : NIL

L-T-P-S : 0-0-0-6
Credits : 1.5

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the array, indexing operations in Matlab and python. Understand the Analysis of LTI Systems and Filters	PO1,PO3/ PSO1	2
CO2	Apply DFT and FFT in speech and bio-signal processing.	PO1,PO3/ PSO2	3
CO3	Explore Multi-rate Signal Processing and Apply Wavelet transform for statistical feature extraction.	PO3,PO5/ PSO1	4
CO4	Explore ANN classifier, Apply Wavelet transform, ANN for classification	PO3,PO5/ PSO1	4

SYLLABUS:

MATLAB- Vector and Matrix operations and Indexing, Mathematical operations on Arrays, Scripts and Functions, Introduction to Python, Data Frames in Python, Numerical Python (Numpy) & Array Indexing and scientific calculations, Multi-dimensional array (Matrix) indexing and operations.
Convolution and Correlation, Filtering by convolution for elementary signals, real time signals and Images. Filtering in time domain, filtering in frequency domain (Case Study).
Review of Discrete Fourier Transform (DFT) and and Fast Fourier Transform (FFT), Comparison of the computational complexity of DFT and FFT, DFT and FFT applied in audio Processing, Plotting the FFT values with normalized frequency, Cepstrum Aliasing, Introduction to Biosignal processing- ECG and EEG signal processing preliminaries, Power spectrum estimation, ECG detection algorithm for filtering, Power Spectrum Estimation of EEG with FFT.
Multirate Digital Signal Processing , Short Time Fourier Transform (STFT) , Fourier to Wavelets , Translation and Scaling, Discrete Wavelet Transform, Statistical Feature extraction, STFT applied to non- stationary (Speech) signals, Wavelet Transform - Evolution, Haar Wavelets, Daubechies wavelet, Signal and Image feature extraction with wavelet transforms (case MATLAB).
Artificial Neural Systems: Preliminaries, Wavelet Transform for Classification of ECG and EEG Signal using ANN (Case study MATLAB), Introduction to Convolution Neural Networks, Deep Learning (Case study Python).

TEXT BOOKS:

1. John G Proakis, Dimtris G Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education.
2. Alan V Oppenherim, Ronald W Schafer, John R Back, Discrete Time Signal Processing, Pearson Education, 2nd Edition.

REFERENCE BOOKS:

1. Matlab - An Introduction with Applications- Amos Gilat , V Edition, Wiley, 2010.
2. Getting Started with MATLAB, Rudra Pratap, VII edition, 2006.
3. Audio and Speech Processing with MATLAB, Paul Hill, CRC Press, 2019
4. P.P. Vidyanathan, "MultirateMultirate systems and filter banks,"Pearson (1993).
5. Jacek M. Zurada, "Introduction to Artificial Neural Systems" Jaico Publishing House, 2004

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COMPUTER ORGANIZATION AND ARCHITECTURE

Course Code : 19EC1202
Credits : 2
L-T-P-S : 2-0-0-0
Pre-requisite : 19EC1101

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the functionality and design the CPU functional units - control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.	PO1, PO2/ PSO1	2
CO2	Understand, analyze and design main, cache and virtual memory organizations.	PO1, PO2/ PSO1	2
CO3	Understand, analyze and design different types of I/O transfer techniques.	PO1, PO2/ PSO1	2
CO4	Understand the design issues of RISC and CISC CPUs and the design issues of pipeline architectures.	PO2, PO3/ PSO1	2

Syllabus:

Computer Architecture, Computer system and its sub modules: State Diagram various Architectures, Moore Machine, Mealey Machine, Van Neuman architecture and hardware implementation of Arithmetic and Logic Unit, Buses Types, Specifications of a computer, Concepts of Machine level programming, Assembly level programming and High-level programming. Various addressing modes and designing of an Instruction set. Concepts of subroutine and subroutine call, use of stack for handling subroutine call and return.

CPU Design: Introduction to CPU design, Instruction interpretation and execution, Micro-operation and their RTL specification. Hardwired control CPU design. Micro programmed control CPU design. Concepts of semiconductor memory, CPU-memory interaction, organization of memory modules.Cache memory and related mapping and replacement policies.Virtual memory, paging concepts, VAS to PAS and Vice-versa mapping.

Input / Output Devices: Introduction to input/output processing, working with video display unit and keyboard and routine to control them. Program controlled I/O transfer. Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Introduction to buses and connecting I/O devices to CPU and memory, TRAP and Interrupts.

Pipelining: Introduction to RISC and CISC paradigm. Design issues of a RISC processor and example of an existing RISC processor. Introduction to pipelining and design issues of pipeline architecture.Introduction to parallel computing.

Text Books

1 William Stallings, Computer Organization and Architecture: Designing for Performance, 8/e, Pearson Education India. 2010.
2 D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 4/e, Morgan Kaufmann, 2008.

Reference Books

1 V. C. Hamacher, Z. G. Vranesic and S. G. Zaky, Computer Organization, 5/e, McGraw Hill, 2002
2 Morris Mano, Computer System Architecture, 3/e, Pearson, 2008.

Web References

1 NPTEL Computer Organization and Architecture Lecture by IIT Guwahati. https://onlinecourses.nptel.ac.in /noc19_cs04/
2 MOOCS:https://www.edx.org/course/computation-structures-3-computer-mitx-6-004-3x-0

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ANALOG ELECTRONIC CIRCUIT DESIGN

Course Code : 18EC2103 L-T-P-S : 3-0-2-0

Credits : 4 Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

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:

Transistor Amplifiers:

BJTs: Biasing, types of biasing, h-parameters, equivalent representation of a transistor using h - parameter model, self bias design, amplifier design from biasing, amplifier analysis using h-parameters (Gain, Bandwidth, input and output impedances), Design of a CE amplifier. Negative feedback amplifiers: need for negative feedback, feedback characteristics, 4 topologies (quantitative analysis only), comparison of the input and output impedances of all the four topologies. Power amplifiers: concept of power amplifiers, class A class B and class AB, class C and class D power amplifiers, Distortion analysis. (Introductory level only)

FETs and MOSFETs:

FETs: Theory and fundamentals, classification of FETs, JFET, MOSFET, DMOS, EMOS, CMOS, VMOS (introductory level only), FET (BFW10) data sheet, CMOS ICs, difference between CMOS and TTL ICs, biasing, FET characteristics, Channel length modulation, FET amplifier and analysis (Gain, Bandwidth, input and output impedances). IC Design & Fabrication: Introduction to different types of ICs and Packaging's, IC Design and Fabrication.

Operational Amplifiers:

Basics: Ideal OPAMP, OPAMP characteristics, ideal and practical OPAMP, CMRR, slew rate, Virtual Ground, inverting and non inverting amplifiers, (3 hrs)

Applications of OPAMPs: Adders, subtractors, scaling amplifier (using LM324 - Quad OPAMP), Integrator, Differentiator, comparator using 710 IC, Schmitt trigger, Instrumentation amplifier. Active filters: design of LP, HP, BP, BS filters (Butterworth filter, first order and 2nd order).

Misc. Topics:

Oscillators: Function generator using LM1428, Barkhausen's criteria for sustained oscillations, Classification of oscillators, RCPS, WBO (using 741 OPAMP), Hartley and Colpitts oscillators (using transistors), crystal oscillator, 555 Timer, functional architecture of 555, Astable, monostable and bistable operation using 555. (6 hrs) Filters: Continued LC Filters, RC Filters, RLC Filters, ripple factor for Half Wave rectifier and Full wave Rectifier. Regulators: Concept of regulation, Design of voltage regulators using LM339, IC 723, 78XX and 79XX series, SCR, Triac.

Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell
3 Linear IC Applications - RamakanthGaykwad

Reference Books

1 Integrated Electronics by Millman&Halkias
2 Electronic Circuits by Schilling &Belove
3 Digital Integrated Electronics by Taub and Schilling

S. No.	List of Experiments
1	Transistor as a switch, as a squarer, as an opto driver, as a logic gate
2	Design of Zener diode as a voltage regulator and Transistor regulator
3	Design of a plus minus DC Adapter
4	Design of a Audio amplifier with speaker as a load

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5	Design of hybrid FET-BJT amplifier
6	Design of Scaling Amplifier using LM324/ 741
7	Design of 80db notch filter
8	Design of Hartley and Colpitt'sOscilator
9	Design of Astablemultivibrator with relay driven blinking LED using 555
10	Design of Monostable Multi Vibrator
S. No.	**Mini projects**
1	Smart irrigation system using soil moisture sensor
2	Measurement of BMI using load cell and ultra-sonic sensor
3	Measurement of EMG
4	Measurement of blood pressure using BMP180 sensor
5	Design of valve controller using potentiometer

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EMBEDDED CONTROLLERS

Course Code : 19EC2205
Credits : 4
L-T-P-S : 2-0-3-2
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the architecture and programming concepts of 8086 Microprocessor	1,2/1	2
CO2	Apply the Programming concepts of 8051 Microcontroller	5/2	3
CO3	Analyse the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers	3/1	4,2
CO4	Understand the basic concepts of CORTEX STM-32 microcontroller and RTOS	2/1	2
CO5	Analyze the applications of programming with 8051 and 8086 on hardware / software. Analyze the applications of programming with Arduino	5/1	4

Syllabus:

Basics of Embedded System: Basics, Introduction and History of Processors, 8086 Architecture, Instruction set, 8086 programming and examples.

Microcontroller Fundamentals: 8051 Architecture, Addressing modes, Instruction set, Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Interrupts.

Serial Data Communication and RS-232C Standard with 8051 Programming, Peripherals and Input Output with 8051 Microcontroller (PIO, Timers and Interfacing).

Modern Microcontrollers: Introduction and Architecture of PIC Microcontroller, Introduction of ARM7 (LPC2148), Basic Architecture of ARM7, Pin Description, Advanced Microcontroller Bus Architecture (AMBA).

Advanced Topics: Introduction to CORTEX (STM 32), Architecture and Introduction to RTOS (Real Time operating systems).Basic concepts and applications of RTOS.

Text Books

1 Mazidi& McKinley "The 8051 Micro controller and Embedded systems: using assembles and C, 2nd edition, 2007.

2 Frank Vahid, "Embedded System Design", Wiley; Student edition (2006).

3 A K Ray and K M Bhurchandi "Advanced Microprocessors and Periperals" The McGraw Companies,2nd Edition,2006

Reference Books

1 Make: Arduino Bots and Gadgets: Six Embedded Projects with Open Source Hardware and Software by TeroKarvinen, Kimmo Karvinen

2 Practical Microcontroller Engineering with ARM Technology by Ying Bai

Web References

1 https://www.youtube.com/watch?v=DmwOSdwzZ3E
2 https://www.youtube.com/watch?v=GPz_mR7Flas
3 https://www.youtube.com/watch?v=fI20Bsx3EPM
4 https://www.youtube.com/watch?v=S2_KtA_6y80

S. No. List of Experiments

1 Implement Arithmetic Operations and Find the number of Positive and Negative numbers in a given array using 8086 Programming, and transfer the program to EEPROM.

2 (a)Write ALP to Sort the Array of Numbers in ascending and descending order using 8086 Programming.
(b)Optional: Different methods of sorting numbers can also be attempted for programming.

3 Design a System to display the continuous Count on seven segments LED Display using Arduino Microcontroller Board.

4 (a) Design Doorbell Music Synthesis with buzzer using Arduino Microcontroller Board.

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(b) Optional: Doorbell Tone/Music may also be synthesized.

5 Design Temperature controlled fan with LM35 and Arduino Microcontroller Board.

6 Design a Traffic Light controller System using Microcontroller 8051 Programming.

7 Design a System to count the number of students entering to a class. And then:
(a) Display the same on 16X2 LCD,
(b) Also send the Data to PC using RS-232 interfaced with Microcontroller 8051.

8 (a) Develop an Assemble Language/ C Program to interface a DC Motor and L293D driver with Microcontroller 8051.
(b) Optional: Design the prototype of Elevator with DC Motor and L293D using 8051 programming.

9 Interface a Servo Motor with ARM7/Raspberry Pi Microcontroller Board.

10 Design a Garbage monitoring system using Ultrasonic Sensor with ARM7/Raspberry Pi Microcontroller Board.

11 Design an Automatic LPG Gas Detection System using ARM7/Raspberry Pi Microcontroller Board.

S. No.	**Mini projects (Default Options)**
1	Design Bluetooth controlled industrial automation with android applications using a Microcontroller Board.
2	Design RFID interfacing for any real time application using a Microcontroller Board.
3	Design a communicating system with GSM Module using a Microcontroller Board.
4	Design Weather Monitoring System for IOT application using a Microcontroller Board.

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SIGNAL PROCESSING

Course Code : 19EM3201
Credits : 4
L-T-P-S : 3-0-2-0
Pre-requisite : NIL

Course outcomes

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand basic concepts related to Signal Processing System	PO2/PSO1	2
CO2	Analyse the Signal Processing Algorithms	PO2/PSO1	4
CO3	Analyse the Filter design Methodologies	PO2/PSO1	4
CO4	Analyse Signal Processing algorithms in different case studies	PO2/PSO1	4

Syllabus

Introduction Signal Processing System: Introduction, Basic Components of DSP System, Classification of Signals, Classification of Systems, Sampling Theorem, Sampling and Quantization, Z- Transforms, Discrete Fourier Transforms, Transfer Function, Convolution, Correlation.

Signal Processing Algorithms: DFT/ FFT Algorithms: DFT, Properties of DFT, Frequency Resolution and windowing, DTFT Computation, the Matrix form of DFT, Modulo N Reduction, Inverse DFT, FFT (Fast Fourier Transforms), Properties of FFT, Circular Convolution.

Filter Design: FIR Filter Design: Window Method, Kaiser window, Frequency Sampling. IIR Filter Design: Bilinear Transformation Method, First order Low pass and High Pass Filter, Second order Filters.

Applications: Audio Processing, Image Formation and Display, Linear Image Processing, Spectral Image Techniques, Neural Networks, Data Compression, Digital Signal Processors, Digital Waveform Generators, Noise Reduction and Signal Enhancement.

Text Book(s):

1. Sophocles J. Orfanidis "Introduction to Signal Processing "
2. Stewen W. Smith " The Scientist and Engineer's Guide to Digital Signal Processing" 2nd Addition.

Reference Book(s):

1. Ramesh Babu "Digital Signal Processing" 3rd Edition
2. Anand Kumar "Digital Signal Processing"

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ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION

Course Code : 19EE2102
Credits : 4
L-T-P-S : 3-1-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand working of various generating stations and economical aspects of generation	PO1, PO3/ PSO1	2
CO2	Understand the parameters of overhead transmission lines and underground cables	PO1, PO2/PSO1	2
CO3	Analyze the performance of overhead transmission lines and AC/DC distribution.	PO1, PO3/PSO1	4
CO4	Understand Mechanical Sag, corona, Insulators and substation layouts.	PO1, PO3/PSO1	2

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 and 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, and 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. G D Rai, "Non-Conventional Energy Sources", Khanna Publishers,2014 Edition.
2. Soni, Gupta and Bhatnagar "A Course in Electric Power" Dhanpat Rai & Sons.
3. S. N. Singh "Electric Power Generation, Transmission & Distribution" Prentice Hall India.

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POWER ELECTRONICS

Course Code : 19EE2202
Credits : 4
L-T-P-S : 3-0-2-0
Pre-requisite : 19EE2101

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Select appropriate switch for a given power converter	PO1,PO7/PSO2	3
CO2	Analyze the steady state performance of Basic DC-DC converters	PO3,PO4/PSO1	4
CO3	Analyze the performance of Basic Switch-Mode PWM Inverter	PO3,PO4/PSO1	4
CO4	Understand the operation of basic phase controlled converters	PO1,PO7/PSO1	2
CO5	Test the basic power electronic converters by hardware realization and MATLAB software.	PO11 / PSO1	4

Syllabus

Power Semiconductor 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: Volt-sec balance, Charge-sec balance and Small Signal ripple approximation principles, Ideal analysis of non-isolated DC-DC converter: Buck, Boost, Buck- Boost, Cuk and SEPIC converters. Introduction of non-idealities in DC-DC converters, DC transformer model approach, Boundary conditions between CCM and DCM. Introduction to isolated Power
supplies: Fly-back, forward and Push-pull converters.

INVERTERS: Voltage source inverters: principle of square wave inverter operation with R and R-L loads, single phase inverters-performance analysis and switch rating determination, three phase square wave inverters (120, 180 modes of operation), Introduction to current source inverter. Sinusoidal PWM and Space Vector PWM schemes and their application to three phase inverters.

Line frequency phase controlled converters: Introduction, Single-Phase Semi & fully controlled converters with R,RL & RLE loads, Three-Phase Semi & fully controlled Converters for R, RL loads, Line current harmonics, Power factor and distortion factor calculations, effect of source inductances, Introduction to Dual converters.

AC voltage controllers: Introduction, Single Phase AC Voltage controllers with R, RL Loads and three Phase AC voltage controllers with Applications. Matrix Converter: principle of operation and applications.

Text books

1. Ned Mohan, Undeland, Robbinds,"Power Electronics Converters Applications and Design", 3rd Edition, John Wiley and sons Publications.2009
2. Robert W. Erickson, Dragan Maksimović"Fundamentals of Power Electronics", Kluwer Academic Publlshers, (2004)

Reference books

1. M.H.Rashid, "Power Electronics, circuits, devices and applications" 4th Edition, PHI 2014
2. M.D.Singh and Khanchandani, "Power Electronics", 2nd edition , TMH Publications.
3. Dr. P.S Bimbra ,"Power Electronics" Khanna Publishers,(2012).
4. JohnG.Kassakian, Marfin F Sehelchet"Principles of Power Electronics" Pearson Publications (2010).
5. Daniel W. Hart, "Power Electronics", TataMcgraw Hills, (2011).

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CONTROL SYSTEMS

Course Code : 19EE2204 L-T-P-S : 3-0-2-0

Credits : 4 Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Control system components and its modelling.	PO1, PO5/ PSO1	2
CO2	Analyse the control systems under time domain and stability analysis.	PO1, PO5/ PSO1	4
CO3	Analyze the control systems under frequency domain analysis.	PO2, PO5/ PSO1	4
CO4	Analyze the state space model equations and Understand the control though PLC	PO2, PO5/ PSO1	4
CO5	Test the operation of control systems using software & prototype models	PO1, PO5/ PSO2	4

Syllabus

Control System Concepts: 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, block diagram representation of control systems, 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.

Frequency response Analysis & Design: Introduction, frequency response specifications, correlation between time and frequency response, specifications, polar (Nyquist) plot, Bode plot, phase margin and gain margin; stability analysis from Nyquist plot effect of adding poles & zeros to G(s) H(s) on the shape of polar plots. Preliminary design considerations – Introduction to lead, lag, lead - lag compensation techniques in frequency domain.

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,. Concepts of controllability and observability.

Process control through PLC: Basic PLC architecture - CPU, memory, I/O Modules, programming formats, I/O devices, PLC programming- input/contact and output/coil instructions, control process to PLC logic diagram, ladder diagram for basic control processes.

Text books

1. J Nagrath& M Gopal, "Control System Engineering", 5th Edition,New Age International Publication, New Delhi (2011).
2. B.C. Kuo," Automatic Control Systems", 10th Edition, Prentice Hall India Publications, NewDelhi2017,
3. J W Werb& Ronald A Reis, "Programmable Logic Controllers Principles and Applications", 5th Edition, Pearson Publications

Reference books

1. K Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall India Publication, New Delhi ,
2. M.Gopal, "Control Systems Principles and Design", Fourth Edition, Tata Mc-Graw Hill Publications,
3. J W Werb& Ronald A Reis, " Programmable Logic Controllers Principles and Applications", 5th Edition, Pearson Publications.

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ELECTRICAL MACHINES

Course Code : 19EE2103 L-T-P-S : 3-0-2-0

Credits : 4 Pre-requisite : NIL

CO No.	Course outcome	PO/PSO	BTL
1	Understand the basic principles of electro mechanical energy conversion.	PO1 /PSO1	2
2	Compute the performance of DC machines.	PO4, /PSO1	3
3	Select a suitable technique to find the voltage regulation of an alternator and analyze the load sharing.	PO4, PO5/PSO1	4
4	Determine the performance of Transformers.	PO4, PO5/PSO1	4
5	Test the performance of Electrical Machines.	PO1, PO4/PSO1	4

SYLLABUS (As approved by BoS):

Electromechanical Energy Conversion: Basic principle Energy, Lorentz force equation, general expression of stored magnetic energy and Coenrgy. Force and Torque equations of single and multiple excited systems. Working principle and construction of DC machines, methods of excitation. EMF equation. **DC. Generators:** Circuit models, Armature reaction, commutation process, Compensating winding, Characteristics of various types of generators. **DC. Motors:** Torque equation and types of DC motors. **Performance of DC Machines**- Testing- Direct, indirect 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, Separation of hysteresis and eddy current losses, Autotransformer, Three phase Transformer, Scott connections, cooling methods. **Synchronous Machines:** Rotating magnetic field. 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. Parallel operation of Alternators- Synchronization and load division.

Text books

1. P.S. Bimbra "Electrical Machines" 7th ed., Khanna Publishers., 2007.
2. I.J Nagrath& D.P Kothari "Electrical Machines"4th ed., Tata Mc Graw-Hill, 2010.
3. Stephen J Chapman, Electric Machinery Fundamentals, Fourth Edition, McGraw Hill, Singapore 2005.

Reference books

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

List of experiments

1. Familiarization of the electrical machine laboratory apparatus
2. To study the magnetization characteristics of DC shunt generator
3. To study the load characteristics of DC shunt generator
4. Load Test On Separately Excited DC Motor
5. Swinburne's test
6. To obtain the equivalent circuit parameters from OC and SC tests of a single phase transformer.
7. To estimate efficiency & regulation of given single phase transformer at various loads from OC and SC tests.
8. Regulation of Alternator by synchronous impedance method
9. Regulation of Alternator by MMF method
10. Regulation of Alternator by Z.P.F method.

Extra experiments for self learning

11. To study the generation of magnetic field in a single coil system due to DC and AC current
12. Load test on 3-phase alternator.

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Industrial Applications of Electrical Machines

Course Code : 19EE2201 L-T-P-S : 3-0-2-0

Credits : 4 Pre-requisite : 19EE2103

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
CO 1	Understand the concepts of the 3- phase induction motor	4, 5 /1	2
CO 2	Select different speed control and starting methods of induction machine.	4, 5/1	3
CO 3	Analyze the performance of 3-phase synchronous motor	4, 5/1	4
CO 4	Select suitable motor for particular industrial applications.	4, 5/1	3
CO 5	Test the performance of Motors for various applications.	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 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. DC Motors applications based on their characteristics- Stating methods, speed control methods- field control, armature control and Ward Leonard method. **Special machines-** Brush less DC motor, Permanent Magnet Synchronous Motor, Stepper motor, Reluctance motor and their applications.

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.
3. Stephen J Chapman, Electric Machinery Fundamentals, Fourth Edition, McGraw Hill, Singapore 2005.

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.

List of Experiments:

1. Speed control of slip ring Induction Motor
2. No Load Test on Three Phase Induction Motor
3. Blocked Rotor Test on Three Phase Induction Motor
4. To start the induction motor by applying Star-Delta starter
5. To start the induction motor using 3-phase auto transformer
6. Synchronization of an alternator with infinite bus
7. 'V' and 'Inverted V' curves of a three phase synchronous motor
8. Speed Control of DC motor by field resistance control
9. Speed Control of DC motor by armature resistance control
10. To perform speed control of DC motor by using Ward- Leonard Method of speed control

Extra experiments for self learning

11. Speed Control of Separately Excited DC Motor
12. To study the behavior of rotating magnetic field in a three coil system due to AC current

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Computer Applications in Power Systems (19EE2203)

Course Code : 19EE2203
Credits : 3
L-T-P-S : 2-1-0-0
Pre-requisite : NIL

Course Outcomes (CO):

CO No:	Course Outcome (CO)	PO/PSO	BTL
CO 1	Apply load flow and fault analysis in a power system	1,5/1	3
CO 2	Understand the principle of protective relays & circuit breakers	1,5/1	2
CO 3	Understand over current, distance and differential protection schemes	1,5/1	2
CO 4	Understand rotor angle stability	1,5/1	2
CO 5	Analysis of Power system problems using simulation tools	1,5/1	4

SYLLABUS

Power System Analysis: Network model formulation, Formation of YBUS by Direct Inspection Method, Power flow problem formulation- NR Method (Polar Coordinate Approach), Symmetrical & Unsymmetrical Fault Analysis – Per Unit System, Calculation of symmetrical & Unsymmetrical short circuit currents for simple systems(unloaded).

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 earthing, step voltage, Types of neutral grounding.

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. Badri Ram, D N Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, TataMc-Graw Hill Publications.

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).
3. C.L.Wadhwa ,"Electrical Power Systems", New Age International (P) Limited,(2008).
4. Sunil S Rao, "Switch Gear Protections", Khanna Publications.

Web Reference/MOOCS:

1. https://nptel.ac.in/downloads/108101039/
2. https://nptel.ac.in/courses/108102047/

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AI TECHNIQUES IN ELECTRICAL ENGINEERING

COURSE CODE: 19EE3101
L-T-P-S: 3-0-0-0

Course Outcomes:

CO NO	COURSE OUTCOME	PO/PSO	BTL
CO1	Understand the neural network models, different architectures with different learning types and various algorithms for ANN to solve the load forecasting problems in Power systems	PO1,PO4	2
CO2	Apply ANN paradigms in Electrical Engineering	PO6,PO5	3
CO3	Apply the fuzzy logic concept, fuzzy sets, with suitable membership function with proper de-fuzzification methods Electrical Engineering	PO1,PO4	3
CO4	Apply the different cross over methods and their elitism, convergence of algorithm Electrical Engineering	PO1,PO5,PO6	3

Syllabus :

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, Electrical Drives. **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,Electrical Drives. **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, Electrical Drives.

Text Books :

1. Daniel Graupe-Principles of Artificial Neural Networks-World Scientific publishing Company (2013)
2. S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.
3. 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 McGraw Hill Publishing Company Private Limited, 2006
3. K Sundareswaran, 'Fuzzy Logic Systems', Jaico Publishing House, 2005

Web Links :

1. NPTEL Course Introduction to soft computing techniques,https://nptel.ac.in/courses/106105173/
2. NPTEL (Course) on Optimization https://nptel.ac.in/courses/111105039/
3. NPTELCourse Constrained and unconstrained optimization, https://nptel.ac.in/courses/111105100/
4. Webinar: AI for Energy: https://www.youtube.com/watch? v=I BBBfgV5wVI
5. Webinar: What AI means for power generation industry: https://www.youtube.com/watch?v=Iq0vYCPA6z4
6. Webinar: AI is the new electricity: https://www.youtube.com/watch?v=21EiKfQYZXc

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INDUSTRIAL COMMUNICATION PROTOCALS& CYBER SECURITY

Course Code : 19EE3111
Credits : 3
L-T-P-S : 3-0-0-0
Pre-requisite : 19EC3109

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the various Industrial Data Communication networks	PO5, PO6/ PSO1	2
CO2	Understand the industrial protocols and standards.	PO5, PO6/ PSO1	2
CO3	Apply the knowledge of cyber-security in industrial and various automation domains.	PO5, PO6/ PSO2	3
CO4	Understand the hacking concepts and counter attacking methods in automation.	PO5, PO6/ PSO1	2

Syllabus

Different types of Communication technologies for the smart grid, Modbus - Modbus Protocol Overview - PROFIBUS-FMS, DP,PA and technology overview - DNP3- IP based Real Time data Transmission, Substation communication network.

PROTOCOL & STANDARDS

Introduction to Industrial Network Technology CAN and CiA (CAN in Automation)- Technical Overview - Application Layers- CAN Kingdom- CAN open -Introduction-Benefits and Challenges Of Interoperability, Model For Smart Grid Network Interoperability, Approach to Smart Grid Interoperability Standards, IEC61850, GOOSE.

INFORMATION SECURITY AND MEASUREMENT TECHNOLOGY

Introduction – Encryption and Decryption Authentication, Digital signature, Message digest, cyber security standards. Communication and Measurement - Monitoring, GIS and Google Mapping Tools- Introduction to Cyber Crime - Classification of Cyber Crimes- Reasons for Commission Of Cyber Crimes - Malware – Types -Cyber Security Initiatives in India -Counter Cyber Security initiatives in India -Wireless Security - Major Issues With WLAN - Secure WLAN- Wi-Fi at Home.

HACKING AND CYBER-SECURITY MODELS

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. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell.5.Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc.
2. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities", Island Press.
3. Eric D. Knapp, Raj Samani "Applied Cyber Security and the Smart Grid: Implementing Security Controls"
4. Pascal Ackerman, "Industrial Cybersecurity", Packet ,oreilly safari, 2017

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INDUSTRIAL PROCESS CONTROL AND AUTOMATION

Course Code : 19EE3112
Credits : 3
L-T-P-S : 3-0-0-0
Pre-requisite : 19EE3205

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic industrial process and control	PO1,PO5/ PSO1	2
CO2	Understand the functional and operational elements of industrial automation	PO1,PO5/ PSO1	2
CO3	Apply industrial automation controls to tune the PID controls	PO1,PO5,PO6/ PSO2	3
CO4	Design the controls for industrial processes	PO1,PO5,PO11/ PSO2	6

Syllabus

Industrial Processes: Introduction to Industrial Processes, **Benefits and types of Industrial Processes,** Industrial Processes in Thermal Power Plant, Steel/Iron Industry, Chemical Industry, Cement Industry. .

Industrial Automation: Introduction to industrial automation, need of automation, Functional Elements of Industrial Automation, Types of Industrial Automation Systems advantages and disadvantages of industrial automation.

Programmable logic controllers- Organization- Hardware details- I/O- Power supply- CPU- Standards- Programming aspects- Ladder programming- Sequential function charts- Man- machine interface- PID Modules, PID tuning, PID functions. Detailed study of one model- Case studies

Design of controllers: Design of controllers to different Industrial Processes in Thermal Power Plant, Steel/Iron Industry, Chemical Industry, Cement Industry.

Text books

1. Mr. Dale & Stephen Fardo "Industrial process control systems"- Fairmont Press, 2009
2. StamatiosManesis, George Nikolakopoulos "Introduction to Industrial Automation" CRC Press. 2018
3. Karl Johan AstromT. Hagglund"PID Controllers: Theory, Design and Tuning", ISA
4. John W. Webb & Ronald A. Reiss "Programmable Logic Controllers- Principles and Applications" Fifth Edition, PHI.

Reference books

1. C D Johnson "Process Control Instrumentation Technology"
2. GhodratKalani "Industrial Process Control" Gulf Professional Publishing.
3. Dale E. Seborg "Process Dynamics and Control"
4. JR.Hackworth&F.D Hackworth Jr. "Programmable Logic Controllers- Programming Method and Applications" Pearson, 2004

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SCADA AND DCS

Course Code : 19EE3113
Credits : 3

L-T-P-S: 3-0-0-0
Pre-requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the need for SCADA for automation	PO1,PO5/ PSO1	2
CO2	Understand the principle of operation of SCADA elements	PO1,PO5/ PSO1	2
CO3	Understand principle operation of DCS	PO1,PO5/ PSO2	2
CO4	Apply the SCADA & DCS for industrial automation	PO1,PO5/ PSO2	3

Syllabus

Introduction to SCADA: History of automation systems, SCADA Systems, Components of SCADA Systems, SCADA applications functions, advantages of SCADA in process automation and utility industry.

SCADA fundamentals: Introduction, Building blocks of SCADA, Remote Terminal Unit (RTU), Intelligent Electronic Devices (IEDs), Data concentrators and merging units, SCADA communication systems, Master station, Human machine Interface (HMI), Building the SCADA systems

Introduction to DCS: Introduction, DCS Architecture, Local Control (LCU) architecture, LCU languages, LCU – Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept – case studies in DCS.

SCADA & DCS applications: Utility industry: Power generation, transmission and distribution, Manufacturing/process industry: Steel, iron plants, case studies.

Text books

1. John W. Webb & Ronald A Boyer, Programmable Logic Controllers- Principles and Applications, Stuart A. SCADA: supervisory control and data acquisition. International Society of Automation, 2009.
2. Thomas, Mini S., and John Douglas McDonald, Power system SCADA and smart grids, CRC press, 2015.

Reference books

1. Wiebe, Michael. A Guide to Utility Automation: AMR, SCADA, and IT Systems. Pennwell Books, 1999.
2. Bailey, D., and E. Wright. Practical SCADA for industry, illustrated ed. Great Britain: Newnes, 2003.
3. Clarke, Gordon, Deon Reynders, and Edwin Wright. Practical modern SCADA protocols: DNP3, 60870.5 and related systems. Newnes, 2004.
4. Forouzan, A. Behrouz. Data communications & networking (sie). Tata McGraw-Hill Education, 2007.

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INDUSTRIAL DRIVES AND CONTROL

Course Code : 19EE3114
Credits : 3

L-T-P-S : 3-0-0-0
Pre-requisite : 19EE3201

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand electric drive system components and dynamics of a drive system.	PO1,PO5/ PSO1	2
CO2	Develop controllers for DC drive systems.	PO2,PO5/ PSO2	3
CO3	Develop controllers for AC drive systems.	PO2,PO5/ PSO2	3
CO4	Apply special machine drives for precise industrial processes.	PO2,PO5/ PSO2	3

Syllabus

Industrial load types –continuous and batch processes, sensors- voltage, current, speed, choice and sizing of drive components, Dynamics of drive System: starting, Braking and Speed control

Closed loop control of DC drives: phase controlled and chopper controlled DC drives, controller design

Closed loop control of Induction motor drives: V/f control, direct torque control, controller design

BLDC motor control: Torque-speed characteristics, Controllers-Microprocessor based controller. Sensor less control.

Stepper motor control: Stepper Motors - Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

Text books

1. R Krishnan," Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education,2001
2. G. K. Dubey & C. R. Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.

Reference books

1. G. K. Dubey ,"Power Semiconductor controlled drives", Prentice Hall Inc., New Jersey(1989).
2. VedamSubrahmanyam," 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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IOT FOR INDUSTRIAL AUTOMATION

Course Code : 19EE3115
Credits : 3

L-T-P-S : 3-0-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the IOT terminology, technology	PO1,PO5/ PSO1	2
CO2	Apply the IOT elements to industrial automation	PO2,PO5/ PSO2	3
CO3	Understand the concept of M2M (machine to machine) with necessary protocols	PO2,PO5/ PSO1	2
CO4	Apply M2M for industrial automation	PO2,PO5/ PSO2	3

Syllabus

Introduction to Internet of Things –Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT communication models, Iot Communication APIs IoTenabaled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems, IoT Levels and Templates Domain Specific IoTs – Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle

IoT and M2M – Software defined networks, network function virtualization, difference between SDN and NFV for IoT Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER

Text books

1. S.K. Singh, "Industrial Instrumentation and control" – The McGraw Hill companies 3rd edition – 2009.
2. Curtis D. Johnson "Prentice Process control Instrumentation Technology" – Hall India, 8 th edition, 2006
3. Thomas Hughes, "Programmable Logic Controller", ISA Publication
4. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.
5. McMillan.G.K, "Process/ Industrial instrument and handbook", McGraw-Hill, New York, 1999
6. Machine- to-machine communications edited by vojislab B. misic, Jelenamisic, CRS press Taylor &francis group – 2015.
7. Internet of Things: A hands on approach by ArshdeepBahga, Vijay madisetti Published by ArshdeepBahga, Vijay madisetti- 2014.

Reference books

1. Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication.
2. Thomas Hughes, "Programmable Logic Controller", ISA Publication.
3. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication
4. PoppovikBhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publication

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SOLAR PV AND MICRO-ENERGY TECHNOLOGIES

Course Code : 19EE3121
Credits : 3
L-T-P-S : 3-0-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Interpret principles and control of Solar PV Energy system	PO1,PO2 / PSO1	2
CO2	Model and Select Solar PV energy system components	PO2,PO5 / PSO1	3
CO3	Interpret and Model dynamics of fuel cell energy conversion	PO1,PO2 / PSO1	3
CO4	Demonstrate ultra micro-energy energy conversion technologies	PO2,PO5 / PSO1	2

Syllabus

Solar PV energy conversion: Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, I –V Curve, Impacts of Temperature and Insolation, Shading impacts on I–V curves, I–V Curves for different loads, MPPT, System sizing, System Performance, Economics

Modelling of Solar PV system components: Mathematical models -PV cell, PV Array, Battery pack, dc-dc converter, P&O MPPT technique, DC bus voltage regulation

Fuel Cell energy conversion: PEM Fuel Cells, Solid Oxide Fuel Cells, Electrolyzers, Power Electronic Interfacing Circuits, Standalone and Grid Connected Fuel Cell Power Generation Systems, Hybrid Fuel Cell Based Energy System Case Studies, Dynamic models and control of PEM, Solid Oxide Fuel Cells

Micro Energy Sources: Ocean Thermal energy conversion, Geo-thermal energy conversion, Tidal Energy conversion, Biomass energy, Bio gas plants

Text books

1. H.P. Garg & J. Prakash, "Solar Energy - Fundamentals and Applications", Indian Edition - First Revised Edition, Mc Graw Hill Education.
2. M. H. Nehrir, C. Wang, "Modeling and Control of Fuel Cells: Distributed Generation Applications", Wiley-IEEE Press, 1st Edition, 2009.

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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WIND AND ENERGY STORAGE TECHNOLOGIES

Course Code : 19EE3122
Credits : 3
L-T-P-S : 3-0-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Interpret principles and control of Wind Energy Conversion	PO1,PO2 / PSO1	2
CO2	Model and Select Solar Wind energy conversion system components	PO2,PO5 / PSO1	3
CO3	Interpret and Model Electro-chemical energy storage components	PO2,PO5 / PSO1	3
CO4	Interpret and Model Mechanical energy storage components	PO2,PO5 / PSO1	3

Syllabus

Wind Energy Conversion System: Components of WECS, Power obtained from the wind, Power Regulation, yaw control, Pitch control, stall control, Schemes for Maximum Power Extraction, Wind Turbines & Generators: Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines

Modelling of WECS components: Mathematical models for DFIG, PMSG, Stand alone and Grid Connected WECS system control, Models for MPP

Electro-chemical Energy Storage: Batteries - lead acid, lithium ion, flow, design considerations, life cycle and reliability study, Ultra-capacitors - operation, applications, Model for lead acid battery and ultra-capacitor.

Mechanical Energy Storage: Models for pumped hydro, compressed gas, flywheel storage, System cost and efficiency, Thermal storage- Materials, Design considerations, Solar thermal energy storage

Text books

1. 1. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", IET Power Electronics Series, 2012.
2. 2. Ali Keyhani Mohammad Marwali and Min Dai, Integration and Control of Renewable Energy in Electric Power System, John Wiley publishing company, 2nd Edition, 2010.
3. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, First edition

Reference books

1. John Twidell& Toney Weir: E&F.N. Spon, "Renewable Energy Sources", Taylor &Francis New York, 2nd edition.

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ENERGY MANGEMENT AND GREEN BUILDINGS

Course Code : 19EE3123
Credits : 3

L-T-P-S : 3-0-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply energy audit for energy management in buildings	PO2,PO5/ PSO1	3
CO2	Interpret energy conservation opportunities in electrical systems	PO1,PO7/ PSO2	2
CO3	Identify energy management strategies for energy efficiency	PO1,PO7/ PSO1	3
CO4	Identify practices for energy efficiency green buildings	PO2,PO5/ PSO1	3

Syllabus

Energy Audit: Need, types, methodology and approach, Instruments for energy audit, Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, maximizing system efficiency, Return of Investment

Energy conservation opportunities: Energy conservation in HVAC, Refrigeration and Air Conditioning, Pumping Systems, lighting control, lighting control, Energy Conservation Building Code, Energy Conservation opportunities in Transformers and cables, Transmission lines

Energy Management: Definition and Objective of Energy Management, General Principles, Energy Management Strategy, Energy Balance sheet and Management Information System (MIS), Energy Modelling and Optimization, Demand Side management (DSM), Peak Demand control- Methodologies

Green Building Practices: Energy efficiency-life cycle perspective, Environmental product declaration, Building information model, choice of heat insulation materials, high thermal mass materials, phase change materials, Green building certifications

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)
3. Energy Management: W.R.Murphy, G.Mckay (Butterworths)

Reference books

1. Energy Management Hand book by Turner, Wayne C, Lilburn, The Fairmont press, 2001
2. Handbook of Energy Audits by Albert Thumann, Fairmont Pr; 5th edition (1998).
3. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.
4. Energy Management Principles: C.B. Smith (Pergamon Press)
5. Bureau of Energy Efficiency Publications-Rating System, Teri Publications – Griha Rating System, Leeds Publications.

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GRID INTEGRATION OF RENEWABLE ENERGY SOURCE

Course Code : **19EE3222** L-T-P-S : 3-0-0-0

Credits : 3 Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO	Description	PO/PSO	BTL
CO1	Apply the control principles for PV - grid integration control	PO5	3
CO2	Apply the control principles for wind power integration control	PO4	3
CO3	Identify power quality challenges in grid integration of renewable energy	PO4	3
CO4	Identify challenges in grid integration of multiple renewable sources	PO5	3

Syllabus:

PV Integration Technology: Photovoltaic (PV) inverter topologies- configurations and control strategies, Grid codes and technical regulations of Solar PV integration

Wind Power Integration Technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control, Grid codes and technical regulations of Wind power integration

Power quality management: THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, effects on system stability

Challenges: Integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection

Text Books:

1. Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York, 2009
2. S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 1st Edition, 2013

Reference Books:

1. Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, CRC Press (Taylor & Francis group), 2017
2. Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (IET digital library), 2007

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AI and IoT for Green Energy Integration

Course Code : 19EE3221
Pre Requisite : NIL

L-T-P-S: 3-0-0-0
Credits: 3

Course Outcomes:

CO	Description	PO/PSO	BTL
CO1	Utilize AI techniques for PV based Power generation	PO4	3
CO2	Utilize AI techniques for wind and hybrid power generation	PO4	3
CO3	Demonstrate IoT devices and tools for Green energy systems	PO2	2
CO4	Build IoT Systems for Green Energy Integration	PO7	3

Syllabus

AI for solar PV Power generation: Fuzzy logic based PV MPP techniques, RMSE and MAPE analysis for short term irradiance, solar energy and load forecasting, Machine learning algorithms for short term irradiation and temperature forecasting, Day ahead power output forecasting for PV systems with regression, machine learning and deep learning techniques, Case studies

AI for Wind and Hybrid Power generation: Frequency control of induction generator using genetic algorithm, stochastic wind generation and congestion management, Intelligent Energy Management System of Hybrid Solar/Wind/Battery Power Sources, Islanding detection, Case studies

IoT Devices and Tools for Green Energy systems: Sensors- temperature, vibration, irradiance, wind speed, PIR, proximity, current, voltage Controllers, networking, Cloud computing, Data analytics

IoT Applications for green energy systems: Cloud based Real- time Monitoring systems: PV Power output, State of Health of Battery Storage, wind turbine vibration, M2M communication case study

Text Books:

1. AI and IoT in Renewable Energy, **Shaw,** R.N., **Mendis, N., Mekhilef, S., Ghosh,** A, Springer, 2011
2. Applications of AI and IoT in Renewable Energy, R.N., **Mendis, N., Mekhilef, S., Ghosh,** A, Elsevier, 2021

Reference Books:

1. Introduction to AI Techniques for Renewable Energy System, Suman Lata Tripathi, Mithilesh Kumar Dubey, Vinay Rishiwal, Sanjeevikumar Padmanaban, CRC Press, Edition 1, 2021

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ENERGY CONSERVATION AND AUDIT

Course Code : 19EE3123
Credits : 3

L-T-P-S : 3-0-0-0
Pre-requisite : NIL

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

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

Reference books

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

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ENERGY ACCOUNTING AND MANAGEMENT SYSTEMS

Course Code : 19EE3132
Credits : 3
L-T-P-S : 3-0-0-0
Pre-requisite : 19EE2101

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.	PO2, PO3/ PSO1	4

Syllabus:

Introduction: Present power generation, transmission, and distribution scenario of India, Elements of power systems, transmission, distribution and generations, 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, 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 Develo DSM Program- Experiences of Power Grid Enterprises in DSM Implementation-Load Management.-Outlook of Demand Side Management under Power Market Environment-Development Potential of Clean Development Mechanism Project of DSM.

Text Books:

1. Participant handbook, Engineer – Distribution, PSS/Q7001, Version 1.0, NSQF Level 6.
2. Jyothi Prakash, "Demand Side Management" TMH Publishers

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DISTRIBUTION SYSTEM PRACTICES

Course Code: 19EE3131
Pre Requisite: 19EE2102

L-T-P-S: 3-0-0-0
Credits: 3

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to understand the basic structure of distribution system and compute AT&C loss.	PO1,PO2 / PSO1	2
CO2	Able to apply the knowledge for erection and commissioning of a substation.	PO1,PO2 / PSO1	3
CO3	Able to understand the various protection systems deployed in distribution system.	PO1,PO2 / PSO1	2
CO4	Able to test and understand the test results of various distribution system equipment.	PO1,PO2 / PSO1	3

Syllabus:

Power Distribution Network: Types of distribution system, AT&C Loss, calculation of aggregate technical and commercial loss, measures to reduce technical and commercial losses, power distribution from distribution substation to end consumers, categories of consumers, functions of power distribution companies.

Substation Erection and Commissioning: Various types of distribution substations, technical specifications of distribution substation equipment, procedure for erection and commissioning of distribution substation, different mounting structures for the transformer, installation procedure of Switchgear, power factors correction panels and control panels, substation automation System (SAS) in power distribution network, importance of capacitor bank.

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.

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, capacitive voltage transformer, lightning arrestor, circuit breaker, energy meter etc. to ensure their healthiness.

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. Sallam, A. A., & Malik, O. P. (2018). Electric distribution systems, Wiley Online Library.

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DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS

Course Code: 19EE3132 **L-T-P-S: 3-0-0-0**
Pre Requisite: NIL **Credits: 3**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to understand different types of distributed energy resources	PO1,PO2 / PSO1	2
CO2	Able to apply the principles for integrating DERs to grid	PO2,PO5 / PSO1	3
CO3	Able to understand smart grid objectives and its activities in India	PO1,PO2 / PSO1	2
CO4	Able to monitor various applications in smart grid with its smart infrastructure.	PO2,PO5 / PSO1	3

Syllabus:

Distributed Energy Resources: Introduction, combined heat and power (CHP) systems, solar photovoltaic (PV) systems, Wind energy conversion systems (WECS), small-scale hydroelectric power generation, batteries, ultra-capacitors, flywheels.

Integration of Distributed Generation to Grid: Introduction, concepts of micro grid, typical micro-grid configurations, AC and DC micro grids, interconnection of micro-grids, protection and control issues in micro-grids, technical and economic advantages of micro-grid, challenges and disadvantages of micro-grid.

Introduction to Smart Grid: Introduction to smart grid, architecture of smart grid, smart grid standards and policies, smart grid components, smart grid technologies, the fundamental components of smart grid designs, and smart-grid activities in India.

Smart Grid Monitoring: Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI);smart metering; demand side management and demand response programs, demand pricing and time of use, real time pricing, peak time pricing, smart grid system monitoring and self-healing.

Text Books:

1. S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 1st Edition, 2013.
2. G. Masters, "Renewable and Efficient Electric Power System", Wiley–IEEE Press, 2nd Edition, 2013.

Reference Books:

1. INIEWSKI , Smart Grid Infrastructure and Networking, McGraw-Hill Education India Pvt.Ltd (2012), 1 st Edition.
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, IEEE Computer Society Press (2012).
3. EkanayakeJ.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.
4. Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons. Flick T., Morehouse J., Securing the smart grid: Next generation power grid security, paperback).

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ENERGY MANAGEMENT SYSTEMS AND SCADA

Course Code: 19EE3133
Pre Requisite: NIL

L-T-P-S: 3-0-0-0
Credits: 3

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand SCADA and its architecture.	PO1,PO2 / PSO1	2
CO2	Understand the application of SCADA in various utilities.	PO2,PO5 / PSO1	2
CO3	Apply the knowledge in analyzing various real time applications on transmission side.	PO2,PO5 / PSO1	3
CO4	Apply the knowledge in analyzing various real time applications on distribution side.	PO2,PO5 / PSO1	3

Syllabus:

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries, SCADA System Components. SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850. SCADA Communication.

SCADA Applications: Utility applications, Transmission and Distribution sector -operations, monitoring, analysis and improvement. Industries - oil, gas and water.

Energy Management Systems (EMS): Introduction- Smart substations - Substation Automation - Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

Distribution Management System (DMS): Introduction – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, functions of load management systems: Load analysis and forecasting, remote automatic meter reading, electricity purchase management and electricity theft prevention.

Text Books:

1. Handschin, E. "Energy Management Systems", Springer Verlag, 1990.
2. Clarke, Gordon, Deon Reynders, and Edwin Wright. Practical modern SCADA protocols: DNP3, 60870.5 and related systems. Newnes, 2004.
3. Thomas, Mini S., and John Douglas McDonald, "Power system SCADA and smart grids," CRC press, 2015.

Reference Books:

1. Turner, W. C, " Energy Management Handbook", 5 th Edition, 2004.
2. Wiebe, Michael, "A Guide to Utility Automation: AMR, SCADA, and IT Systems,"Pennwell Books, 1999.
3. Bailey, D., and E. Wright, "Practical SCADA for industry," illustrated ed. Great Britain: Newnes, 2003.

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SMART GRID COMMUNICATION AND CYBERSECURITY

Course Code: 19EE3231
Pre Requisite: NIL

L-T-P-S: 3-0-0-0
Credits: 3

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the communication technologies for smart grid	PO1/ PSO2	2
CO2	Analyze the information security of smart grid and measurement technologies	PO5/ PSO2	3
CO3	Understand the substation standards for communication	PO1/ PSO2	2
CO4	Analyze the hacking and cybersecurity aspects in smart grids	PO5 / PSO2	3

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

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.

Text Books:

1. Janaka Ekanayake , Kithsiri Liyanage , Jianzhong Wu , Nick Jenkins, "Smart Grid: Technology and Applications" first Edition, John Wiley & sons Limited (2012).
2. James Momoh "Smart grid: Fundamental of Design and analysis" ,John Wiley & sons Limited IEEE Press (2012).

Reference Books:

1. Eric D. Knapp,Raj Samani "Applied Cyber Security and the Smart Grid", Elsevier Inc.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell.
4. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc.
5. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities", Island Press.

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INTERNET OF THINGS AND SMART GRID ANALYTICS

Course Code: 19EE3232
Pre Requisite: NIL

L-T-P-S: 3-0-0-0
Credits: 3

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand network protocols and standards	PO1 / PSO1	2
CO2	Analyze IoT architecture and data analytics archeitecture	PO5/ PSO2	3
CO3	Anderstand varlous applications of IoT to to Smart Grids	PO5/ PSO2	2
CO4	Analyze the Big Data Analytics	PO5/ PSO2	3

Syllabus:

Networking Protocols and Standards for Internet of Things: Introduction, IoT Data Link Protocols, Network Layer Routing Protocols, Network Layer Encapsulation Protocols, Session Layer Protocols, IoT Management Protocols, Security in IoT Protocols, IoT Challenges.

IoT Architecture: Introduction, Architectural Approaches, Business Architecture, Functional Architecture, Application Architecture, Data and Analytics Architecture, Technology Architecture, Security and Governance.

Applications of IOT to Smart Grid: Energy monitoring, energy harvesting, smart parking, smart medium access in mobile IOT.

Introduction to Big Data Analytics: Attributes of Big Data: Volume of data, velocity of data, variety of data; Overview of big data analytics, benefits of big data analytics, big data analytics for smart grids, big data analytics tools.

Smart Grid Data Management and Applications: Smart Meter Data Management: Smart metering architecture, challenges and opportunities, smart meter data management, future trends and issues; PHEVs: Internet of Vehicles: Convergence of PHEVs and internet of vehicles, electric vehicles management, future trends and issues; Smart Buildings: Concept of smart buildings, challenges and opportunities, different approaches for establishing smart buildings, future trends and issues.

Text Books:

1. Al-Turjman, Fadi. *Smart Grid in IoT-enabled Spaces: The Road to Intelligence in Power*. CRC Press, 2020.
2. Misra, Sudip, and Samaresh Bera. *Smart Grid Technology: A Cloud Computing and Data Management Approach*. Cambridge University Press, 2018.

Reference Books:

1. Geng, Hwaiyu, ed. *Internet of things and data analytics handbook*. John Wiley & Sons, 2017.

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POWER TRAIN DESIGN FOR ELECTRIC VEHICLE

Course Code: 19EE3141
Pre Requisite: NIL
L-T-P-S: 3-0-0-0
Credits: 3

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the History, Economics, Environmental issues and power train of Electric Vehicles	PO10/ PSO1	1
CO2	Analyze the dynamics of EV	PO7/ PSO1	4
CO3	Select and size the power train for 2W	PO6/ PSO1	3
CO4	Select and size the power train for 4W	PO6/ PSO2	3

Gist:

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

Syllabus:

HISTORY, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE

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

Power train components: BEV, HEV, PHEV and FCEV including working of Fuel cell

INTRODUCTION TO EV DYNAMICS

Motion and dynamic equations of electric vehicles, General description of vehicle movement, Vehicle resistance, Dynamic equation, Tire Ground Adhesion and maximum tractive effort, different drive cycles for, Drive cycles for vehicle emission, fuel consumption and performance testing.

2W POWER TRAIN SIZING

Chassis, differential and transmission selection for different drive trains, Battery, converter and motor drive sizing for different 2W drive trains. Analysis on the effect of sizing of different components for different drive cycles

4W POWER TRAIN SIZING

Chassis, differential and transmission selection for different drive trains, Battery, converter and motor drive sizing for different 4W drive trains. Analysis on the effect of sizing of different components for different drive cycles

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.

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BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE

Course Code: 19EE31421 L-T-P-S: 3-0-0-0
Pre Requisite: NIL Credits: 3
Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the specifications and Li-ion chemistry	PO1, PO3/ PSO1	2
CO2	Understand the key functions of Battery management systems	PO1,PO5/ PSO2	2
CO3	Develop Enhanced Self Correcting (ESC) Model of battery	PO7/ PSO1	4
CO4	Develop Algorithms for SOC estimation of battery	PO5/ PSO2	4

Syllabus:

Battery specifications and L-ion chemistry

Battery specifications, cell-module-pack formation and specification calculation, working principle of Li-ion cell, materials used for various components of Li-ion cell, different li-ion chemistries and there specification comparison

Functions of battery-management systems

BMS architecture, BMS functionality: Sensing and High Voltage Control, Protection-isolation, overvoltage, overcurrent protection, Performance-Battery pack energy and power calculations using HPPC, Balancing- passive and active cell balancing, Interface, and Diagnostics

Battery Modelling

Simple OCV model, Rint model, Thevinins model, Hysteresis effect and ESC model of battery cell.Charge, discharge tests to determine battery cell parameters,

SOC estimation

Stoichiometry for SOC estimation, Look-table method and Coulomb counting methods and their limitation for accurate state estimation. Linear and nonlinear Kalman filter based estimation techniques

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.

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CHARGING STATION FOR ELECTRIC VEHICLE

Course Code: 19EE3143
Pre Requisite: 19EE2202
Mapping of Course Outcomes with PO/PSO:

L-T-P-S: 3-0-0-0
Credits: 3

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:

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

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

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, Load management at charging station and peak load management

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

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AI and IOT FOR ELECTRIC VEHICLE

Course Code: 19EE3241
Pre Requisite: NIL

L-T-P-S: 3-0-0-0
Credits: 3

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand various AI open-source tools (AWS-Academics)	PO5/ PSO1	2
CO2	Understand various IOT open-source tools	PO5/ PSO2	2
CO3	Apply AI and IOT for EV performance management	PO3/ PSO1	3
CO4	Apply AI and IOT for online vehicle assistance	PO3/ PSO2	3

AI and IOT Cloud Tools :
Data Engineering, Data types Data types, Python Librarles (pandas, Numpy, scikit Learn, Matplot Lib, Seaborn), data distributions, timeseries, Feature Engineering (imputation, binning, encoding, and normalization) Amazon SageMaker, Amazon S3 Storage services, AWS Glue AWS Services and Algorithms Amazon SageMaker, Amazon S3 Storage services, AWS Kinesis Services, Basic Regression and Clustering ML Algorithms in AWS

Program the ESP8266, ESP32, or Raspberry Pi 3 to send data to AWS IoT Core
Understand MQTT, JSON, IoT, and the AWS cloud, Place IoT data into Dynamo DB by creating a table and data fields, device to cloud communication, designing graphs and using analytics on IoT data, Use Node-Red to connect devices to AWS IoT

AI and IOT Tools for EV Applications: Electric Vehicle Battery state estimation, health monitoring, SOL determination, Power management, Charging optimization and Electric Drive applications, Online vehicle Assistance

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.

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19EE4162: Communication protocols and Testing of EV

L Course Code: 19EE3242
Pre Requisite: NIL

L-T-P-S: 3-0-0-0
Credits: 3

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the communication protocols used in Electric Vehicles	PO5/ PSO1	2
CO2	Apply the communication protocols for fault diagnostics of Electric Vehicle	PO3/ PSO2	3
CO3	Analyze the intricacies of integrating HV and LV components of vehicle	PO6/ PSO1	4
CO4	Understand the overview of system engineering/system validation	PO3/ PSO2	2

Introduction to serial communication protocols: SPI I2C CAN, CAN standard, CAN message: Arbitration, message types, valid frame, error checking CAN bus: Transceiver features, CAN physical layer, CAN connectors, Bit Timing, Error Handling, High Layer Protocols: IEC 61851, SAE J2601

Common Sensors modules used in EV: Air Bag, ABS, Window Mirror, Cruise Control, Transmission control, CAN Interface with Sensor Modules

Power Distribution Box, Components like HVDC Relays connections, Insulation Monitoring Devices Fuses, BTMS, Driveline Cooling, Coolant tanks, Level Sensors, Vehicle Wiring, Terminals, Electrical Distribution Boards, Temperature Considerations for wiring, Cable selection, Instrument Panel, HVIL,24V converters, Junction boxes or Fuse Boxes, Fuses, derating, EMI and EMC.

V cycle, reliability calculations, DFMEA/FMEA analysis, Design for manufacturing, servicing & data analytics, supply chain management

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.

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SKILLING FOR ENGINEERS-3 (Model Based Design)

Course code: 19TS6003
Pre-requisites: NIL

L-T-P-S:0-0-0-4
Credits: 1

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to understand Model basic Design concepts and architectures	1,5/1	2
CO2	Able to apply MBD physical models in Simulink	1,5/1	3
CO3	Able to apply MBD model deployed in Hardware	1,5/1	3
CO4	Analyze the MBD model using HIL testing	1,5/1	4

Syllabus:

Model Based Design Overview:

Traditional Design Process Vs MBD Approach, advantages, Modeling Building Philosophy ,MBD workflow ,V cycle, Steps of Modeling, Tools for Model analysis and simulation- UML, Simulink,- basic static models models.

Modelling and Analysis:

Requirements for Control System Design , Identification of the System, Mathematical Models for Control basics, Models from Science, Models from Experimental Data, Linearization of Nonlinear Models, Case studies, Modeling and Analysis Tools- Simulink modelling and Simulations of machines, Converters, sensors- accelerometer, *EV and Solar models for* exercises.

Rapid prototyping and Deployment:

Embedded System overview, Architecture of Embedded Control Systems, Electric Power Level, Communication Networks in Embedded Systems, Features of a CAN Communication Network, CAN Message Frames, CAN Controller Modes, Error Detection and Signaling, KVASER Tool, Arduino based MATLAB Interface, Design steps of Experiments to Collect Experimental Data on Motor and Generator.

Hardware In-the-loop testing:

Safety Function and Safety Loop, Classification of Faults , Fault Categories and Failure Rates Safe Failure Fraction, Diagnostic Coverage and Hardware Fault-Tolerance, types of Software Testing and Validation, Hardware in the Loop Tests- Hardware In The Loop Real-Time Simulations, Test controller on real system- case study HIL using embedded hardware.

Text Books :

1. Alexandru Forrai , Embedded Control System Design A Model Based Approach, ISBN 978-3-642-28594-3 e-ISBN 978-3-642-28595-0, DOI 10.1007/978-3-642-28595-0, Springer Heidelberg New York Dordrecht London.
2. Model-Based Design for Embedded Control Systems © 2020The MathWorks
2. Gabriela Nicolescu Pieter J. Mosterman, Model-Based Design for Embedded Systems, CRC Press Taylor & Francis Group

MOOCS :

1. HTTPS://WWW.COURSERA.ORG/PROGRAMS/EEE-FACULTY-COURSESVHSQD/ BROWSE?CURRENTTAB =CATALOG &QUERY=MBSE%3A+MODEL-BASED+SYSTEMS+ENGINEERING

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SKILLING FOR ENGINEERS -4 [END-TO-END APPLICATION DEVELOPMENT)

Course code: 19TS6004
Pre-requisites: NIL

L-T-P-S:0-0-0-4
Credits: 1

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to understand Model basic Design concepts and architectures	1,5/1	2
CO2	Able to apply MBD physical models in Simulink	1,5/1	3
CO3	Able to apply MBD model deployed in Hardware	1,5/1	3
CO4	Analyze the MBD model using HIL testing	1,5/1	4

Syllabus:

Cloud based End to End Application Development Module 1: Sensors and Signal Conditioning Circuits : classification , principles, protocolsModule 2: ESP 32 /Node MCU features and board comparison and handling Module 3: Integrating Sensors to esp32 – serial object, Magnetic Switch Module4: Integrating Sensors to esp32 – Relay, Moisture sensor Module 5: Integrating Sensors to esp32 – Ultrasonic, DHT11 Module 6: IntegratingOLED and LCDto ESP32 Module7: Implementation Wifi Connectivity to ESP32 Module 8: Google Firebase Console and functionalities Module 9: Kodular mobileapplication developement Module 10: Integrating Embedded Board and Cloud for data visualization and analytics Module11: Cloud to Mobile applicationData trans receiving . Module12: END to END application development Project assignment Module 13: END to END application development Projectassignment

Text Books :

1. D. Patranabis – "Sensors and Transducers" –PHI Learning Private Limited
2. Sensors and Actuators – D. Patranabis – 2nd Ed.,PHI, 2013
3. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman

Reference Books :

1. Amazon Web Services in Action, Andreas Wittig, Michael Wittig.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Aves and,Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition,Academic Press, 2015.
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015

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TECHNICAL PROFICIENCY & TRAINING-2 (ELECTRICAL PROJECT MANAGEMENT)

Course code: 19TS6006
Pre-requisites: NIL

L-T-P-S:0-0-0-4
Credits: 1

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply SPI, I2C and UART protocols for peripheral communication	5	3
CO2	Apply CAN communication protocol for multiple device communication	5	3
CO3	Analyze CAN communication protocol for EV and automations applications	5	4
CO4	Utilize project management tools and skills for electrical installations	5	3

Syllabus :

Module 1: Communication Technologies Overview – Serial and Parallel , Architectures Module 2: Serial Communication- SPI, I2C and CAN in Arduino/ESP 32/Raspberry Pi Module 3: CAN Bus wiring Sequence and message segmentation Module 4: CAN Bus hard wares- Shield, development kit, CAN BED FD, OBD-II CAN GPS Module 5: Implementation of Sensor data extraction through SPI UART Module 6: Implementation of Sensor data monitoring (MEMS accelerometer) through I2C Module7: Implementation of CAN bus communication using Raspberry Pi Module 8: Implementation of CAN bus communication with MCP2515 module to communicate between two Arduino for sending Temperature data from DHT Module 9: Implementation of EV CAN bus data logger Module 10: Case Study- Industrial CAN Communication application in Automobile, medical infrastructure domains Module 11 and 12: Electrical Project Management – Design, BoM, Procurement, installation, documentation

Text Books :

1. Serial Communication Protocols and Standards: RS232/485, UART/USART, SPI, USB, INSTEON, Wi-Fi and WiMAX, Dawoud Shenouda Dawoud, Peter Dawoud, River Publications, 2020
2. Handbook of Serial Communications Interfaces: A Comprehensive Compendium of Serial Digital Input/Output (I/O) Standards, Louis Frenzel, 1st Edition, Newness publications

Reference Books :

1. Developing IoT Projects with ESP3
2. Automate your home or business with inexpensive Wi-Fi devices, Vedat Ozan Oner

Web Links

1. https://nptel.ac.in/courses/108/102/108102169/
2. https://nptel.ac.in/courses/108/102/108102045/
3. https://nptel.ac.in/courses/106/105/106105159/

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PARADIGMS IN MANAGEMENT THOUGHT

Course code: 19MB4051
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CONo.	Course Outcomes	MappedPO	BTL
CO 1	Understand the basic management concepts along with aninsight into levels of management.	9/1	2
CO 2	Understand the key contributions of classical approach toManagement	12/1	2
CO 3	Understand and apply Quantitative methods to improveManagement performance.	9/1	2
CO 4	Understand the key contributions ofBehavioural andcontemporary 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'scontributions, - 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 FDrucker 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

Course code: 19MB4052
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO	Course Outcomes	Mapped PO	BTL
CO 1	Understand the structure of Indian Economy	7/1	2
CO 2	Understand the structural problems encountered by India	7/1	
CO 3	Develop a perspective approaches to economic planning and development in India	7/1	3
CO 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 sector, 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 – antipoverty 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

Course code: 19MB4053
Pre-requisites: NIL
L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO	Course Outcomes	PO/PSO	BTL
CO 1	Understand the need for effective financial planning	12/1	2
CO 2	Analyze the basic concepts of money management, tax planning, consumer cre housing and other consumer decisions, insurance, investments, retirement planning etc	12/1	4
CO 3	Evaluate various financial tax saving schemes to save money to get tax benefits.	12/1	4
CO 4	Design savings and investment plans.	12/2	6

Syllabus

Financial planning process: Introduction-Importance of Financial Planning- Process offinancial 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 andautomobiles:-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.

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

Course code: 19MB4054
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	PO/PSO	BTL
CO 1	Understand the basic concepts of marketing management	12/1	2
CO 2	Analyze the markets and consumers, the changing environmental factors with special focus on technology products	12/1	4
CO 3	Understand the basics of marketing mix	12/1	2
CO 4	Create an appropriate strategy for the marketing of high tech products and services	12/2	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.

Text books

1. Philip Kotler and Gary Armstrong- Principles of Marketing- 18/e, Pearson Education.
2. Jakki J Mohr, SanjitSengupta and Stanley Slater, Marketing of High-Technology Products and Innovations, 3/e Pearson India

Reference books

1. V.S. Ramaswamy and S.Namakumari – Marketing Management, 4/e, Mc Millan Publications, New Delhi.
2. RajanSaxena, Marketing Management- 3/e, TMH, New Delhi.

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ORGANIZATION MANAGEMENT

Course code: 19MB4055
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO	Course Outcomes	PO/PSO	BTL
CO 1	Understand the theories and approaches of organizational management	9/1	2
CO 2	Understand the basics of organization structure	9/1	2
CO 3	Understand the methods for motivating in competitive business environment.	9/1	2
CO 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 organisationtheory.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, Organisationalmanuals.Motivation, Morale and behavioral 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, Behavioral science, Group dynamics, Group behavior. 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, Hirechy 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 Bargainning, Negotiations, Industrial Safety— working conditions, Accidents, Preventive measures, Safety training.

Text Books

1. Stephen P. Robins, Organizational behavior, PHI / Pearson education, 11tedition , 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

Course code: 19MB4056
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO	Course Outcomes	PO/PSO	BTL
CO 1	Understand the management of materials	12/1	2
CO 2	Understand the management of machinery	12/1	2
CO 3	Understand the basics of safety management	12/1	2
CO 4	Understand the process of quality management	12/1	2

Syllabus

Resource Management (Man Power, Materials & Machinery): Introduction; Resourcesmoothing; Resource Leveling, 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.
2. Construction Planning, Equipment and Methods by Peurifoy R.L; MC Graw-Hill International Book Company.

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ECONOMICS FOR ENGINEERS

Course code: 19MB4057
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO	Course Outcomes	PO/PSO	BTL
CO 1	Understand basic concepts of engineering economics	5, 12/1	2
CO 2	Apply the methods of value engineering	5,12/2	3
CO 3	Apply the methods of cash flow	5,12/2	3
CO 4	Analyze the methods of depreciation	5,12/1	4

Syllabus

Introduction to Engineering Economics: Introduction to Economics- Flow in an economy,Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Elementary economic Analysis.**Value Engineering:** Make or buy decision, Value engineering – Function, aims, value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.**Cash Flow:** Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the method.**Replacement andMaintenance Analysis:** Introduction-Types of maintenance –types of replacement Problem-Determination of economic life of an asset-Replacement of existing asset with a new asset.Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction.

Text books

1. Dr. K K Patra, DhirajBhattacharjee, Engineering Economics and Costing, S. Chand & Company Ltd, New Delhi, 2013.
2. PanneerSelvam, R., ***Engineering Economics***, Prentice Hall of India Ltd, New Delhi, 2001.

Reference books

1. Chan S.Park, **Contemporary Engineering Economics**, Prentice Hall of India, 2002. Donald.G. Newman, Jerome.P.Lavelle, **Engineering Economics and analysis**Engg. Press, Texas, 2002.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, **Engineering Economy**, Macmillan, New York, 1984.
3. William G. Sullivan, Elin M Wicks, and James Luxhoj, Engineering Economy, 13th edition (Prentice-Hall)

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IPR & PATENT LAWS

Course code: 19BT40A1
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course out comes with student out comes:

CO No	Course Outcomes	PO/PSO	B T L
CO 1	Acquire the knowledge of intellectual property rights	5/1	1
CO 2	Describe the principles and regulatory affairs	5/1	2
CO 3	Develop documentation ,Protocols and Case Studies onPatents	7/2	3
CO 4	Compare various Case Studies on Patents	8/2	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)

Text books

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

Course code: 19CE40A2

L-T-P-S:3-0-0-0

Pre-requisites: NIL

Credits: 3

CO NO	Course Outcome (CO)	PO/PSO	BTL
CO1	Understand the effects and control methods of air pollution	PO1,PO3,PO7	2
CO2	Discuss the sources and effects of water pollution and control methods.	PO1,PO3,PO7	2
CO3	Understand the sources, effects and treatment method of waste water and Noise pollution	PO1,PO3,PO7	2
CO4	Discuss the sources and effects of solid waste and solid waste management and Applying the design criteria to construction of landfills	PO7,PO1,PO3	3

Syllabus

Air pollution: Sources, Types, and effects and Fate of air pollutants. Meteorological factorsand 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 equipments 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.Pretreatment, 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

Course code: 19CE40A3
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Syllabus

Solid wastes: Sources, Types, reasons for increase in generation, composition and propertiesof 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 anddemerits, Energy recovery, Bio methanation, use of refuse derived fuels (RDF).

Hazardous Waste, Definition, Sources, Classification, Hazardous wastes rules, and Nuclearwaste, 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

Course code: 19CE40A4
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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

Course code: 19CE40A5
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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
7. Coppola, Damon P. (2006) Introduction to International Disaster Management, Butterworth -Heinemann
8. Jha, Madan Kumar (2010) Natural and Anthropogenic Disasters: Vulnerability, Preparedness and Mitigation, Springer.
9. Glade, Thomas, Malcolm G. Anderson, Michael J. Crozier (2005) Landslide Hazard and Risk, edited Springer
10. Singh, Surendra, LeszekStarkel, Hiambok Jones Syiemlieh (2008) Environmental Changesand Geomorphic Hazards, Bookwell.

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FUNDAMENTALS OF DBMS

Course code: 19CS40A6
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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 Modeling: 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 Book:

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

Course code: 19CS40A7
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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, Modeling techniques for Class & Object Diagrams. Behavioral Modeling :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).
4. Craig Larman, "Applying UML and Patterns: An introduction to OOAD and design and interface deployment", Pearson, (2002).
5. Alan Dix, Janet Finlay, Gregory d Abowd, Russel Bealel,"Human Computer Interaction", 3rd edition, Pearson education, (2008).
6. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited,(2007).

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FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course code: 19CS40A8

Pre-requisites: NIL

L-T-P-S:3-0-0-0

Credits: 3

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, DMLstatements, DCL statements, writing Simple queries. **SQL tuning techniques:** Embedded SQL, OLTP. **Object oriented concepts:** Object oriented programming, relationship, Inheritance, Abstract classes, polymorphism, UML 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
7. RojerPressman,Softer Engineering-A Practitioners approach, McGraw Hill 5th ed., 2001
8. Alfred V Aho,EHoproft, Jeffrey D Ullman, Design and Analysis or computer algorithms, Addison Wesley publishing Co..;1998
9. Henny F korth , Abraham Silbefrschatz, Database System concept, 2nd . McGraw- Hill international editions,1991
10. Elmasri and Navathe, Fundamentals of Database systems, 4th edition, admisonWesely, Person Eductaion

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IMAGE PROCESSING

Course code: 19EC40A9

L-T-P-S:3-0-0-0

Pre-requisites: NIL

Credits: 3

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 ImageProcessing, Fundamental steps in Digital Image Processing, Components of an Image Processing System.

DIGITAL IMAGE FUNDAMENTLS: Elements of Visual perception, Image sampling andQuantization, 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 leveltransformations, histogram processing, enhancement using Arithmetic/Logic operations, Smoothing Spatial Filters, Sharpening Spatial Filters.

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

IMAGE RESTORATION: Noise models, Restoration in the presence of Noise, only SpatialFiltering, 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 FreeCompression, Lossy Compression.

IMAGE SEGMENTATION: Detection of discontinuities, Thresholding, Edge basedSegmentation 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

Course code: 19EM40B1
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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 Educaiton
4. UnixandshellProgramming,S.G.KochanandP.Word3rd edn.PearsoEdn.

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E-COMMERCE

Course code: 19EM40B2
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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

Course code: 19EE40B3
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

COURSE OUTCOMES (Cos):

CO No	COs	PO / PSO	BTL
CO1	Understand the different solar thermal applications and solar photovoltaic cells	PO-4,PO-10/ PSO-1	2
CO2	Understand the operation of wind turbine ,different types of wind turbines and wave energy conversion	PO-4,PO-10/ PSO-1	2
CO3	Understand the energy conversion of Tidal, ocean thermal and various the geo thermal power plants	PO-4,PO-10/ PSO-1	2
CO4	Understand the operation of Bio energy conversion method and the different bio gas plants	PO-4,PO-10/ PSO-1	2

Syllabus

Extraterrestrial 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.

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

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.

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-VerlagBrerlin 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 code: 19EE40B4
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

COURSE OUTCOMES (Cos):

CO No:	CO	PO/PSO	BTL
CO1	Understand the present power scenario in India and need for energy estimation and Audit.	PO2,PO10/ PSO1	2
CO2	Understand 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

Course code: 19ME40B4
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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	Analyze 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 Endeffectors, 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 lasersensors.

TOUCH & SLIP SENSORS: Touch sensors – proximity Rod & Photodetector sensors, Slipsensors – 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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MECHATRONICS

Course code: 19ME40B5

Pre-requisites: NIL

L-T-P-S:3-0-0-0

Credits: 3

CO No	Course Outcome (CO)	PO/PSO	BTL
CO1	Identify appropriate sensor, Identify appropriate actuation system for a given application.	2/1	2
CO2	Identify appropriate microcontroller for a given application and to build a mathematical Model of system for evaluating open loop system performance and behaviour.	2/1	2
CO3	Identify an appropriate closed loop control strategy to attain the desired system behaviour.	2/1	2
CO4	Suggest a Mechatronic product design for a given application and evaluate its performance.	3/1	2

Syllabus:

INTRODUCTION TO MECHATRONICS: Introduction, Elements of Mechatronicsystem, Applications.**SENSORS AND TRASDUCERS**: Introduction, Classification of Sensors, selection ofsensors. Classification of transducers - strain gauges displacement transducers, capacitive and inductive transducers, LVDT, oscillation transducer, piezoelectric potentiometric, velocity transducers, temperature transducers, optical transducers.**SIGNAL CONDITIONING**: Introduction data acquisition –Quantizing theory, Analog toDigital conversion, Digital to Analog conversion.**DATA PRESENTATION SYSTEMS:** Data presentation elements, Data acquisitionsystems, systems measurement, Testing and calibration.**ACTATION SYSTEMS**: Pneumatic and hydraulic actuation systems, Stepper and ServoMotors. **SYSTEM MODELS**: Modeling of one and two degrees of freedom Mechanical, Electrical,fluid and thermal systems. Block diagram representations for these systems.

SYSTEM RESPONSE: Introduction, Transfer function, Time response and Frequencyresponse analysis mechanical systems and electrical systems.**CLOSED LOOP CONTROLERS:** Continuous and discrete processes, control modes,Two-step proportional, Derivative, integral, PID controllers.

DIGITAL LOGIC: Logic gates, Boolean algebra, Karnaugh maps.

PLC: Introduction, basic structure, I/P ,O/P processing, programming, ladder diagrams,Timers, Internal relays and counters ,data handling, Analogue Input and Output, selection of a PLC.

DESIGN: Mechatronics system Design, possible design solutions.

CASE STUDY: pick and place Robot, CNC Machine.

Text books

1. W.Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" , 3rd Edition Pearson education,2007.
2. David G. Alciatore, Michael B. Histand ," Introduction to mechatronics and measurement systems", 2nd Edition McGraw-Hill Professional, 2002.

Reference books

1. A.K.Sawhney, "A course in Electrical and Electronic Measurement and Instrumentation"- Dhanpat Rai & Sons 1991.
2. NitaigourPremchandMahalik, "Mechatronics", Tata McGraw-Hill, 2003.
3. HMT Limited, "Mechatronics", McGraw-Hill Education (India) Pvt Ltd, 2000.
4. T.G. Beckwith &N.L.Buck, "Mechanical Measurements", 3rd Edition, Addison-Wesley Pub. Co., 1969.

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OPERATIONS RESEARCH

Course code: 19ME40B6
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

CO No	Course Outcome (CO)	PO/PSO	BTL
1	Model and Solve for the optimum solutions using LPP	5/1	2
2	Model and Find the Optimized solutions for the problems in the field of Transportation and Management / Assignments.	5/1	2
3	Model 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 method, 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

Course code: 19PH40B7
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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 ofNanostructured 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 forproducing 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. Comparision of evaporation and sputtering.

Special nanomaterials, characterization and tools : Carbon nanotubes, nanocomposites,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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SUBSEA ENGINEERING

Course code: 19PE40B8
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

CO No.	Course Outcome CO)	PO/PSO	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 utilized in subsea (well head, X trees, risers, pipelines)	2/ 2	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

Course code: 19PE40B9
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course outcomes	PO/PSO	BTL
CO 1	Understand the global oil and gas market	1/1	2
CO 2	Understand the E&P activities, marketing and transportation of oil and gas	1/1	2
CO 3	Understand the refining activities, estimating the future of oil and gas industry	1/1	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

Course code: 19GN40C1
Pre-requisites: NIL

L-T-P-S:3-0-0-0
Credits: 3

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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INDIAN CULTURE AND HISTORY

Course code: 19GN40C2
Pre-requisites: NIL
L-T-P-S:3-0-0-0
Credits: 3

Mapping of Course out comes with student out comes:

CO No.	Course outcome	PO/PSO	BTL
CO1	**Understand** the basic features of Indian Culture and early civilizations of Indian History up to Religious Movements	8,9/1	2
CO2	**Gain basic knowledge** in the major socio political concepts of important kingdoms from Mauryas to Mughals.	8,9/1	2
CO3	**Gain Knowledge** in the aspects of Modern India and Indian National Movement up to	8,9/1	2
CO4	**Acquire Knowledge** in the area of Final Phase of Indian National Movement and partition of India	8,9/1	2

Syllabus

Indian culture – characteristics, Salient aspects of Indian Music and Dance - brief introduction of Architecture and Painting.

Pre-Historic Period- Indus Valley Civilization- Vedic Age - Emergence of Mahajanapadas - Age of Religious Movements: Jainism, Buddhism - The Age of the Guptas.

Transformation from the Ancient Phase to Medieval Phase - The Delhi Sultanate - Beginning of Indo-Islamic Culture - Emergence of Provincial Kingdoms - The Mughals - Rise of Independent Autonomous States - The Marathas (1649-1748)

Advent of European Commerce - British Expansion in India - The British Administrative Structure in India- British Policy towards Economy of India - Social and Cultural Awakening in the 19th Century - Education under the British Rule.

The Growth of Nationalism - Foundation of the India National Congress- Growth of Extremism or Militant Nationalism and Partition of Bengal- Beginning of Communalism- Revolutionary Terrorism and Home Rule Movement- Beginning of the Gandhian Era and the Non-Cooperation Movement - Resurgence of Revolutionary Terrorism (1924-1934)- Trade Union Movement - Civil Disobedience Movement - Second world war and the National Movement- Quit India Movement- SubhashChandrabose and Indian National Army- The Final Phase: Independence and Partition

References:

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. Ancient India: V.D. Mahajan: S. Chand & Company Ltd., New Delhi
6. An Advance History of India: R.C. Majumdar, H.C. Raychaudhuri&KalikinkarDatt: Macmillan India Ltd.,
7. The Wonder that was India :A.L.Bhasham.
8. India's struggle for Independence 1857-1947: Bipan Chandra: Penguin Books
9. History of Freedom Movement in India: Vol. 1 to IV: Tara Chand: Publications Division
10. Essays on Contemporary India: Bipan Chandra: Har-Anand Publications.

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RESTRUCTURED POWER SYSTEMS

Course Code : 19EE3202
Credits : 4
L-T-P-S : 3-1-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concept of deregulation market structure, market architecture	PO2,PO8/PSO1	2
CO2	Understand various electricity market structures	PO1,PO2,PO7/ PSO1	2
CO3	Understand transmission pricing and congestion management methods	PO1 / PSO1	2
CO4	Understand ancillary services and system security in deregulation	PO1, PO8,PO7/ PSO1	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. *M. Shahidehpour, H. Yamin and Z. Li, "Market Operations in Electric Power Systems"*, John Wiley and Sons, March 2002.

Reference books

1. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 1996.
2. Steven Stoft, "Power System Economics: Designing markets for electricity" IEEE Computer Society Press.
3. D Kirschen, G Strbac, "*Fundamentals of Power System Economics*", Wiley, 2004.
4. N. S. Rau, "Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry"
5. Sally Hunt and Graham Shuttleworth, "Competition and Choice in Electricity"

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UTILIZATION OF ELECRTICAL ENERGY

Course Code : 19EE3203
Credits : 4

L-T-P-S : 3-1-0-0
Pre-requisite : 19EE2101

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Identify the motor ratings for different applications	PO1,PO8/PSO2	3
CO2	Understand the concepts of electric heating & welding.	PO1,PO8/ PSO1	2
CO3	Compare various illumination methods	PO1,PO8/ PSO2	3
CO4	Apply electrical traction to different services	PO1,PO8/ PSO2	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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POWER QUALITY

Course Code : 19EE3204
Credits : 4
L-T-P-S : 3-1-0-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand various power quality issues.	PO1,PO2/PSO1	2
CO2	Analyze various power quality issues and its causes.	PO1,PO2, PO5/PSO1	4
CO3	Apply different mitigating techniques for improving power quality	PO1,PO2/PSO2	3
CO4	Analyze voltage sag and swell using simulation tools.	PO1,PO4, PO5/PSO1	4

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 books

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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SENSORS AND INTERNET OF THINGS

Course Code : 19EE3106
Credits : 4
L-T-P-S : 3-0-2-0
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Sensors and Actuators	PO5	2
CO2	Understand the Internet of things architecture and applications	PO5	2
CO3	Understand the Internet of things communication and protocols	PO5	2
CO4	Apply the features of IOT using physical devices & endpoints	PO5	3
CO5	Experiments Related to Sensors and IoT using TINKERCAD online platform and Embedded Hardware	PO5	4

Syllabus

SENSORS / TRANSDUCERS/ACTUATORS : Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization. -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors. Pneumatic and Hydraulic Actuation Systems, Servo and proportional control valves – Process control valves – Rotary actuators SMART SENSORS : Introduction – Primary Sensors, MEMS Sensors– Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface– The Automation. Introduction to Internet of Things (IoT)– Functional Characteristics – Recent Trends in the Adoption of IoT – Societal Benefits of IoT, Health Care — Machine to Machine (M2M) - Smart Transportation – Smart Living – Smart Cities- Smart Grid IoT ARCHITECTURE : Functional Requirements - Components of IoT: Sensors – Actuators – Embedded Computation Units – Communication Interfaces – Software Development COMMUNICATION PRINCIPLES : RFID – ZigBEE – Bluetooth – Internet Communication- IP Addresses - MAC Addresses - TCP and UDP – IEEE 802 Family of Protocols – Cellular-Introduction to EtherCAT. IOT PHYSICAL DEVICES & ENDPOINTS Exemplary Device Board-ARM AND CORTEX, Exception handling, interrupts programming, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption,

Text Books :

1. D. Patranabis – "Sensors and Transducers" –PHI Learning Private Limited
2. Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013
3. Joseph Yiu," The Definitive Guide to the ARM Cortex-M3", Second Edition, Elsevier Inc. 2010

Reference Books :

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman
2. Amazon Web Services in Action, Andreas Wittig, Michael Wittig.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2015.
4. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015

MOOCS :

https://www.coursera.org/learn/cloud-computing 2 https://www.coursera.org/learn/internet-of-things- cloud-services-version2

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19EE3111: Industrial Automation and Robotics

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

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the principle of automation	1/1	3
CO2	Analyze control systems in automation	2/1	4
CO3	Apply the fundamentals of Industrial Robots	1/1	3
CO4	Analyze the robotic end effectors and Sensors	2/1	4

Syllabus:

Introduction: Definition of industrial automation, Mechanization vs automation, advantages of automation, goals of automation, reasons for automation, social issues of automation, types of automation, current emphasis in automation, Controllers Employed in Automated Systems, Case Studies.

Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. Industrial automation and Case studies.

Fundamentals of Industrial Robots-Specifications and Characteristics, Criteria for selection. Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks Robotic Control Systems-Robot Motions, Drives, Actuators, Robot controllers, Power transmission systems.

Robotic End Effectors and Sensors-Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, force and torque sensing. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, Industrial Applications and Case Studies

Text Books:

1. "Automation, Production Systems & Computer Integrated Manufacturing", Mikell P. Groover, PHI Learning Pvt. Ltd. New Delhi, 3rd Edition 2012.
2. "Industrial Robotics, Technology, Programming & Applications",Groover

Reference Books:

1. An Introduction to Robot Technology (Vol. I-V) Phillipe Collet Prentice Hall Coiffet and Chirooza Kogan.
2. S.R. Deb, Robotics and Flexible Automation, Tata mc Graw Hill.
3. A.K Gupta, S.K. Arora, Industrial Automation and Robotics, Laxmi Publication (P) Ltd..

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19EE3112: Introduction to Industrial Internet of Things

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

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Industry 4.0 Globalization	1/2	2
CO2	Understand the Model and architecture of IIOT	1/2	2
CO3	Understand the IIoT Computing	1/2	2
CO4	Understand the Various Applications of IIoT	1/2	2

Syllabus:

Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems , Sensing & actuation, Communication, Networking types.

Cyber Physical Systems and Next Generation Sensors: Collaborative Platform and Product Lifecycle Management.

Basics of Industrial IoT: Industrial Processes Industrial Sensing & Actuation, Industrial IoT: Business Model and Reference Architecture, Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing, IIoT Networking.

Industrial IoT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT

Industrial IoT Application Domains: Healthcare, Power Systems, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

Text Books:

1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017.
2. "Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017.

Reference Books:

1. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

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Annexure-IV

Course structure and Syllabus Revision for 2019-20 M.Tech-PS & M.Tech PED programs

1. Course structure for 2019-20 admitted M.Tech-PS program

Course Code	Course Name	Course Category	L	T	P	S	CR	Pre-Requisite	New Course/Revised Course/ Retained	Changes Proposed by	Focused on Employability/ Entrepreneurship / Skill	Justification
18EE5101	Power System Dynamics & stability	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5102	Advanced Power System Analysis	PC	3	1	2	0	5	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5103	Deregulated Operation of Power Systems	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5104	Modern Control Theory	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5205	Real Time Control of Power System	PC	3	1	2	0	5	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5206	AI Techniques in Power Systems	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE5207	Smart Grids Technologies	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study

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18EE5208	Digital Protection of Power Systems	PC	3	1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE51A1	Reactive Power Compensation &	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE51A2	Distribution System Planning & Automation	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE51A3	Power System Reliability	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE51B1	Alternative Sources of Electrical Energy	PE	3	0	0	0	3	Nil	Retained	No Changes	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
18EE51B2	Digital Signal Processors and Applications	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE51B3	Optimization Techniques	PE	3	0	0	0	3	Nil	Retained	No Changes	Entrepreneurship	Covers the advanced topics which enable employability in the core sector and further study
18EE52C1	FACTS DEVICES	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE52C2	Energy Conservation & Audit	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
18EE52C3	Adaptive Control Systems	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study

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19EE52D1	Floating Solar and Off Shore wind Technologies	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
18EE52D2	Power Quality	PE	3	0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable employability in the core sector and further study
19EE52D3	Energy Management 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
18IE5149	Seminar	PRI	0	0	4	0	2	Nil	Retained	No Changes	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
18IE5250	Term Paper	PRI	0	0	4	0	2	Nil	Retained	No Changes	Skill Development	Covers the practical knowledge of tools required for technical problem-solving
18IE6050	Dissertation	PRI	0	0	72	0	36	Nil	Retained	No Changes	Skill Development	Covers the practical knowledge of tools required for required for technical problem-solving

Percentage of Courses focusing on Employability= 59/23=78%

Percentage of Courses focusing on Entrepreneurship= 2/23=9%

Percentage of Courses focusing on Skill Development = 3/23=13%

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1. Syllabus of New Course for Y19 admitted students

Course Code	Course Name	Cat	New Syllabus	Topics Added/ Removed/ Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
19EE52D1	Floating Solar and Off Shore wind Technologies	PE	Concept of Floating Solar PV System – Selection of Floating Solar PV Plant: Site Survey of Floating Solar PV Plant, Dam Dimension calculations, Environment factor assessment, Power evacuation level, pontoon angle, Magnetic North & True North with a variation of azimuth angle, Temperature factor - Selection of floating pontoon: Types of Pontoon, Specification of main Pontoons, Selection criteria for PV module pontoons, etc. – Preparation of Floating Solar PV Plant: Overall plant layout, DC blocking layout, Earthing Layout for Floating solar Power Plant, Connection of Leap frog method for string connection – PV Modules & Sizing – Inverter Selection & Sizing – HT Switch & Sizing. Overview of offshore wind technology - Energy Conversion Systems for Offshore Wind Turbines - Modelling and Analysis of Drivetrains in Offshore Wind Turbines - Fixed and Floating Offshore Wind Turbine Support Structures – Offshore Wind Turbine Controls - Operation and Maintenance Modelling - Supervisory Wind Farm Control - Offshore Transmission Technology - Grid Integration and Control for Power System Operation Support.	New	yes	As per Industry expert feedback to elective	100
19EE52D3	Energy Management Systems	PE	General Theory: Purpose and necessity, general structure, data acquisition, transmission and monitoring, general power system hierarchical structure, an overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, cables, telephone lines, power line carrier, microwaves, fibre- optical channels and satellites.Supervisory and Control Functions: Data acquisitions, status indications, measured values, energy values, monitoring alarm and event application processing. Control function: ON/OFF control of lines, transformers, capacitors and applications in process industry, valve, opening, closing etc. Regulatory functions: set points and feedback loops, time-tagged data, disturbance data collection and analysis, calculation and report preparation. MAN- Machine Communication: Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities. Databases - SCADA, EMS and network databases: SCADA system structure - local system, communication system and central system, Configuration- non-redundant single processor, redundant dual processor, multi-control centres, system configuration. Performance considerations: real-time operation system requirements, modularization of software programming languages. Energy Management Center Functions performed at a centralized management centre, production control and load management, economic dispatch, distributed centres and power pool management.	New	yes	As per Academic peers' feedback to elective	100

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Course Code: 18EE5101 **POWER SYSTEM DYNAMICS & STABILITY**

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.Padlyar "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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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	Understand 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	Understand 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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FLOATING SOLAR & OFF SHORE WIND TECHNOLOGIES

Course Code: 19EE52D1

L	T	P	C
3	0	0	3

CO. No	Course Outcome	PO	BTL
1	Understand the selection of floating solar power plant	3,4	2
2	Understand different layouts and selection of converters	3,4	2
3	Understand the operation of off shore wind power plants	3,4	2
4	Compare the operation of floating solar and off shore with power operation	3,4	4

Concept of Floating Solar PV System – **Selection of Floating Solar PV Plant**: Site Survey of Floating Solar PV Plant, Dam Dimension calculations, Environment factor assessment, Power evacuation level, pontoon angle, Magnetic North & True North with variation of azimuth angle, Temperature factor - **Selection of floating pontoon:** Types of Pontoon, Specification of main Pontoons, Selection criteria for PV module pontoons, etc,. – **Preparation of Floating Solar PV Plant**: Overall plant layout, DC blocking layout, Earthing Layout for Floating solar Power Plant, Connection of Leap frog method for string connection – PV Modules & Sizing – Inverter Selection & Sizing – HT Switch & Sizing.

Overview of offshore wind technology - Energy Conversion Systems for Offshore Wind Turbines - Modelling and Analysis of Drivetrains in Offshore Wind Turbines - Fixed and Floating Offshore Wind Turbine Support Structures – **Offshore Wind Turbine Controls** - Operation and Maintenance Modelling - Supervisory Wind Farm Control - Offshore Transmission Technology - Grid Integration and Control for Power System Operation Support.

Text Books:

1. Marco Rosa-Clot Giuseppe Marco Tina, "Submerged and Floating Photovoltaic Systems", Springer Publishers, ISBN: 9780128121498
2. Olimpo Anaya-Lara, John Olav Tande, Kjetil Uhlen, Karl Merz, "Offshore Wind Energy Technology", Wiley Publishers, ISBN: 978-1-119-09780-8

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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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ENERGY MANAGEMENT SYSTEMS

Course Code: 19EE52D3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
CO1	Outline data acquisition components of power system	PO2	2
CO2	Demonstrate energy data monitoring, reportingand communication	PO2	2
CO3	Apply supervisory control for energy management	PO2, PO5	3
CO4	Illustrate Energy management center functions	PO2	2

General Theory: Purpose and necessity, general structure, data acquisition, transmission and monitoring, general powersystem hierarchical structure, overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, cables, telephone lines, power line carrier, microwaves, fiber- optical channels and satellites.**Supervisory and Control Functions:** Data acquisitions, status indications, measured values, energy values, monitoring alarm and event application processing. Control function: ON/OFF control of lines, transformers, capacitors and applications in process industry, valve, opening, closing etc. Regulatory functions: set points and feed-back loops, time tagged data, disturbance data collection and analysis, calculation and report preparation. **MAN- Machine Communication:** Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities. **Data bases - SCADA, EMS and network data bases:** SCADA system structure - local system, communication system and central system, Configuration- non-redundant single processor, redundant dual processor, multi control centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.**Energy Management Center** Functions performed at a centralized management center, production control and load management, economic dispatch, distributed centers and power pool management.

Textbooks:

1. TorstenCegrell, Power System Control Technology, Prentice Hall International, 1986
2. Stuart A. Boyer, SCADA: Supervisory Control And Data Acquisition, The Instrumentation, Systems and Automation Society, 4th edition, 2009.
3. Krishna Kant, Computer-Based Industrial Control, PHI Learning,2nd edition, 2013.
4. Bela G. Liptak, Instrument Engineers Handbook, Volume 3: Process Software and Digital Networks, CRC Press, 4th edition, 2011.
5. Behrouz Forouzan, Data Communications and Networking, McGraw-Hill,5thedition, 2012.

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2. **Course structure for 2019-20 admitted M.Tech-PED program**

Course Code	Course Name	Course Category	L		T	P	S	CR	Pre-Requisite	New Course/Revised Course/ Retained Course	Changes Proposed by	Focused on Employability/	Justification
18EE5109	Modeling and Analysis of Electrical	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5110	Analysis of Power Converters	PC	3		1	2	0	5	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5111	Power Electronic Control Of Drives	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5104	Modern Control Theory	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5113	Advanced Power Converters	PC	3		1	2	0	5	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5114	Advanced Electrical Drives	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5207	Smart Grids Technologies	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18EE5116	FPGA controllers and	PC	3		1	0	0	4	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study

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19EE52D1	18EE52C3	18EE52H2	18EE52C1	18EE51B3	18EE51B2	18EE51F1	18EE51E3	18EE51E2	18EE51E1
Floating Solar and off shore wind	Adaptive Control Systems	Electric and Hybrid Vehicles	FACTS DEVICES	Optimization Techniques	Digital Signal Processors and	Soft Computing Techniques	Industrial Control Electronics	Digital Simulation of Power Electronic	Microcontrollers and Applications
PE	PE	PE	PE	PE	PE	PE	PE	PE	PE
3	3	3	3	3	3	3	3	3	3
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
3	3	3	3	3	3	3	3	3	3
Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Retained	Retained	Retained	Retained	Retained	Retained	Retained	Retained	Retained	Retained
No Changes	No Changes	No Changes	No Changes	No Changes	No Changes	No Changes	No Changes	No Changes	No Changes
Enterpreneurship	Employability	Employability	Employability	Entrepreneurship	Employability	Entrepreneurship	Employability	Employability	Employability
Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study	Covers the advanced topics which enable for employability in core sector and further study

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18EE52D2	Power Quality	PE	3		0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
19EE52D3	Energy Management Systems	PE	3		0	0	0	3	Nil	Retained	No Changes	Employability	Covers the advanced topics which enable for employability in core sector and further study
18IE5149	Seminar	PRI	0		0	4	0	2	Nil	Retained	No Changes	Skill Development	Covers the advanced topics which enable for employability in core sector and further study
18IE5250	Term Paper	PRI	0		0	4	0	2	Nil	Retained	No Changes	Skill Development	Covers the advanced topics which enable for employability in core sector and further study
18IE6050	Dissertation	PRI	0		0	72	0	36	Nil	Retained	No Changes	Skill Developmen	Covers the advanced topics which enable for employability in core sector and further study

Percentage of Courses focusing on Employability= 59/23=78%

Percentage of Courses focusing on Entrepreneurship= 2/23=9%

Percentage of Courses focusing on Skill Development = 3/23=13%

3. Course wise New Syllabus of approved structure as mentioned in point 1 and point 2

SNO	Course Code	Course Name	Course Category	Existing Syllabus	New Syllabus	Topics Added/Removed/Replaced	Change in Outcome	Justification for the Modificat	Revision Percentage
1	19EE52D1	Floating Solar and off shore wind technologies	PE	-	New	New	Yes		100%
2	19EE52D3	Energy Management Systems	PE	-	New	New	Yes		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	Apply 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	Illustrate 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	BLOOMS TAXANOMY LEVEL
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	BLOOMS TAXANOMY LEVEL
CO1	Analyze ac-dc and dc-dc converter fed DC motor drives	PO1	4
CO2	Understand converter fed stator side control of Induction Motor drives.	PO3	2
CO3	Analyze rotor side control and slip power recovery scheme of 3-phase Induction Motor drives	PO2/PO3	4
CO4	Analyze 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	Blooms Taxonomy Level (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:

3. Discrete Time Control Systems-K.Ogata Pearson Education-2005.
4. Digital Control systems and State Variables methods by M.Gopal-2006.

REFERENCE BOOKS:

5. Modern Control System Theory by M. Gopal – New Age International – 2005
6. M. Gopal : Modern Control Systems Theory, Wiley Eastern Limited, New Delhi, 1996.
7. Modern Control Engineering by Ogata. K – Prentice Hall –2006
8. 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, AlirezaKhaligh, ZhongNie, 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 DariuszCzarkowski, "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 & SmartGrid, 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, Isolationand 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 MeasurementUnit (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 CLOUDcomputing 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. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley 2012.

REFERENCES BOOKS

1. Control and Optimization Methods for Electric Smart Grids, AranyaChakraborthy, Marija D Ilic Editor, Springer Publications.
2. Smart Grid Fundamentals of Design and Analysis, James Momoh, Wiley IEEE Press, Ed 2012.
3. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang "Smart Grid – The New andImproved 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	Blooms Taxonomy Level (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	3
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.
3. Xilinx (2006) Spartan-3E Starter Kit Board User Guide. UG230 (v1.0) March 2006
4. 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	Blooms Taxonomy Level (BTL)
CO1	Outline functional and operational features of PIC18C7X micro-controller	PO2	2
CO2	Demonstrate programming of PIC18C7X	PO2,PO5	2
CO3	Develop interfacing of PIC18C7X to analog and digital controller components	PO2,PO5	3
CO4	Apply PIC18C7X programming to real time control applications	PO2,PO5	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:

2. Mazidi& Mc Kinley, " The 8051 Micro controller and Embedded Systems using Assembly and c", 2nd edition, published by Person Education, 2006
3. 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	Blooms Taxonomy Level (BTL)
CO1	Understand Pspice modeling of power semiconductor devices and passive components behavior with protection circuits.	PO2,PO5	3
CO2	Analyze performance of AC-DC controlled, uncontrolled converters and DC-DC converters using Pspice and Matlab Simulink model.	PO2,PO5	3
CO3	Evaluate DC-AC converters performance using modern simulation tools.	PO2,PO5	3
CO4	Analyze AC voltage controller and cyclo-converter performance with programming and simulation tools.	PO2,PO5	3

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	Blooms Taxonomy Level (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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SOFT COMPUTING TECHNIQUES (ELECTIVE -2)

COURSE CODE: 18EE51F1

L T P C
3 0 0 3

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (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	Blooms Taxonomy Level (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/PSO	Blooms Taxonomy Level (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: 18EE52G1

L	T	P	C
3	0	0	4

Co.No:	Course Outcomes	PO	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	Demonstratetheoperation 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:

2. N.G Hingorani&L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,2000
3. 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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ELECTRIC AND HYBRID VEHICLES(ELECTIVE -3)

Course Code: 18EE52G2

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (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 propulsionmotor, sizing the power electronics, selecting the energy storage technology, Communications, supportingsubsystems.

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 PermanentMagnet 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-implementationissues of energy strategies.

TEXT BOOKS:

1. Iqbal Hussain, CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, MehrdadEhsani, 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. MehrdadEhsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric,Hybrd Electric, andFuel 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	Blooms Taxonomy Level (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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FLOATING SOLAR & OFF SHORE WIND TECHNOLOGIES (ELECTIVE-4)

Course Code: 19EE52D1

L	T	P	C
3	0	0	3

CO. No	Course Outcome	PO	BTL
1	understand the selection of floating solar power plant	3,4	2
2	understand different layouts and selection of converters	3,4	2
3	understand the operation of off shore wind power plants	3,4	2
4	compare the operation of floating solar and off shore with power operation	3,4	4

Concept of Floating Solar PV System – **Selection of Floating Solar PV Plant**: Site Survey of Floating Solar PV Plant, Dam Dimension calculations, Environment factor assessment, Power evacuation level, pontoon angle, Magnetic North & True North with variation of azimuth angle, Temperature factor - **Selection of floating pontoon:** Types of Pontoon, Specification of main Pontoons, Selection criteria for PV module pontoons, etc,. – **Preparation of Floating Solar PV Plant**: Overall plant layout, DC blocking layout, Earthing Layout for Floating solar Power Plant, Connection of Leap frog method for string connection – PV Modules & Sizing – Inverter Selection & Sizing – HT Switch & Sizing.

Overview of offshore wind technology - Energy Conversion Systems for Offshore Wind Turbines - Modelling and Analysis of Drivetrains in Offshore Wind Turbines - Fixed and Floating Offshore Wind Turbine Support Structures – **Offshore Wind Turbine Controls** - Operation and Maintenance Modelling - Supervisory Wind Farm Control - Offshore Transmission Technology - Grid Integration and Control for Power System Operation Support.

Text Books:

3. Marco Rosa-Clot Giuseppe Marco Tina, "Submerged and Floating Photovoltaic Systems", Springer Publishers, ISBN: 9780128121498
4. Olimpo Anaya-Lara, John Olav Tande, Kjetil Uhlen, Karl Merz, "Offshore Wind Energy Technology", Wiley Publishers, ISBN: 978-1-119-09780-8

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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	Blooms Taxonomy Level (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 componentLOAD **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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ENERGY MANAGEMENT SYSTEMS (ELECTIVE -4)

Course Code: 19EE52D3

L	T	P	C
3	0	0	3

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
CO1	Outline data acquisition components of power system	PO2	2
CO2	Demonstrate energy data monitoring, reportingand communication	PO2	2
CO3	Apply supervisory control for energy management	PO2, PO5	3
CO4	Illustrate Energy management center functions	PO2	2

Syllabus:

General Theory: Purpose and necessity, general structure, data acquisition, transmission and monitoring, general powersystem hierarchical structure, overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, cables, telephone lines, power line carrier, microwaves, fiber- optical channels and satellites.**Supervisory and Control Functions:** Data acquisitions, status indications, measured values, energy values, monitoring alarm and event application processing. Control function: ON/OFF control of lines, transformers, capacitors and applications in process industry, valve, opening, closing etc. Regulatory functions: set points and feed-back loops, time tagged data, disturbance data collection and analysis, calculation and report preparation. **MAN- Machine Communication:** Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities. **Data bases - SCADA, EMS and network data bases:** SCADA system structure - local system, communication system and central system, Configuration- non-redundant single processor, redundant dual processor, multi control centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.**Energy Management Center** Functions performed at a centralized management center, production control and load management, economic dispatch, distributed centers and power pool management.

Textbooks:

1. TorstenCegrell, Power System Control Technology, Prentice Hall International, 1986
2. Stuart A. Boyer, SCADA: Supervisory Control And Data Acquisition, The Instrumentation, Systems and Automation Society, 4th edition, 2009.
3. Krishna Kant, Computer-Based Industrial Control, PHI Learning,2nd edition, 2013.
4. Bela G. Liptak, Instrument Engineers Handbook, Volume 3: Process Software and Digital Networks, CRC Press, 4th edition, 2011.
5. Behrouz Forouzan, Data Communications and Networking, McGraw-Hill,5thedition, 2012.

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ANNEXURE-IV

Course wise Syllabus revision of Y19 approved structure as mentioned

Sl	code	Title	Cat	Existing Syllabus	New Syllabus	Topics Added/Removed /Replaced	Change in Outcome	Justification for the Modification	Revision Percentage
1	19EE2101	ELECTRICAL CIRCUITS	ESC	. 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.	Transient response of R-L, R-C, R-L-C circuits for different excitations, initial conditions, time domain and Laplace transform methods of solutions, introduction to two port networks. AC Circuits- RMS and average values and form factor of different periodic wave forms steady state analysis of R, L and C with sinusoidal excitation, concept of power factor, Real and Reactive powers. Three phase circuits-phase sequence, Relation between line and phase quantities, Analysis of balanced and unbalanced 3 phase circuits, Introduction to network topology. Resonance: Resonance:-Series and parallel resonance, bandwidth, selectivity, Q factor, current locus diagrams. Magnetic circuits: concept of mutual inductance, dot convention, coefficient of coupling, Magnetic Circuits, Analysis of series and parallel magnetic circuits. Network Topologies: definitions, graph, tree, basic cut-set and basic tie set matrices for planar network, Loop and Nodal methods of analysis of networks Two-port Networks: one port and two port networks Two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships.	**Added:** AC Circuits- RMS and average values and form factor of different periodic wave forms. steady state analysis of R, L and C with sinusoidal excitation, concept of power factor, Real and Reactive powers. **Removed:** . 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.	Co-2	On contemporary needs lab is introduced	25%

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Annexure-VI

List of Certificate Courses to be offered by Department of EEE for AY 2019-20

SNO	Name of the Course	Regulation	Course Level	Offered to Specializations	Organizing Institute	Focused on
1	Basics of PLC	Y16	3	PE, PS, CS, ES	APSSDC	Employability

Annexure-VI

List of Certificate Courses to be offered by Department of EEE for AY 2019-20

SNO	Name of the Course	Regulation	Course Level	Offered to Specializations	Organizing Institute	Focused on
1	Factory Automation & process visualization	Y16	3	PE, PS, CS, ES	Udemy	Employability
2	Magnetics for Power Electronics	Y16	3	PE, PS, CS, ES	Course Era	Employability
3	Introduction to IoT and Embedded Systems	Y16	3	PE, PS, CS, ES	Course Era	Employability

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