B. Tech. Degree

in

ELECTRICAL AND ELECTRONICS ENGINEERING

SYLLABUS FOR

FLEXIBLE CURRICULUM

(For students admitted in 2023-24 Onwards)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA.

INSTITUTE VISION

- To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

INSTITUTE MISSION

- To offer undergraduate, postgraduate, doctoral, and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

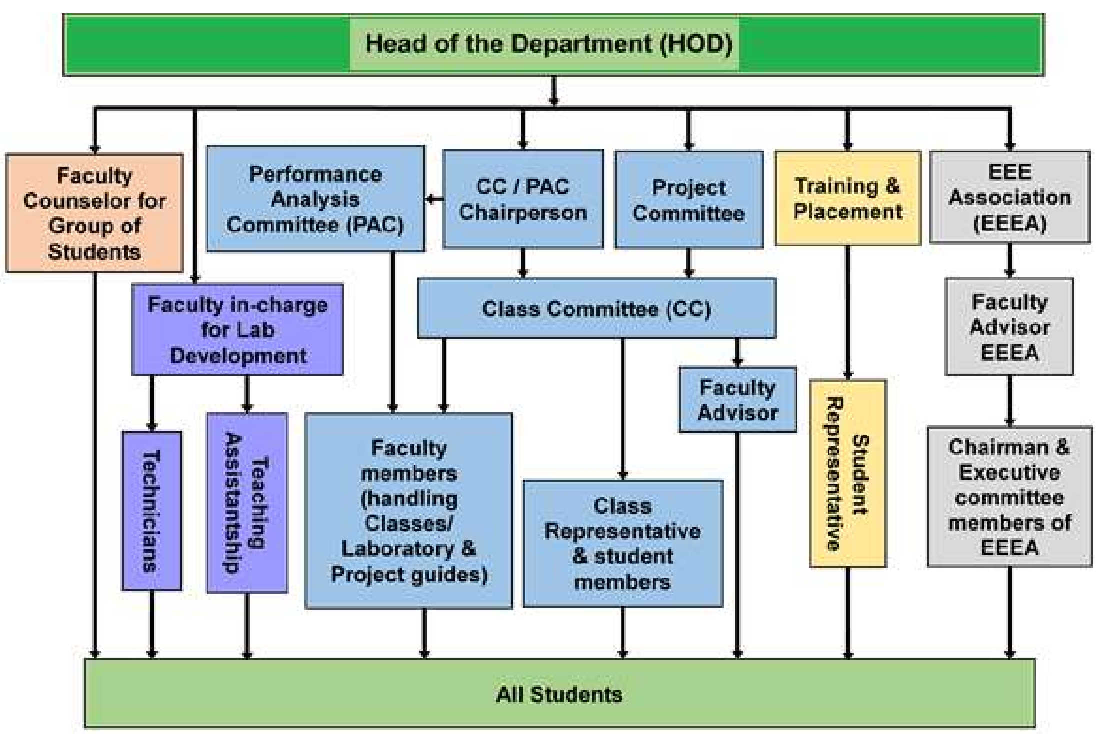
DEPARTMENT VISION

- To be a centre of excellence in Electrical Energy Systems.

DEPARTMENT MISSION

- Empowering students and professionals with state-of-art knowledge and technological skills.
- Enabling industries to adopt effective solutions in energy areas through research and consultancy.
- Evolving appropriate sustainable technologies for rural needs.

ORGANIZATION CHART/ VARIOUS COMMITTEES OF THE DEPARTMENT



Programme Educational Objectives (PEOs)

The major objectives of the B. Tech. programme in Electrical and Electronics Engineering are to prepare students:

1. for graduate study in engineering
2. to work in research and development organizations
3. for employment in electrical power industries
4. to acquire job in electronic circuit design and fabrication industries
5. to work in IT and ITES industries

Program Outcomes (POs)

The students who have undergone the B.Tech. programme in Electrical and Electronics Engineering (EEE) will be able to

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CURRICULUM

The total minimum credits required for completing the B.Tech. programme in Electrical and Electronics Engineering is **163.**

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES:

Course Structure

Course Category	**Courses**	**No. of Credits**	**Weightage (%)**
GIR (General Institute Requirement Courses)	22	50	30.67
PC (Programme Core)	15	55	33.74
Programme Electives (PE) / Open Electives (OE)	$14^{\$}$	42	25.77
Essential Laboratory Requirements (ELR)	Maximum 2 per session up to 6th semester	16	9.82
Total		**163**	**100**
Minor (Optional)	Courses for 15 credits	15 Additional credits	-
Honours (Optional)	Courses for 15 credits	15 Additional credits	-

** Minimum of 4 programme core courses shall be 4 credits each

$^{\$}$Out of 14 elective courses (PE/OE), the students should study **at least eight programme elective courses (PE)**

Programme Electives (PE) are offered by the Department of Electrical and Electronics Engineering for students of B.Tech. in the Electrical and Electronics Engineering programme. Out of 14 elective courses (PE/OE), the students should study at least eight programme elective courses (PE). To meet the minimum credit requirement for Electives, the remaining elective courses can be chosen from either PE courses offered by the Department of Electrical and Electronics Engineering, or Open Electives (OE) offered by any other Department within National Institute of Technology, Tiruchchirappalli and online courses to be approved by the department committee. A student can opt for Project Work instead of two electives equivalent to 6 credits.

MI – Minor Degree: To meet the requirement of minor, 15 additional credits should be taken from the MI category over and above the minimum credits specified by the Department. The details of MINOR will be mentioned only in the transcript and not in the Degree certificate.

HO – Honors Degree: 15 credits over and above the minimum credit as specified by the departments. The students shall register for three 4-credit courses and one 3-credit course.

Online courses: Maximum of 12 credits can be taken from online elective courses listed out by the department.

GIR Courses

Sl. No.	Name of the course	Number of courses	Max. Credits
1.	Mathematics	**3**	10
2.	Physics	**1 Theory**	3
		1 Lab	2
3.	Chemistry	**1 Theory**	3
		1 Lab	2
4.	Industrial Economics and Foreign Trade	**1**	3
5.	English for Communication	**1 Theory**	2
		1 Lab	2
6.	Energy and Environmental Engineering	**1**	2
7.	Professional Ethics	**1**	3
8.	Engineering Graphics	**1**	3
9.	Engineering Practice	**1**	2
10.	Basic Engineering	**2**	4
11.	Introduction to computer Programming	**1**	3
12.	Branch Specific Course (Introduction to the Branch of study)	**1**	2
13.	Summer Internship	**1**	2
14.	Project work	**-**	-
15.	Comprehensive viva	**1**	1
16.	Industrial Lecture	**1**	1
17.	NSS/NCC/NSO	**1**	Compulsory participation
Total		**22**	**50**

Credit Distribution

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	19	21	25	25	25	24	14	10	163

I. GENERAL INSTITUTE REQUIREMENT (GIR)

1. MATHEMATICS

S.No.	Course Code	Course Title	Credits
1	MAIR12	Linear Algebra and Calculus	3
2	MAIR22	Complex Analysis and Differential Equations	3
3	MAIR32	Fourier Transforms and Numerical Techniques	4
		Total	**10**

2. PHYSICS

S.No.	Course Code	Course Title	Credits
1.	PHIR11	Physics	3
2.	PHIR12	Physics Lab	2
		Total	**5**

3. CHEMISTRY

S.No.	Course Code	Course Title	Credits
1.	CHIR11	Chemistry	3
2.	CHIR12	Chemistry Lab	2
		Total	**5**

4. HUMANITIES

S.No.	Course Code	Course Title	Credits
1.	HSIR13	Industrial Economics and Foreign Trade	3
		Total	**3**

5. COMMUNICATION

S.No.	Course Code	Course Title	Credits
1.	HSIR11	English for Communication (Theory and Lab)	2+2
		Total	**4**

6. ENERGY AND ENVIRONMENTAL ENGINEERING

S.No.	Course Code	Course Title	Credits
1.	ENIR11	Energy and Environmental Engineering	2
		Total	**2**

7. PROFESSIONAL ETHICS

S.No.	Course Code	Course Title	Credits
1.	HSIR14	Professional Ethics	3
		Total	**3**

8. ENGINEERING GRAPHICS

S.No.	Course Code	Course Title	Credits
1.	MEIR12	Engineering Graphics	3
		Total	**3**

9. ENGINEERING PRACTICE

S.No.	Course Code	Course Title	Credits
1.	PRIR11	Engineering Practice	2
		Total	**2**

10. BASIC ENGINEERING

S.No.	Course Code	Course Title	Credits
1.	CEIR11	Basic Civil Engineering	2
2.	MEIR11	Basic Mechanical Engineering	2
		Total	**4**

11. INTRODUCTION TO COMPUTER PROGRAMMING

S.No.	Course Code	Course Title	Credits
1.	CSIR12	Introduction to Computer Programming (Theory and Labs)	3
		Total	**3**

12. BRANCH SPECIFIC COURSE

S.No.	Course Code	Course Title	Credits
1.	EEIR15	Introduction to Electrical and Electronics Engineering	2
		Total	**2**

13. SUMMER INTERNSHIP

S.No.	Course Code	Course Title	Credits
1.	EEIR16	Summer Internship	2
		Total	**2**

The student should undergo industrial training/internship for a minimum period of six weeks during the summer vacation of III year. Registration for this course shall be along with the courses for VII semester. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training. A report is to be submitted to the Head of the Department and evaluation (2 credit) will be based on the report and viva-voce examination.

14. PROJECT WORK

S.No.	Course Code	Course Title	Credits
1.	EEIR17	Project Work	6
		Total	**6**

15. COMPREHENSIVE VIVA

S.No.	Course Code	Course Title	Credits
1.	EEIR18	Comprehensive Viva-Voce Examination	1
		Total	**1**

Note: Students can appear for Comprehensive Viva-Voce Examination only after completing all Programme Core (PC) courses.

16. INDUSTRIAL LECTURES

S.No.	Course Code	Course Title	Credits
1.	EEIR19	Industrial Lectures	1
		Total	**1**

A minimum of five lectures of two hours duration each by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture. Due weightage shall be given to attendance also. However, the HoD or her/his nominee may devise a suitable methodology for evaluation and the same should be informed to the students before the commencement of the semester.

17. NSS/NCC/NSO

S.No.	Course Code	Course Title	Credits
1.	SWIR11	NSS/NCC/NSO	0
		Total	**0**

All students admitted to the B.Tech. Program will have to take either NCC or NSO or NSS as a non-credit extra-curricular Program. NCC Program is not available for foreign nationals. The NCC / NSO / NSS requirement should be completed within the first two semesters.

II. PROGRAMME CORE (PC)

LIST OF ESSENTIAL PROGRAMME CORE COURSES				
S.No.	**Course Code**	**Course Title**	**Pre-Req**	**Credits**
1.	EEPC10	Circuit Theory	MAIR12	4
2.	EEPC11	Networks and Linear Systems	EEPC10	4
3.	EEPC12	DC Machines and Transformers	EEPC10	4
4.	EEPC13	Electron Devices	-	3
5.	EEPC14	Digital Electronics	-	3
6.	EEPC15	AC Machines	EEPC12	4
7.	EEPC16	Analog Electronic Circuits	EEPC13	4
8.	EEPC17	Transmission and Distribution of Electrical Energy	EEPC10	4
9.	EEPC18	Power System Analysis	MAIR32 EEPC10	4
10.	EEPC19	Power Electronics	MAIR32 EEPC10 EEPC13	4
11.	EEPC20	Control Systems	MAIR32	4
12.	EEPC21	Linear Integrated Circuits	EEPC10	3
13.	EEPC22	Microprocessors and Microcontrollers	EEPC14	3
14.	EEPC23	Measurements and Instrumentation	EEPC21	3
15.	EEPC24	Power System Protection and Switchgear	EEPC18	4
		TOTAL		**55**

III. ELECTIVE COURSES

1. PROGRAMME ELECTIVES (PE)

LIST OF PROGRAMME ELECTIVE COURSES				
S.No.	**Course Code**	**Course Title**	**Pre-Req.**	**Credits**
1	EEPE10	Power Generation Systems	-	3
2	EEPE11	Electrical Safety	-	3
3	EEPE12#	Thermodynamics and Mechanics of Fluids	-	3
4	EEPE13	Fuzzy Systems and Genetic Algorithms	-	3
5	EEPE14	Industrial Automation	-	3
6	EEPE15	High Voltage Engineering	EEPC10	3
7	EEPE16	Computer Organization and Architecture	EEPC14	3
8	EEPE17	Digital System Design and HDLS	EEPC14	3
9	EEPE18	Digital Signal Processing	MAIR32, EEPC14	3
10	EEPE19	Artificial Neural Networks	MAIR32	3
11	EEPE20	Design of Electrical Apparatus	EEPC15	3
12	EEPE21	Utilization of Electrical Energy	EEPC15	3
13	EEPE22	Computer Networks	-	3
14	EEPE23	Modern Control Systems	EEPC20	3
15	EEPE24	Fundamentals of FACTS	EEPC11, EEPC19	3
16	EEPE25	Special Electrical Machines	EEPC15, EEPC19	3
17	EEPE26	Wind and Solar Electrical Systems	EEPC15, EEPC19	3

18	EEPE27	Solid State Drives	EEPC15, EEPC19.	3
19	EEPE28	Embedded System Design	EEPC22	3
20	EEPE29	Power System Economics and Control Techniques	EEPC20, EEPC18	3
21	EEPE30	Digital Control Systems	EEPC20	3
22	EEPE31*	Operations Research	MAIR32	3
23	EEPE32	Electric Vehicle Technology	-	3
24	EEPE33	Design Thinking	-	3
25	EEPE34	Machine Learning and Deep Learning	MAIR32	3
26	EEPE35	Nano Electronics	EEPC13	3
27	EEPE36##	Communication Systems	EEPC14, EEPC17	3
28	EEPE37	Data Structures and Algorithms	-	3
29	EEPE38	Electric Power Quality	EEPC17, EEPC18	3
30	EEPE39	VLSI Design	EEPC14, EEPC21	3
31	EEPE40	Power System Restructuring	EEPC18	3
32	EEPE41	Economic Evaluation of Power Projects	EEPC17	3
33	EEPE42	Introduction to Switched Mode Power Supplies	EEPC19	3
34	EEPE43	Optimal and Robust Control	EEPC20	3
35	EEPE44	Robotics	-	3
36	EEPE45	Battery Management Systems	-	3
37	EEPE46	Power System Reliability	EEPC17	3

* *Will be offered by the Department of Mathematics.*

\# *Will be offered by Department of Mechanical Engineering*

\## *Will be offered by the Department of Electronics and Communication Engineering.*

2. OPEN ELECTIVES (OE)

The courses listed below are offered by the Department of Electrical and Electronics Engineering for students of other Departments.

LIST OF OPEN ELECTIVES				
S.No.	**Course Code**	**Course Title**	**Pre-Req**	**Credits**
1.	EEOE10	Electrical Safety	-	3
2.	EEOE11	Fuzzy Systems and Genetic Algorithms	-	3
3.	EEOE12	Artificial Neural Networks	-	3
4.	EEOE13	Modern Control Systems	-	3
5.	EEOE14	Digital Control Systems	-	3
6.	EEOE15	Electric Vehicle Technology	-	3
7.	EEOE16	Basics of Electrical Circuits*	-	3
8.	EEOE17	Electrical Machines*	-	3
9.	EEOE18	Control Systems Engineering*	-	3
10.	EEOE19	Analog and Digital Electronics*	-	3
11.	EEOE20	Power Electronic Systems*	-	3
12.	EEOE21	Power Systems Engineering*	-	3
13.	EEOE22	Electric Power Utilization*	-	3
14.	EEOE23	Renewable Power Generation Systems*	-	3
15.	EEOE24	Design Thinking	-	3
16.	EEOE25	Optimal and Robust Control	Control Systems	3
17.	EEOE26	Robotics	-	3
18.	EEOE27	Battery Management Systems	-	3

3. MINOR (MI)

Students who have registered for B.Tech. (Minor) in Electrical and Electronics Engineering can opt to study any 5 of the courses listed below. Students from non-circuit branches alone can opt for this Minor Programme.

LIST OF COURSES FOR B.Tech. (MINOR) PROGRAMME				
S.No.	**Course Code**	**Course Title**	**Pre-Req**	**Credits**
1.	EEMI10	Basics of Electrical Circuits	-	3
2.	EEMI11	Electrical Machines	-	3
3.	EEMI12	Control Systems Engineering	-	3
4.	EEMI13	Analog and Digital Electronics	EEMI10	3
5.	EEMI14	Power Electronic Systems	EEMI11	3
6.	EEMI15	Power Systems Engineering	EEMI11	3
7.	EEMI16	Electric Power Utilization	EEMI11	3
8.	EEMI17	Introduction to Microcontrollers	EEMI13	3
9.	EEMI18	Renewable Power Generation Systems	EEMI14	3

4. ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)

LIST OF ESSENTIAL PROGRAMME LABORATORY REQUIREMENT				
S.No.	**Course Code**	**Course Title**	**Co-Req***	**Credits**
1.	EELR10	Circuits and Digital Laboratory	EEPC10	2
2.	EELR11	DC Machines and Transformers Laboratory	EEPC12	2
3.	EELR12	Electronic Circuits Laboratory	EEPC13	2
4.	EELR13	Synchronous and Induction Machines Laboratory	EEPC15	2
5.	EELR14	Integrated Circuits Laboratory	EEPC21	2
6.	EELR15	Power Electronics Laboratory	EEPC19	2
7.	EELR16	Micro-controller Laboratory	EEPC22	2
8.	EELR17	Power Systems Laboratory	EEPC18	2
		TOTAL		**16**

NOTE: Students can register for 2 laboratory courses during one session along with the regular courses (PC / Electives).

5. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

LIST OF ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)				
S.No.	**Course Code**	**Course Title**	**Pre-Req.**	**Credits**
1.	EEHO10	Distribution System Automation	EEPC11	3
2.	EEHO11	EHV AC and DC Transmission	EEPC11	3
3.	EEHO12	Non-linear Control Systems	EEPC20	4
4.	EEHO13	Power Switching Converters	EEPC19	4
5.	EEHO14	Vehicular Electric Power Systems	EEPC15, EEPC19	4
6.	EEHO15	Power System Dynamics	EEPC18	4
7.	EEHO16	Modern Optimization Techniques for Electric Power Systems	EEPC18	4
8.	EEHO17	Computer Relaying and Phasor Measurement Unit	EEPC24	3
9.	EEHO18	Electricity Markets	EEPC18	4
10.	EEHO19	Design with PIC Microcontrollers	EEPC14	4
11.	EEHO20	Aircraft Electronic Systems	EEPC22	3

- **Eligibility for Award of B.Tech. (Honours) Degree**:
  - Students should not have obtained “V” or” X” grade in any course.
  - Continue to maintain the CGPA of 8.5 in all semesters excluding honours courses.
  - Completed additional theory courses for 15 credits from the basket of honors generally in the level of P.G. courses offered by the department, maintaining an aggregate of at least B grade in Honours courses.
- B.Tech. (Honours) students are permitted to take one M.Tech. (Power Systems/Power Electronics) course offered during a session in their 4th year of study.
- B.Tech. (Honours) students must earn 15 credits in addition to the credits specified by the department for B.Tech. degree. They can register an additional course from the 5th semester from the basket of honours courses offered by the department.

Curriculum Structure

Semester I (July Session)

S No	Code	Course	Credits	Category
1	ENIR11	Energy and Environmental Engineering	2	GIR
2	MAIR12	Linear Algebra and Calculus	3	GIR
3	PHIR11	Physics	3	GIR
4	PHIR12	Physics Lab	2	GIR
5	CSIR12	Introduction to Computer Programming (Theory & lab)	3	GIR
6	MEIR11	Basics of Mechanical Engineering	2	GIR
7	PRIR11	Engineering Practice	2	GIR
8	CEIR11	Basics of Civil Engineering	2	GIR
Total Credit			**19**	

Semester II (January Session)

S No	Code	Course	Credits	Category
1	HSIR11	English for Communication (Theory and lab)	2+2	GIR
2	MAIR22	Complex Analysis and Differential Equations	3	GIR
3	CHIR11	Chemistry	3	GIR
4	CHIR12	Chemistry Lab	2	GIR
5	EEIR15	Introduction to Electrical and Electronics Engineering	2	GIR
6	MEIR12	Engineering Graphics	3	GIR
7	EEPC10	Circuit Theory (Programme Core – I)	4	PC
Total Credit			**21**	

Semester III (July Session)

S No	Code	Course	Credits	Category
1	MAIR32	Fourier Transforms and Numerical Techniques	4	GIR
2	EEPC11	Networks & Linear Systems (Programme Core – II)	4	PC
3	EEPC12	DC Machines & Transformers (Programme Core – III)	4	PC
4	EEPC13	Electron Devices (Programme Core - IV)	3	PC
5	EEPC14	Digital Electronics (Programme Core - V)	3	PC
6	EELR10	Circuits & Digital Laboratory (Laboratory - I)	2	ELR
7	EELR11	DC Machines & Transformers Laboratory (Laboratory - II)	2	ELR
8		Elective – I	3	PE/OE
Total Credit			**25**	

Note: Department(s) to offer Minor (MI) Course, ONLINE Course (OC) and Honors to those willing students in addition to 25 credits.

Semester IV (January Session)

S No	Code	Course	Credits	Category
1	HSIR13	Industrial Economics and Foreign Trade	3	GIR
2	EEPC15	AC Machines (Programme Core – VI)	4	PC
3	EEPC16	Analog Electronic Circuits (Programme Core - VII)	4	PC
4	EEPC17	Transmission & Distribution of Electrical Energy (Programme Core - VIII)	4	PC
5	EELR12	Electronics Circuits Laboratory (Laboratory - III)	2	ELR
6	EELR13	Synchronous & Induction Machines Laboratory (Laboratory - IV)	2	ELR
7		Elective – II	3	PE/OE
8		Elective – III	3	PE/OE
Total Credit			**25**	

Note: Department(s) to offer MI/PE/OE/OC and Honous course as 2/3/4 credits to those willing students in addition to 25 credits.

Semester V (July Session)

S No	Code	Course	Credits	Category
1	EEPC18	Power System Analysis (Programme Core - IX)	4	PC
2	EEPC19	Power Electronics (Programme Core - X)	4	PC
3	EEPC20	Control Systems (Programme Core - XI)	4	PC
4	EEPC21	Linear Integrated Circuits (Programme Core - XII)	3	PC
5	EELR14	Integrated Circuits Laboratory (Laboratory - V)	2	ELR
6	EELR15	Power Electronics Laboratory (Laboratory - VI)	2	ELR
7		Elective – IV	3	PE/OE
8		Elective – V	3	PE/OE
Total Credit			**25**	

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3/4 credits to those willing students in addition to 25 credits.

Semester VI (January Session)

S No	Code	Course	Credits	Category
1	EEIR19	Industrial Lecture	1	GIR
2	EEPC22	Microprocessors & Microcontrollers (Programme Core - XIII)	3	PC
3	EEPC23	Measurements & Instrumentation (Programme Core - XIV)	3	PC
4	EEPC24	Power System Protection & Switchgear (Programme Core - XV)	4	PC
5	EELR16	Microcontroller Laboratory (Laboratory - VII)	2	ELR

6	EELR17	Power Systems Laboratory (Laboratory - VIII)	2	ELR
7	HSIR14	Professional Ethics	3	GIR
8		Elective - VI	3	PE/OE
9		Elective - VII	3	PE/OE
Total Credit			**24**	

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3/4 credits to those willing students in addition to 25 credits.

Semester VII (July Session)

S No	Code	Course	Credits	Category
1	EEIR16	Summer Internship	2	GIR
2		Elective – VIII	3	PE/OE
3		Elective – IX	3	PE/OE
4		Elective – X	3	PE/OE
5		Elective – XI	3	PE/OE
Total Credit			**14**	

Note: Department(s) to offer MI/PE/OE/OC and Honours course as 2/3/4 credits to those willing students in addition to 14 credits.

Semester VIII (January Session)

S No	Code	Course	Credits	Category
1	EEIR18	Comprehensive Viva Voce Examination	1	GIR
2	EEIR17	Project Work	6	Optional
3		Elective – XII	3	PE/OE
4		Elective – XIII	3	PE/OE
5		Elective – XIV	3	PE/OE
Total Credit			**10**	

Note: Department(s) to offer MI/PE/OE/OC and Honours course as 2/3/4 credits to those willing students in addition to 10 credits.
$Optional course

GENERAL INSTITUTE REQUIREMENT

MAIR12 LINEAR ALGEBRA AND CALCULUS
(Common to CSE, EEE, ECE and ICE)

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 3

OBJECTIVES:

1. Introduce vector space and inner product space and it properties.
2. Introduce eigen value and eigen vectors and its properties.
3. Determine canonical form of given quadratic form.
4. Discuss the convergence of infinite series.
5. Analyze and discuss the extrema of the functions of several variables.
6. Evaluate the multiple integrals and apply in solving problems.

COURSE CONTENT:

Vector space – Subspaces – Linear dependence and independence – Spanning of a subspace– Basis and Dimension. Inner product – Inner product spaces – Orthogonal and orthonormal basis – GramSchmidt orthogonalization process. Linear transformation. Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem. Quadratic form

Sequence and series: Convergence of sequence. Infinite Series-Tests for Convergence-Integral test, comparison test, Ratio test, Root test, Raabe's test, Logarithmic test and Leibnitz's test; Power series;

Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor series, Maxima, minima and saddle points; Method of Lagrange multipliers; Double and triple integrals, change of variables, multiple integral in cylindrical and spherical coordinates.

COURSE OUTCOME:

1. Compute eigenvalues and eigenvectors of the given matrix.
2. Identity vector space and its basis.
3. Construct orthonormal basis for a given vector space.
4. Transform given quadratic form into canonical form.
5. Discuss the convergence of infinite series by applying various test.
6. Compute partial derivatives of function of several variables
7. Write taylor's series for functions with two variables.
8. Evaluate multiple integral and its applications in finding area, volume.

REFERENCES:

1. Dennis Zill, Warren S. Wright, Michael R. Cullen, Advanced Engineering Mathematics, Jones & Bartlett Learning, 2011
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2019.
3. Strauss M.J, G.L. Bradley and K.J. Smith, Multivariable Calculus, Prentice Hall, 2002.
4. Ward Cheney, David Kincaid, Linear Algebra: Theory and Applications, Jones & Bartlett Publishers, 2012.

MAIR22 COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS

(Common to CSE, EEE, ECE and ICE)

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --

No. of Credits: 3

OBJECTIVES

The course presents
1. an introduction to analytic functions and power series.
2. various Cauchy' theorems and its applications in evaluation of integral.
3. various approach to find general solution of the ordinary differential equations
4. Laplace transform techniques to find solution of differential equations
5. Partial differential equations and methods to find solution of it.

COURSE CONTENT:

Analytic functions; Cauchy-Riemann equations; Line integral, Cauchy's integral theorem and integral formula (without proof); Taylor's series and Laurent series; Residue theorem (without proof) and its applications.

Higher order linear differential equations with constant coefficients; Second order linear differential equations with variable coefficients; Method of variation of parameters; CauchyEuler equation.

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – solution of ordinary differential equation and simultaneous equations with constant coefficients and integral equations by Laplace Transform.

Formation of partial differential equations by eliminating arbitrary constants and functions – solution of first order equations – four standard types – Lagrange's equation. Method of separation of variables

COURSE OUTCOME

Completion of the course, student will be able to

1. understand analytic functions discuss its properties
2. obtain series representation of analytic functions
3. evaluate various integrals by using Cauchy's residue theorem
4. classify singularities and derive Laurent series expansion
5. find the solutions of first and some higher order ordinary differential equations
6. apply properties of special functions in discussion the solution of ODE.
7. Find Laplace transform of a given function and its inverse Laplace transform.
8. Find solution of first order partial differential equations.

REFERENCES:

1. James Ward Brown, Ruel Vance Churchill, Complex Variables and Applications, McGraw-Hill Higher Education, 2004
2. Dennis Zill, Warren S. Wright, Michael R. Cullen, Advanced Engineering Mathematics, Jones & Bartlett Learning, 2011
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2019.
4. William E. Boyce, Richard C. DiPrima, Douglas B. Meade, Elementary Differential Equations and Boundary Value Problems, Wiley, 2017. 5. Ian N. Sneddon, Elements of Partial Differential Equations, Courier Corporation, 2013

MAIR32 - FOURIER TRANSFORMS AND NUMERICAL TECHNIQUES

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** MAIR12, MAIR22

No. of Credits: 4

1. understand the importance of transform techniques to solve engineering problems.
2. apply Laplace and Fourier transform to solve the mathematical equations arising in mechanical engineering.
3. understand Fourier series analysis and its use in solving boundary value problems.
4. Numerical Methods for Solving Linear Systems
5. Methods to solve equations of One Variable as well as system of equations with two variables.
6. curve fitting for the given data.
7. numerical solution of linear difference equation.

Course Content:

Fourier series - Dirichlet's conditions - Half range Fourier cosine and sine series - Parseval's relation - Fourier series in complex form – Harmonic analysis.

Fourier transforms - Fourier cosine and sine transforms – inverse transforms - convolution theorem and Parseval's identity for Fourier transforms - Finite cosine and sine transforms.

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method for $f(x) = 0$ and for $f(x,y) = 0$, $g(x,y) = 0$ - Order of convergence.
Newton's forward, backward and divided difference interpolation – Lagrange's interpolation –

Curve fitting - Method of least squares and group averages - Least square approximation of functions - solution of linear difference equations with constant coefficients.

Reference Books:

1. Grewal.B.S., Higher Engineering Mathematics, 43rdEdition, Khanna Publisher, Delhi
2. Debnath L., and Dambaru Bhatta, Integral Transforms and Their Applications, 2nd Ed. (Special Indian Ed).Chapman & Hall/CRC, Indian Edtion, 2010
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2010.
4. David Kincaid and Ward Cheney, Numerical Analysis\, 3rd edition, American Mathematics Society, (Indian edition) – 2010.
5. Gerald C.F., and Wheatley P.O., Applied Numerical Analysis, Addison-Wesley Publishing Company, 1994
6. Jain, M.K., Iyengar, S.R. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age international,2003

PHIR11 PHYSICS

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** **--**
No. of Credits: 3

OBJECTIVES:

- To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibers to engineering students.
- To comprehend and explain the concepts of matter waves, wave functions and its interpretation to understand the matter at atomic scale.
- To teach the fundamentals of nuclear forces, models and classification of matter.
- To impart knowledge about the basics of conductors, superconductors, nanomaterials and their applications in science, engineering and technology.

COURSE CONTENT:

Lasers
Introduction to Laser-characteristics of Lasers-Spontaneous and stimulated emissions – Einstein's coefficients – population inversion and lasing action – laser systems: Ruby laser, He-Ne Laser, semiconductor laser-applications.

Fiber Optics
Snell's law-optical fiber – principle and construction – acceptance cone - numerical aperture - types of fibers, fiber optic communication principle – fiber optic sensors-other applications of optical fibers.

Quantum Mechanics:
Inadequacy of classical mechanics-black body radiation, photoelectric effect- wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction – Heisenberg's uncertainty principle – Schrodinger's wave equation – eigen values and eigen functions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential.

Nuclear and Particle Physics:
Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-life. Fundamental forces - Particle physics - classification of matter - quark model.

Physics of Advanced Materials:
Conductors: classical free electron theory (Lorentz –Drude theory) – electrical conductivity. Superconductors: definition – Meissner effect – type I & II superconductors – BCS theory (qualitative). Nanomaterials: introduction and properties – synthesis – top-down and bottom-up approach – applications.

COURSE OUTCOME

1. On completion of this course, the students will be able to,
2. know principle, construction and working of lasers and their applications in various science and engineering.
3. explain light propagation in optical fibers, types and their applications.
4. experience and appreciate the behaviour of matter at atomic scale, and to impart knowledge in solving problems in modern science and engineering.
5. understand the role of nuclear and particle physics in applications like radioactivity and nuclear reactions.
6. recognize, choose and apply knowledge to develop materials for specific applications for common needs.

References

1. William T. Silfvast, Laser Fundamentals, 2nd Edition, Cambridge University press, New York, 2004. 2. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, 6th Edition, John Wiley and Sons, New York, 2001.
3. Arthur Beiser, Concepts of Modern Physics, Tata McGraw-Hill, New Delhi, 2010.
4. R. Shankar, Fundamentals of Physics, Yale University Press, New Haven and London, 2014.
5. R. Shankar, Fundamentals of Physics II, Yale University Press, New Haven and London, 2016.
6. C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley, New Delhi, 2007.
7. Charles Kittel, Introduction to Solid State Physics, 8th Edition, John Wiley & Sons, NJ, USA, 2005.

PHIR12 PHYSICS LAB

Course Type: General Institute Requirement (GIR) *Prerequisite:* --

No. of Credits: 2

OBJECTIVES

- To introduce the spirit of experiments to verify physics concepts such as reflection, refraction, diffraction and interference on light matter interaction.
- To perform experiments to estimate the materials properties and to check their suitability in science and engineering.
- To familiarize physics concepts and to design instruments and experimental set up for better and accurate measurements.
- To teach and apply knowledge to measure and verify the values of certain constants in physics

LABORATORY EXPERIMENTS:

1. Determination of rigidity modulus of a metallic wire
2. Conversion of galvanometer into ammeter and voltmeter
3. Wavelength of laser using diffraction grating
4. Dispersive power of a prism – Spectrometer
5. Radius of curvature of lens-Newton's Rings
6. Numerical aperture of an optical fiber
7. Field along the axis of a Circular coil
8. Wavelength of white light – Spectrometer
9. Calibration of Voltmeter – Potentiometer
10. Thickness of a thin wire – Air Wedge
11. Specific rotation of a liquid – Half Shade Polarimeter
12. Photoelectric effect – Planck's constant

COURSE OUTCOME

On completion of this course, the students will be able to

1. Know how to calibrate a galvanometer and convert it into a current and voltmeters.

2. To make experimental setup to verify certain physics concepts of wave and particle nature of light. 3. Understand the light propagation in fibers, light matter interaction and use of lasers in science and engineering.

4. Acquire knowledge, estimate and suggest materials for engineering applications.

References

1. Physics Laboratory Manual, Department of Physics, National Institute of Technology Tiruchirappalli, 2018.

2. R.K. Shukla, Anchal Srivastava, Practical Physics, New age international, 2011.

3. C.L Arora, B.Sc. Practical Physics, S. Chand & Co., 2012.

CHIR11 - CHEMISTRY

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 3

OBJECTIVES:

To introduce the student's basic principles of Electrochemistry and Corrosion. They will be familiar with phase rule & its applications. Students will know about the essential requirements of water and its importance in day-to-day life. To provide students with a brief outline of the types and applications of polymers. Finally, students will be equipped with the usage of spectroscopy in industrial applications.

COURSE CONTENT

Electrochemistry and Corrosion

Cell EMF- its measurement and applications - concentration cell - electrode electrolyte concentration cell - concentration cell with and without transference - Dry corrosion and wet corrosion, mechanisms, types of corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Passivity, Pitting, Polarization - Chemical conversion coatings and organic coatings- Paints, enamels.

Phase rule

Definition of terms – phase- components- degree of freedom- derivation of Gibbs phase rule – one component system – H2O, CO2, Sulfur – Two-component system – Eutectic systems – reduced phase rule - Pb-Ag system – Compound Formation with congruent melting – Zn- Mg Alloy system- Copper-nickel alloy system - systems with incongruent melting – Na2SO4- H2O system and simple three-component systems.

Water

Sources, Hard & soft water, Estimation of hardness by EDTA method, Scale & Sludge- Caustic embrittlement - softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, internal treatment methods-specifications for drinking water, BIS & WHO standards, treatment of water for domestic use, desalination - Reverse osmosis & Electrodialysis.

Spectroscopy

Interaction of electromagnetic radiation with matter, Electronic spectroscopy - Theory of electronic transitions, instrumentation, Beers Lambert law, Woodward FIESER rule, applications. IR spectroscopy - Fundamentals, Instrumentation, and applications, Raman spectroscopy – Fundamentals and applications.

Polymers and composites

Concept of macromolecules- Tacticity- Classification of Polymers- Types of Polymerization-Mechanism- - Ziegler Natta Polymerization - Effect of Polymer structure on properties -Important addition and condensation polymers –synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering- Rubbers –Vulcanization – Synthetic rubbers – Conducting polymers- Composite materials

COURSE OUTCOMES

- Students will learn about the Electrochemistry and phase rule.
- They will be familiarized with the importance of polymer and its application in industries.
- Additionally, a brief introduction in the area of water, spectroscopy will be very useful for the students in future endeavour

References & Textbooks

1. P.C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company, New Delhi, 2005.
2. P. Atkins, J.D. Paula, *Physical Chemistry*, Oxford University Press, 2002.
3. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Company, 2008
4. F.W. Billmayer, *Textbook of Polymer Science*, 3rd Edison, Wiley. N.Y. 1991.
5. S.S. Darer, S.S. Umare, *A Text Book of Engineering Chemistry*, S. Chand Publishing, 2011.

CHIR12 - CHEMISTRY LAB

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 2

LIST OF EXPERIMENTS

1. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
2. Estimation of dissolved oxygen in the given water sample.
3. Determination of the percentage of Fe in the given steel sample.
4. Estimation of Fe3+ by spectrophotometer.
5. Corrosion rate by polarization technique
6. Conductometric titration
7. Potentiometric titration
8. pH-metric titration
9. Percentage purity of bleaching powder
10. Determination of molecular weight of the polymer by Viscometry
11. Study of three component system.
12. Demonstration experiments using Advanced Spectroscopic Techniques, (UV-Vis, FTIR, Raman)

COURSE OUTCOME

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
- The students will learn how to estimate various components from the corresponding bulk mixture.

Reference Books

1. *Laboratory Manual*, Department of Chemistry, National Institute of Technology, Tiruchirappalli.
2. S.K. Bhasin, S. Rani, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai Publishing Company, New Delhi, 2011.

HSIR13 – INDUSTRIAL ECONOMICS AND FOREIGN TRADE

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

To provide a thorough understanding of the principles of economics that apply to the decisions of individuals and the application of those principles to the world around them and a framework for consistent reasoning about international flows of goods, factors of production, and financial assets, and trade policy.

Course Content:

Demand Analysis and Forecasting: Cardinal Ordinal Approaches. Demand and Supply, Elasticities, Forecasting techniques, Consumer behavior.

Production, Cost, **and Market structure**: Variable proportions, Returns to Scale, Isoquants Analysis, Production Function, Cost Curves, Cost Function, Market Analysis and game theory.

Types, Location, Efficiency and Finance: Mergers & Amalgamations, Location of Industries and Theories, Productivity and Capacity Utilization, Shares, Debentures, Bonds, Deposits, Loan etc., FDI, Foreign Institutional Investment, Euro Issues, GDR, ADR, External Commercial Borrowings.

Introduction: Features of International Trade, Inter-regional and international Trade, Problems of International Trade. Theories:
Terms of Trade- Concept, Measurement, Types, Factors affecting Terms of Trade, Exchange rate.
Free Trade, Protection and Tariffs, Balance of Payments: Free Trade, Protection- Quotas, Dumping, etc., Balance of Trade and Balance of Payments.

Regional Economic Groupings and International Institutions: BRICS, EU, SAARC, OPEC, ASEAN. International Institutions: GATT, WTO, UNCTAD, IBRD, IMF.

Reference Books:

1. *Chauhan,S.P.S., 'Micro Economics, An Advanced Treaties', PHI, 2009.*
2. *Jhingan,M.L, 'International Economics', Vrinda Publications, 2009.*
3. *Francis Charunilam, 'International Economics', Mc-Graw Hill, 5th Edition. 2008.*
4. *Paul, R. Krugman, 'International Economics', Pearson, 2013.*
5. *Kenneth D. George, 'Industrial Organization', Routledge, 2009.*

COURSE OUTCOMES:

Upon completion of this course, the students will be able to understand the principles of economics and International Trade.

HSIR11- ENGLISH FOR COMMUNICATION

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 4

Course Objectives:

- The primary objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for academic and social needs.

Course Content:

Theory: Language and communication-reading strategies: skimming, scanning, inferring, predicting and responding to content – Guessing from context – Note making – Vocabulary extension - speed reading practice – use of extensive reading texts.

Analytical and critical reading practice- critical, creative and lateral thinking- language and thinking – thinking process and language development.

Effective writing practice – Vocabulary expansion - Effective sentences: role of acceptability, appropriateness, brevity & clarity in writing – Cohesion & coherence in writing –Writing of definitions, descriptions - Paragraph writing.

Reciprocal relationship between reading and writing –thinking and writing - Argument Writing practice – Perspectives in writing –professional writing - Narrative writing.

Lab: Listening process & practice – Exposure to recorded & structured talks, class room lectures – Problems in comprehension & retention – Note-taking practice – Listening tests- Importance of listening in the corporate world.

Barriers to listening: Physical & psychological – Steps to overcome them – Purposive listening practice – Active listening and anticipating the speaker – Use of technology to improve the skill.

Fluency & accuracy in speech –Improving self-expression – Tonal variations – Listener oriented speaking - Group discussion practice – Interpersonal Conversation -Developing persuasive speaking skills.

Barriers to speaking – Building self-confidence & fluency – Conversation practice- Improving responding capacity - Extempore speech practice – Speech assessment.

COURSE OUTCOMES:

The students will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.

Reference Books:

1. *M. Ashraf Rizvi 'Effective Technical Communication', Tata McGraw-Hill, New Delhi, 2005.*
2. Strunk, William, and E B. White, *The Elements of Style*. Boston: Allyn and Bacon, Pearson Edition, 1999.
3. Garner, Bryan A, *HBR Guide to Better Business Writing*, Hardvard Business Review Press, Boston, Massachusetts, 2013.

ENIR11 - ENERGY AND ENVIRONMENTAL ENGINEERING

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 2

Course Objectives:

- To teach the principal renewable energy systems.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

Course Content:

Present Energy resources in India and its sustainability - Different type of conventional Power Plant--Energy Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants – Conventional vs Non-conventional power generation.

Basics of Solar Energy- Solar Thermal Energy- Solar Photovoltaic- Advantages and Disadvantages-Environmental impacts and safety.

Power and energy from wind turbines- India's wind energy potential- Types of wind turbines- Off shore Wind energy- Environmental benefits and impacts.

Biomass resources-Biomass conversion Technologies- Feedstock preprocessing and treatment methods- Bio energy program in India-Environmental benefits and impacts.

Geothermal Energy resources –Ocean Thermal Energy Conversion – Tidal.

Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water pollution-Sources and impacts, Soil pollution-Sources and impacts, disposal of solid waste.

Greenhouse gases – effect, acid rain. Noise pollution. Pollution aspects of various power plants. Fossil fuels and impacts, Industrial and transport emissions- impacts.

COURSE OUTCOMES:

Students will be introduced to the Principal renewable energy systems and explore the environmental impact of various energy sources and also the effects of different types of pollutants.

Reference Books:

1. *Boyle, G. ' Renewable Energy: Power for a Sustainable Future', Oxford University Press, 2004.*
2. *B H Khan, 'Non Conventional Energy Resources' The McGraw –Hill Second Edition.*
3. *G. D. Rai, 'Non Conventional Energy Sources', Khanna Publishers, New Delhi, 2006.*
4. *Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd Edition, Prentice Hall, 2003.*
5. *G Sargsyam, M Bhatia, S G Banerjee, K Raghunathan and R Soni, Unleashing the Potential of Renewable Energy in India, World bank report, Washington D.C, 2011.*
6. *Godfrey Boyle, Bob Everett and Janet Ramage. 'Energy Systems and Sustainability, Power for a sustainable future'. Oxford University Press, 2010.*

HSIR14 - PROFESSIONAL ETHICS

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** **--**
No. of Credits: 3

Course Objectives:

- Identify the core values that shape the ethical behavior of an engineer.
- To create an awareness on professional ethics and Human Values
- To appreciate the rights of others

Course Content:

UNIT 1: HUMAN VALUES
Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Co-operation – Commitment – Empathy – Self-confidence – Character – Spirituality – The role of engineers in modern society – Social expectations.

UNIT II: ENGINEERING ETHICS
Sense of 'Engineering Ethics' – Variety of moral issued – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of Professional Roles & Professionalism – theories about right action – Self-interest – customs and religion – uses of ethical theories.

UNIT III: ENGINEERING AS SOCIAL EXPERIMENTATION
Engineering as experimentation – engineers as responsible experimenters – Research ethics – Codes of ethics – Industrial Standard – Balanced outlook on law – the challenger case study.

UNIT IV: SAFETY, RESPONSIBILITIES AND RIGHTS
Safety and risk – assessment of safety and risk – Riysis – Risk benefit analysis and reducing risk – Govt. Regulator's approach to risks – the three mile island and Chernobyl case studies & Bhopal – Threat of Nuclear Power, depletion of ozone, greenery effects – Collegiality and loyalty – respect for authority – collective bargaining – Confidentiality – conflicts of interest – occupation crime – professional rights – employees' rights – Intellectual Property Rights (IPR) – discrimination.

UNIT V: GLOBAL ISSUES
Multinational corporations – Business ethics – Environmental ethics – computer ethics – Role in Technological Development – Weapons development – engineers as managers – consulting engineers – engineers as expert, witnesses and advisors – Honesty – Leadership – sample code of conduct ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE), India, etc.,

Textbooks:

1. *Mika Martin and Roland Scinger, 'Ethics in Engineeering', Pearson Education/Prentice Hall, New York 1996.*

2. *Govindarajan M., Natarajan S., Senthil Kumar V. S., 'Engineering Ethics' Prentice Hall of India, New Delhi, 2004.*

3. *Charles D. Fleddermann, 'Ethics in Engineering', Pearson Education/Prentice Hall, New Jersey, 2004 (Indian Reprint).*

4. *Charles E. Harris, Michael S. Protchard and Michael J. Rabins, 'Engineering Ethics – Concept and Cases', Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available).*

5. *'Concepts and Cases', Thompson Learning (2000).*

6. *John R. Boatright, 'Ethics and Conduct of Business', Pearson Education, New Delhi, 2003.*

7. *Edmund G. Seebauer and Robert L. Barry, 'Fundamentals of Ethics for Scientists and Engineers', Oxford University of Press, Oxford, 2001.*

COURSE OUTCOMES:

Upon completion of this course, the students should have understood the core values that shape the ethical behavior of an engineer, and they have exposed an awareness on professional ethics and human values.

MEIR12 - ENGINEERING GRAPHICS

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

- Irrespective of engineering discipline, it has become mandatory to know the basics of Engineering graphics. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.
- Provide neat structure of industrial drawing.
- Enables the knowledge about position of the component and its forms Interpretation of technical graphics assemblies.
- Preparation of machine components and related parts.

Course Content :

Fundamentals Drawing standard - BIS, dimensioning, lettering, type of lines, scaling- conventions.

Orthographic projection: Introduction to orthographic projection, drawing orthographic views of objects from their isometric views - Orthographic projections of points lying in four quadrants.

Orthographic projection of lines parallel and inclined to one or both planes Orthographic projection of planes inclined to one or both planes. Projections of simple solids - axis perpendicular to HP, axis perpendicular to VP and axis inclined to one or both planes.

Sectioning of solids: Section planes perpendicular to one plane and parallel or inclined to other plane.

Intersection of surfaces: Intersection of cylinder & cylinder, intersection of cylinder & cone, and intersection of prisms.

Development of surfaces: Development of prisms, pyramids and cylindrical & conical surfaces.

Isometric and perspective projection: Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection.

COURSE OUTCOMES:

- At the end of the course the students will be able to visualize the engineering components. A number of chosen problems will be solved to illustrate the concepts clearly.

Reference Books:

1. *Bhatt, N. D. and Panchal, V.M, Engineering Drawing, Charotar Publishing House, 2010.*
2. *Ken Morling, Geometric and Engineering Drawing, 3rd Edition, Elsevier, 2010*
3. *Jolhe, D. A., Engineering drawing, Tata McGraw Hill, 2008*
4. *Shah, M. B. and Rana, B. C., Engineering Drawing, Pearson Education, 2009*
5. *K.V. Natarajan, A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006.*

PRIR11 - ENGINEERING PRACTICE

Course Type: General Institute Requirement (GIR) ***Pre-requisites*:** --
***No. of Credits*:** 2

Course Objectives:

- To use hand tools and machinery in Carpentry, welding shop, Foundry, Fitting shop and Sheet Metal work.
- To manufacture engineering products or prototypes.

Course Content:

Foundry: Mould preparation for Flange and Hand Wheel, Plastic moulding / Wax moulding.

Welding: Fabrication of Butt Joint and Fabrication of Lap Joint.

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make; Tee Through Halving Joint and Dovetail Scarf Joint.

Fitting: Preparation of joints, markings, cutting and filling for making; Semi-circle part with the given work piece, Dovetail part with the given work piece.

Sheet metal: Fabrication of Dust Pan and Fabrication of Corner Tray.

COURSE OUTCOME

1. Know to utilize hand tools and machineries in Carpentry, Welding shop, Foundry, Fitting shop and Sheet Metal work.
2. Produce simple engineering products or prototypes

References

1. R.K. Rajput, *Workshop Practice*, Laxmi Publications (P) Limited, 2009.
2. Shashi Kant Yadav, *Workshop Practice*, Discovery Publishing House, New Delhi, 2006.

CEIR11 – BASIC CIVIL ENGINEERING

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 2

Course Objectives:

- To give an overview of the fundamentals of the Civil Engineering fields to the students of all branches of Engineering.
- To realize the importance of the Civil Engineering Profession in fulfilling societal needs.

Course Content:

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations - Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.

Roads-Classification of Rural and urban Roads- Pavement Materials-Traffic signs and road marking-Traffic Signals.

Surveying -Classification-Chain Survey- Ranging - Compass Survey - exhibition of different survey equipment.

Sources of Water - Dams- Water Supply-Quality of Water-Waste water Treatment – Sea Water Intrusion – Recharge of Ground Water.

COURSE OUTCOMES:

1. The students will gain knowledge on site selection, construction materials, components of buildings, roads and water resources.
2. A basic appreciation of multidisciplinary approach when involved in Civil-Related Projects.

Reference Books:

1. *Punmia, B.C, Ashok Kumar Jain, Arun Kumar Jain, 'Basic Civil Engineering', Lakshmi Publishers, 2012.*
2. *SatheeshGopi, 'Basic Civil Engineering', Pearson Publishers, 2009.*
3. *Rangwala, S.C, 'Building materials', Charotar Publishing House, Pvt. Limited, Edition 27, 2009.*
4. *Palanichamy,M.S, 'Basic Civil Engineering', Tata Mc Graw Hill, 2000.*
5. *Lecture notes prepared by Department of Civil Engineering, NITT.*

MEIR11 - BASIC MECHANICAL ENGINEERING

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 2

Course Objectives:

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and automobile systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

Course Content:

Introduction to Mechanical Engineering, Thermal Engineering, Design, manufacturing Engineering.

IC Engines – 2 Stroke and 4 stroke systems in IC Engines. Automobiles - Transmission systems, Suspension system, E-Vehicles.

Energy Systems - Power plants, Types, Gas Turbines, Steam Turbines, Utility boilers, R & A/C system- Green Energy production and Devices.

Engineering materials, Machine elements, Transmission, Fasteners, Support systems.

Manufacturing, Classification, Metal forming, Casting, Lathe, Drilling machines, Milling machines, Metal joining.

COURSE OUTCOMES:

At the end of the course, students will be able

1. To identify the basic concept and fundamentals of mechanical engineering.
2. To understand the working principle of IC engines and Energy systems.
3. To appreciate the process and materials involved in the manufacture of various machine element components.

Reference Books:

1. Basant Agarwal and C.M. Agarwal, *Basic Mechanical Engineering*, Wiley India Pvt. Ltd., 2008.
2. Sadhu Singh, *Basic Mechanical Engineering*, S. Chand & Company Limited, 2009.
3. P.K. Nag, Karthikeya Tripathi, C.S. Pawar, *Basic Mechanical Engineering*, Tata McGraw Hill Publishing Company, 2009.
4. Lecture notes prepared by Department of Mechanical Engineering, NITT, 2018.

CSIR12 – INTRODUCTION TO COMPUTER PROGRAMMING

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

- To learn the fundamentals of computers.
- To learn the problem-solving techniques writing algorithms and procedures.
- To learn the syntax and semantics for C programming language.
- To develop the C code for simple logic.
- To understand the constructs of structured programming including conditionals and iterations.

Course Content:

Introduction to computers - Types of programming languages- Developing a program - Algorithms-Characteristics- Flow Charts- Principles of structured programming- Sequential selecting structures- Repetitive Structures-Bounded, Unbounded and Infinite iterations.

Introduction to C- C character set- Identifiers and Keywords- Data types- Constants- Variables- Declarations-Expressions- Statements- Symbolic Constants- Operators- Library Functions- Data input and output: Single character input and output- Entering input data- Writing output data- gets and puts functions - Control Statements-Branching: if-else-looping: while- do-while-for; Nested control Structures- switch statements- Break statements-Continue Statements- Comma operator- goto statements.

Modular Programming- Functions and Procedures - Examples- Parameters passing methods - Arrays- Defining an array- Processing an array- Multi dimensional arrays- Pointers- Variables definitions and initializations-Pointer operators- Pointer expressions and arithmetic- Pointers and one dimensional arrays - String operations.

Functions- Defining function- Accessing a function- Function prototypes- Passing arguments to a functions-Passing arrays to a function- Passing Pointers to function- Recursion – Dynamic memory allocation - malloc, calloc, realloc – Structures – Declaration – Structures and Functions – Arrays of Structures – Pointers to structures – Typedef - Unions – Bit-fields.

Files – Input / Output using files – fread, fwrite, fprintf, fscanf – Formatted input – File access - argc, argv.

COURSE OUTCOMES:

1. Ability to write algorithms for problems
2. Knowledge of the syntax and semantics of C programming language
3. Ability to code a given logic in C language
4. Knowledge in using C language for solving problems

Reference Books:

1.Byron Gottfried, *Programming with C*, 3rd Edition, Tata McGraw Hill Education, 2010.
2. R.G. Dromey, H*ow to solve it by Computers?* Prentice Hall, 2011.
3. Brian W Kernighan and Dennis Ritchie, *The C Programming language*, 2nd Edition, Prentice Hall, 1988.
4. J.R.Hanly and E.B. Koffmann, *Problem Solving and Program design in C*, 6th Edition, Pearson Education, 2009.
5. Paul Deital and Harvey Deital, *C How to Program*? 7th Edition, Prentice Hall, 2012.
6. YashvantKanetkar, *Let Us C*, 12th Edition, BPB Publications, 2012.

EEIR15 – INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** **--**
No. of Credits: 2

Course Objectives:

- This course facilitates the students to get a comprehensive exposure to electrical and electronics engineering.

Course Content:

History, major inventions, scope, significance and job opportunities in electrical and electronics engineering, brief overview of various energy resources.

Basics of energy conversion, Power apparatus used in power generation, transmission and distribution, Power apparatus used in various industries.

Basic ideas about utility supply, electrical tariff, energy audit and importance of energy saving.

Introduction to different types of electrical circuits, house wiring, electronic circuits for signal processing, specifications of electronic components.

Brief overview of curriculum, laboratories and various software packages, electronic testing and measuring equipment.

Reference Books:

1. *Clayton Paul, Syed A Nasar and Louis Unnewehr, 'Introduction to Electrical Engineering', 2nd Edition, McGraw-Hill, 1992.*
2. *Kothari D.P. & Nagrath I.J., 'Basic Electrical Engineering', 2nd Edition, Tata McGraw-Hill, 2001.*
3. *P.S. Dhogal, 'Basic Electrical Engineering – Vol. I& II', 42nd Reprint, McGraw-Hill, 2012.*

COURSE OUTCOMES:

The students shall develop an insightful knowledge on various fundamental elements of electrical and electronics engineering.

PROGRAMME CORE

EEPC10 - CIRCUIT THEORY

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR12
No. of Credits: 4

Course Objectives:

To provide the key concepts and tools in a logical sequence to analyze and understand electrical and electronic circuits.

Course Content:

Fundamental concepts of R, L and C elements, DC circuits, series and parallel circuits - loop and nodal analysis, AC circuits - complex impedance - phasor diagram, real and reactive power - loop and nodal analysis applied to AC circuits.

Voltage source –current source transformations, Various Network theorems and applications to dc and ac circuits, star-delta transformations.

Resonance in series and parallel circuits, self and mutual inductances, coefficient of coupling - dot convention - analysis of coupled circuits.

Three-phase star and delta circuits with balanced and unbalanced loads - power measurements - power factor calculations.

Time response of RL, RC and RLC circuits for step and sinusoidal inputs.

Textbooks:

1. *Hayt, W. H, Kemmerly J. E. & Durbin, 'Engineering Circuit Analysis', McGraw Hill Publications, 8th Edition, 2013.*
2. *Charles K. Alexander, Matthew N.O.Sadiku, 'Fundamentals of Electric Circuits', McGraw-Hill Publications, 5th Edition, 2013.*

Reference Books:

1. *Joseph. A. Edminister, 'Electric Circuits - Schaum's Outline Series', McGraw-Hill Publications, 6th Edition, 2003.*
2. *Robins & Miller, 'Circuit Analysis Theory and Practice', Delmar Publishers, 5th Edition, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. apply mesh and nodal analysis techniques and solve simple dc and single-phase ac circuits in steady state.
2. apply network theorems to solve dc and ac circuits with single or multiple independent and dependent sources.
3. analyze the phenomena of resonance in series-parallel circuits and solve simple electro-magnetic circuits.
4. perform computations needed in three-phase circuits in steady state
5. compute the transient and steady-state responses of simple dc and ac circuits.

EEPC11 - NETWORKS AND LINEAR SYSTEMS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC10
No. of Credits: 4

Course Objectives:

To emphasize the relationship between the conceptual understanding and problem-solving approach for (i) analyzing the electric circuit/system excited with non-sinusoidal and non-periodic source, (ii) one-port and two- port networks, (iii) system modeling and simplifications, (iv) transfer function, state- space analysis and z-transform analysis.

Course Content :

Frequency response - Fourier series - Harmonic analysis of simple circuits – Fourier integral - Fourier transforms – application to simple circuits.

Classification of signals – representation in terms of elementary signals - impulse functions - Time response of circuits - complex frequency - poles and zeros - frequency response from pole-zero configuration – Driving point impedances - two-port networks.

Differential equation of translational and rotational systems - transfer function modeling for simple electrical and mechanical systems-open loop and closed loop systems - block diagram representation -Block diagram algebra - signal flow graph - Mason's gain formula.

Concepts of state and state variables – state space modeling for simple electrical and mechanical systems – state transition matrix - solution of state equations.

Introduction to discrete time system – difference equations – z-transforms – inverse z-transforms for typical signals – pulse transfer function – solution of difference equation – stability analysis.

Text Books:

1. *D. Roy Choudhury, 'Networks and Systems', New Age International Publications, 1st Edition, 2013.*
2. *James W. Nilsson and Susan A. Riedel, 'Electric Circuits', Pearson Education Publications, 9th Edition, 2011.*
3. *F.F.Kuo, 'Network Analysis and Synthesis', John Wiley Inc Publications, 2nd Edition, 2010.*
4. *M.E. Van Valkenburg, 'Network Analysis', PHI Learning Publications, 3rd Edition, 2014.*

Reference Books:

1. *Cheng.D. K, 'Analysis of Linear System', Addison Wesley Publications, Revised Edition, 2009.*
2. *William D. Stanley, 'Network Analysis with Applications', Pearson Education Publication, 2009.*
3. *Hayt, W. H, Kemmerly J. E. & Durbin, 'Engineering Circuit Analysis', McGraw Hill Publications, 8th Edition, 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the significance of Fourier series and Fourier Transform and apply them for typical electrical systems.
2. Apply Laplace Transform for typical circuits and be able to determine the two-port network parameters.
3. Model the systems in transfer function and state-space domains and analyze the system using these models.
4. Apply Z-transforms for the analysis of discrete time systems.

EEPC12 - DC MACHINES AND TRANSFORMERS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC10
No. of Credits: 4

Course Objectives:

This course aims to equip the students with a basic understanding of DC machines and Transformer fundamentals, machine parts and help to gain the skills for operating DC machines and Transformers . The course also equips students with ability to understand and analyze the equivalent circuits of DC machines and Transformers.

Course Content:

Principles of Energy conversion – basic magnetic circuit analysis, Faraday's law of electromagnetic induction – singly and doubly excited magnetic field systems – torque production in rotating machines and general analysis of electro mechanical system.

DC Generator – construction, principle of operation – emf equation– types, Characteristics, commutation - armature reaction.

DC motor – principle of operation – torque equation – types – electrical & mechanical characteristics–starting – speed control – various testing – braking.

Transformers – principle of operation – types – basic construction – equivalent circuit - regulation and efficiency – auto transformer.

Three-phase transformer connection-Scott connection – all day efficiency - Sumpner's test - parallel operation of transformers.

Textbooks:

1. *Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.*
2. *Nagrath, I.J. and Kothari, D.P., 'Electrical Machines', Tata McGraw-Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.*

Reference Books:

1. *A.E. Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw-Hill Education Publications, 6th Edition, 2002.*
2. *Vincent Del Toro, 'Electrical Engineering Fundamentals', 2nd Edition, Prentice Hall Publications, 2003.*
3. *Parker Smith, N.N., 'Parker Smith's Problems in Electrical Engineering', 9th Edition, CBS Publishers and Distributers, 9th Edition, 2003.*

COURSE OUTCOMES:

Upon the completion of the course, the student will be able to

1. Understand various properties and applications of magnetic circuits in linear and rotational systems.
2. Understand constructional details and principles of DC machines and transformers.
3. Analyze the performance parameters/characteristics of the DC machines under various operating conditions through proper testing
4. Evaluate the performance of single-phase transformer using equivalent circuits and phasor diagrams
5. Understand various connection and performance testing of various transformers

EEPC13 - ELECTRON DEVICES

Course Type: Programme Core (PC) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

To educate on the construction and working of common electronic devices and to prepare for application areas.

Course Content:

Semi-conductors – charge carriers, electrons and holes in intrinsic and extrinsic semi-conductors –Hall effect.

Diodes – PN junction – current equation – Junction Capacitance – breakdown characteristics of Zener diode, Tunnel diode, Schottky diode.

Bipolar junction transistors – Characteristics – Analysis of CB, CE, CC amplifier configurations.

Unipolar devices – FET, MOSFET, UJT and Opto-Electronic devices – theory and characteristics.

Rectifiers and switched mode power supplies – theory and design, filter circuits, applications.

Textbooks:

1. *David, A. Bell, 'Electronic Devices and Circuits', PHI, 5th Edition, 2008.*
2. *Millman and Halkias 'Electronic Devices and Circuits', McGraw - Hill International Student, 2nd Edition, 2007.*
3. *Robert L. Boylestad and Louis Nashelsky, 'Electronic Devices and Circuit Theory', Pearson Prentice Hall, 10th Edition, 2009.*
4. *Thomas L. Floyd, 'Electronic Devices', Pearson Education Limited, 9th Edition, 2013.*

Reference Books:

1. *Allen Mottershead, 'Electronic Devices and Circuits - An Introduction', PHI, 18th Reprint, 2010.*
2. *Albert Malvino and David J Bates, 'Electronic Principles', McGraw Hill, 7th Edition, 2007.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Understand the semiconductor physics of the intrinsic, p and n materials and various devices and characteristics.
2. Analyze simple diode circuits under DC and AC excitation.
3. Analyze and design simple amplifier circuits using BJT in CE, CC and CB configurations.
4. Understand the analysis and salient features of CE, CC & CB amplifier circuits.
5. Understand the construction and characteristics of FET, MOSFET and UJT.

EEPC14 - DIGITAL ELECTRONICS

Course Type: Programme Core (PC) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

This subject exposes the student to digital fundamentals.

Course Content:

Review of number systems, binary codes, error detection and correction codes. Digital Logic Families – MOS Logic Circuits. Combinational logic representation of logic functions – SOP and POS forms, K-map representations – minimization using K-maps

Simplification and implementation of combinational logic – multiplexers and demultiplexers – Decoder and Encoder – Priority Encoder - code converters, adders, subtractors, magnitude comparator. Memory units – Types of memory units – RAM and ROM – Importance of memory units – Programmable Logic device (PLD) and its types.

Sequential logic- SR, JK, D and T flip-flops – level triggering and edge triggering – counters – Pulse forming circuits - asynchronous and synchronous type – Modulo counters – Shift registers – Ring counters.

Synchronous Sequential Logic circuits - state table and excitation tables - state diagrams - Moore and Mealy models - design of counters - analysis of synchronous sequential logic circuits - state reduction and state assignment – Sequence detector

Asynchronous sequential logic circuits-Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – implication table – Races and hazards in logic circuits - Introduction to Hardware Description Languages – VHDL – Modeling styles.

Textbooks:

1. *Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.*
2. *Anil K. Maini, "Digital Electronics: Principles, Devices and Applications", Wiley, 1st Edition, 2007.*
3. *Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2015.*

Reference Books:

1. *Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.*
2. *Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Interpret, convert and represent different number systems and Simplify the Boolean expressions for digital design.
2. Manipulate and examine Boolean algebra, logic operations and design Combinational logic circuits.
3. Design the basic components for the sequential logic circuits.
4. Analyse the synchronous sequential logic ciruits.
5. Evaluate the Asynchronous sequential logic circuits.

EEPC15 - AC MACHINES

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC12
No. of Credits: 4

Course Objectives:

This course provides a basic understanding of AC machinery fundamentals, machine parts and helps to gain the skills for operating AC machines. The course also equips students with ability to understand and analyse the phasor diagrams and equivalent circuits of AC Induction and Synchronous Machines.

Course Content:

Alternators – construction, principle and types - armature reaction - load characteristics – voltage regulation – two-reaction theory – parallel operation.

Synchronous motors - Synchronous machines on infinite bus bars - phasor diagram - V and inverted-V curves - Hunting and its suppression - starting methods.

Poly-phase induction motors - construction, principle and types – no-load and load characteristics – no-load and blocked rotor test - equivalent circuit – circle diagram.

Poly-phase induction motors - Starting and speed control methods – Braking methods. Induction generators – types, principle of operation, equivalent circuit and applications.

Single-phase induction motors - construction, principle and types - double revolving field theory – equivalent circuit. Permanent magnet brushless motors – construction, principle and types – torque equation.

Textbooks:

1. *Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.*
2. *Nagrath, I.J. and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.*
3. *M. G. Say, 'Performance and Design of Alternating Current Machines', CBS Publishers & Distributors Pvt. Ltd., New Delhi, 3rd Edition, 2002.*

Reference Books:

1. *Arthur Eugene Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw Hill Education Publications, 6th Edition, 2002.*
2. *Miller, T.J.E., 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press-Oxford, 1989.*
3. *Parkar Smith, N.N., 'Problems in Electrical Engineering', CBS Publishers and Distributers, 9th Edition, 1984.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the constructional details and principle of operation of AC Induction and Synchronous Machines.
2. Understand and appraise the principle of operation and performance of single-phase induction motors and other special motors.
3. Analyze the performance of the AC Induction and Synchronous Machines using the phasor diagrams and equivalent circuits.
4. Select appropriate AC machine for any application and appraise its significance.

EEPC16 - ANALOG ELECTRONIC CIRCUITS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC13
No. of Credits: 4

Course Objectives:

To give a comprehensive exposure to all types of amplifiers and oscillators constructed with discrete components such as BJTs and FETs. This helps to develop a strong basis for building linear and digital integrated circuits.

Course Content:

Small signal amplifiers - biasing circuits of BJT and FET transistors, analysis and design of BJT and FET amplifiers, chopper stabilized amplifiers, case studies – application of current amplifiers in SCR firing circuits and power supplies.

Large signal amplifiers – analysis and design of class A and class B power amplifiers, class C and class D amplifiers, thermal considerations, tuned amplifiers.

Feedback amplifiers – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers, case studies – application of negative feedback in dc-dc converters.

Oscillators – Barkhausen criterion for oscillation – Hartley & Colpitt's oscillators – phase shift, Wien bridge and crystal oscillators - Clapp oscillator – oscillator amplitude stabilization.

Pulse circuits – attenuators – RC integrator and differentiator circuits – diode clampers and clippers – multivibrators - Schmitt Trigger- UJT Oscillator, case studies – application of UJT oscillator in SCR firing circuits and opto-electronic control circuits.

Textbooks:

1. *Jacob Millman, 'Microelectronics', McGraw Hill, 2nd Edition, Reprinted, 2009.*
2. *David A Bell, 'Fundamentals of Electronic Devices and Circuits', Oxford University Press, Incorporated, 2009.*
3. *Allen Mottershead, 'Electronic Devices and Circuits-An Introduction', PHI, 18th Reprint, 2006.*

Reference Books:

1. *Thomas L. Floyd, David M. Buchla, 'Electronics Fundamentals', Pearson Prentice Hall, 7th Edition, 2010.*
2. *Robert.L.Boylestad, 'Electronic Devices and Circuit Theory', Pearson, 10th Edition, 2009.*
3. *Sedra Smith, 'Microelectronic Circuits', Oxford University Press, 6th Edition, 2010.*
4. *Jacob Millman and Christos C. Halkias, 'Integrated Electronics: Analog and Digital Circuits and Systems', 2nd Edition, Tata McGraw Hill Education, 2011.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the working of different types of amplifiers, oscillator and multivibrator circuits.
2. Design BJT and FET amplifier and oscillator circuits.
3. Analyze transistorized amplifier and oscillator circuits.
4. Understand the applications of different types of amplifiers, oscillator, attenuators and multivibrator circuits.

EEPC17 - TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC10
No. of Credits: 4

Course Objectives:

- Identify major components of power transmission and distribution systems.
- Describe the principle of operation of transmission and distribution equipment.
- Know and appreciate the key factors in transmission and distribution system equipment specification and network design.

Course Content:

Transmission line parameters – Resistance, Inductance and Capacitance calculations – Single-phase and three-phase lines – double circuit lines – effect of earth on transmission line capacitance.

Performance of transmission lines – Regulation and efficiency – Tuned power lines, Power flow through a transmission line – Power circle diagrams, Introduction to Transmission loss and Formation of corona – critical voltages – effect on line performance – travelling waveform phenomena.

Mechanical design of overhead lines – Line supports – Insulators, Voltage distribution in suspension insulators – Testing of insulators – string efficiency – Stress and sag calculation – effects of wind and ice loading.

Underground cables – Comparison with overhead line – Types of cables – insulation resistance –potential gradient – capacitance of single-core and three-core cables.

Distribution systems – General aspects – Kelvin's Law – A.C. distribution – Single-phase and three phase – Techniques of voltage control and power factor improvement – Introduction to Distribution loss – Recent trends in transmission and distribution systems.

Textbooks:

1. *D.P.Kothari and I.J. Nagrath, 'Power System Engineering', Tata McGraw–Hill, 2nd Edition, 2008.*
2. *Gupta B.R, 'Power System Analysis & Design', S.Chand and Company Ltd., 5th Edition, 2001.*
3. *John .J. Grainger & Stevenson. W. D., 'Power System Analysis', McGraw-Hill, 1st Edition, 2003.*

Reference Books:

1. *Turan Gonen, 'Electric Power Distribution System Engineering', CRC Press INC, 2nd Edition 2007.*
2. *'Electrical Transmission and Distribution Reference Book', Westinghouse Electric Corporation, 4th Edition 2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will

1. Understand the major components of Transmission and Distribution Systems (TDS) and its practical significance.
2. Have good knowledge of various equipment specifications and design for TDS.
3. Have awareness of latest technologies in the field of electrical transmission and distribution.

EEPC18 - POWER SYSTEM ANALYSIS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR32, EEPC10
No. of Credits: 4

Course Objectives:

To model various power system components and carry out load flow, short-circuit and stability studies.

Course Content:

Modeling of power system components – single line diagram – per unit quantities– bus impedance and admittance matrix.

Power flow analysis methods – Gauss-Seidel, Newton-Raphson and Fast decoupled methods of load flow analysis.

Fault studies – Symmetrical fault analysis, Analysis through impedance matrix, Current limiting reactors.

Fault analysis - Unsymmetrical short circuit analysis - LG, LL, LLG; Fault parameter calculations – Open circuit faults.

Stability studies – Steady state and transient stability– Swing equation - Equal area criterion – multi-machine stability analysis.

Textbooks:

1. *John .J. Grainger & Stevenson.W.D., 'Power System Analysis', McGraw Hill, 1st Edition, 2003.*
2. *D P Kothari, I J Nagrath 'Modern Power System Analysis', 3rd Edition, 2011.*
3. *Hadi Saadat, 'Power System Analysis ', Tata McGraw-Hill Education, 2nd Edition, 2002.*

Reference Books:

1. *J. Duncan Glover, M.S.Sarma & Thomas J. Overbye, 'Power System Analysis and Design', Cengage Learning, 5th Edition, 2011.*
2. *J.C.Das, 'Power System Analysis, 'Short-Circuit Load Flow and Harmonics', Marcel Dekker Inc., 1st Edition, 2002.*
3. *Arthur R. Bergen, 'Power System Analysis', Pearson Education India, 2nd Edition, 2009.*
4. *Gupta B.R., 'Power system Analysis & Design', S.Chand and Company Ltd., 5th Edition, 2001.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Carry out load flow study of a practical system.
2. Simulate and analyze fault.
3. Study the stability of power systems.

EEPC19 - POWER ELECTRONICS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR32, EEPC10 & EEPC13
No. of Credits: 4

Course Objectives:

This course aims to equip the students with a basic understanding of modern power semiconductor devices, various important topologies of power converter circuits for specific types of applications. The course also equips students with an ability to understand and analyze non-linear circuits involving power electronic converters.

Course Content:

Power Semiconductor Devices –power diodes, power transistors, SCRs, TRIAC, GTO, power MOSFETs, IGBTs-Principles of operation, characteristics, ratings, protection and gate drive circuits.

Controlled rectifiers- single- phase and three-phase- power factor improvement - dual converters.

DC-DC converters- Buck, Boost, Buck-Boost- with circuit configuration and analysis.

DC-AC converters- single-phase/three-phase, VSI, CSI, frequency and voltage control.

AC-AC converters- single/three-phase controllers, phase control, PWM AC voltage controller, Principle of ON-OFF control and cyclo-converters.

Textbooks:

1. *Rashid, M.H, 'Power Electronics - Circuits, Devices and Applications', Prentice Hall Publications, 3rd Edition, 2003.*
2. *M.D.Singh and K.B.Kanchandhani, 'Power Electronics', Tata McGraw-Hill Publishing Company Limited, 2nd Edition, 2006.*
3. *Ned Mohan, Tore M. Undeland, William P. Robbins, 'Power Electronics', John Wiley & Sons Publications, 3rd Edition, 2006.*

Reference Books:

1. *Vedam Subramaniam, 'Power Electronics', New Age International (P) Ltd Publishers, 2001.*
2. *Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, 1st Edition, 2012.*
3. *V.R.Moorthi, 'Power Electronics- Devices, Circuits and Industrial Applications', Oxford University Press, 1st Edition, 2005.*
4. *P.S. Bimbhra, 'Power Electronics', Khanna Publishers, 3rd Edition, 13th Reprint, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the principle of operation of commonly employed power electronic converters.
2. Analyze non-linear circuits with several power electronic switches.
3. Equipped to take up advanced courses in Power Electronics and its application areas.

EEPC20 - CONTROL SYSTEMS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR32
No. of Credits: 4

Course Objectives:

To equip the students with the fundamental concepts in control systems.

Course Content:

Modelling of physical systems: Electrical systems - Electromechanical systems – Mechanical systems – Transfer function and state space models – Block Diagram Reduction – Signal Flow Graph

Time domain analysis - Time-domain specifications - Generalized error series – various test signals and its importance - Routh-Hurwitz stability criterion – Frequency Domain Analysis – Bode plot

Stability Analysis – BIBO stability – Nyquist stability – Routh-Hurwitz stability criterion – Stability Margin – Internal Stability

Controller design: Design of P, PI, PID using root locus technique, lag, lead, lead-lag compensator design – Controllability – State Feedback Controller Design

Textbooks:

1. *Katsuhiko Ogata, 'Modern Control Engineering', Pearson Education Publishers, 5th Edition, 2010.*
2. *Nagrath I.J. and Gopal M, 'Control Systems Engineering', New Age International Publications, 5th Edition, 2010.*
3. *Benjamin C. Kuo and Farid Golnaraghi, 'Automatic Control Systems', John Wiley & Sons Publications, 8th Edition, 2002.*
4. *Chi-Tsong Chen, 'Linear System Theory and Design', Oxford University Press, Fourth Edition 2014*
5. *Norman S. Nise, 'Control Systems Engineering', John Wiley & Sons, Eighth Edition, 2019*

Reference Books:

1. *Richard C. Dorf and Robert H. Bishop. 'Modern Control Systems', Pearson Prentice Hall Publications, 12th Edition, 2010.*
2. *Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, 'Feedback Control of Dynamic Systems', Pearson Education India Publications, 6th Edition, 2008.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the concepts of closed loop control systems.
2. Analyze the stability of closed loop systems.
3. Apply the control techniques to any electrical systems.
4. Design the classical controllers such as P, PI, etc., for electrical systems.

EEPC21 - LINEAR INTEGRATED CIRCUITS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC10
No. of Credits: 3

Course Objectives:

To provide in-depth instructions on the characteristics and applications of operational amplifiers, timers and voltage regulators.

Course Content:

Block diagram of a typical op-amp – characteristics of ideal and practical op-amp - parameters of op-amp – inverting and non-inverting amplifier configurations - frequency response - circuit stability.

DC and AC amplifiers - summing amplifier – difference amplifier – voltage follower – differentiator – integrator-clamper - clipper– filters.

Oscillators, sine wave, square wave, triangular wave, saw tooth wave generation, Schmitt trigger, window detector.

Analog-to-digital, digital-to-analog, sample and hold circuits; voltage controlled oscillator, phase locked loop – operating principles, applications of PLL.

IC555 Timer, monostable and astable modes of operation; voltage regulators - fixed voltage regulators, adjustable voltage regulators - switching regulators.

Textbooks:

1. *Gayakwad R.A., 'Op-amps & Linear Integrated Circuits', Prentice Hall of India, New Delhi, 4th Edition, 2009.*
2. *Roy Choudhury and Shail Jain, 'Linear Integrated Circuits', 4th Edition, New Age International Publishers, 2010.*

Reference Books:

1. *Sergio Franco,' Design with Operational Amplifiers and Analog Integrated Circuits', Tata McGraw Hill, 3rd Edition, 2002.*
2. *Sedra Smith, 'Microelectronic Circuits', Oxford University Press, 6th Edition, 2009.*
3. *R P Jain, 'Modern Digital Electronics', Tata McGraw-Hill Education, 3rd Edition, 2003*

COURSE OUTCOMES:

Upon completion of this course , students will be able to

1. Describe the various ideal and practical characteristics of an OPAMP.
2. Develop simple OPAMP based circuits.
3. Implement various analog signal processing circuits.
4. Analyze and design various types of ADCs and DACs.
5. Analyze and construct various application circuits using 555 timer.

EEPC22 – MICROPROCESSORS AND MICROCONTROLLERS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC14
No. of Credits: 3

Course Objectives:

To gain knowledge on the architecture of 8085 microprocessors and 8051 micro controller, their programming and associated peripheral interface devices.

Course Content:

8-Bit Microprocessor - 8085 architecture and memory interfacing (RAM & ROM), interfacing I/O devices - instruction set - addressing modes - assembly language programming – interrupts - timing diagram.

8051 Microcontroller - Intel 8051 architecture, memory organization, flags, stack, and special function registers, I/O, ports - connecting external memory, counters and timers, serial data I/O, Interrupts.

Microcontroller instructions - addressing modes, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns.

Microcontroller programming – Assembly Language Programming, timer and counter programming, connection to RS 232 and RS 485, Interrupt programming.

Peripherals and interfacing - Serial and parallel I/O (8251 and 8255), Programmable DMA controller, Programmable interrupt controller, ADC/DAC interfacing.

Textbooks:

1. *Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Applications with 8085', Penram Intl. Publishing, 6th Edition, 2013.*
2. *Kenneth Ayala, 'The 8051 Microcontroller', Cengage Learning Publications, 3rd Edition, 2007*
3. *Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay 'The 8051 Microcontroller and Embedded Systems using Assembly and C', Prentice Hall Publications, 2nd Edition, 2008.*

Reference Books:

1. *Sencer Yeralan, Helen Emery, 'Programming and Interfacing the 8051 Microcontroller', AddisonWesley Publications, 1st Edition, 2000.*
2. *Krishna Kant, 'Microprocessors and Microcontrollers, Architecture, Programming and System Design - 8085, 8086, 8051, 8096', Prentice Hall India Ltd Publications, 1st Edition, 2010..*
3. *Ray A.K., Bhurchandi K.M., 'Advanced Microprocessor and Peripherals', Tata McGraw-Hill Publications, 3rd Edition, 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Summarize the architecture of 8085 microprocessor and 8051 microcontroller
2. Develop assembly language code for a given problem
3. Design a microcontroller/microprocessor based system for timer-counter/serial communication /interrupt operation
4. Interface appropriate peripheral devices, memory with microprocessor/microcontroller for a given application/problem

EEPC23 - MEASUREMENTS AND INSTRUMENTATION

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC21
No. of Credits: 3

Course Objectives:

To understand the basic operation of different measuring instruments and thereby able to choose appropriate instruments for measuring different parameters.

Course Content:

Measuring Instruments: Classification, characteristics, errors & error analysis in measurements. Electromechanical Instruments – permanent magnet moving coil, moving iron instruments and Electrodynamometer type instruments. Measurement of voltage & current.

Measurement of power and energy - dynamometer and induction instruments, kVAh and kVARh meters, Instrument transformers – Current and Potential transformers.

Measurement of resistance, inductance and capacitance using dc and ac bridges, Transducers –Position transducers, force transducers, piezo-electric transducers, Hall effect transducers. Temperature measurement.

Signal sources, Oscilloscopes, digital multi-meters, Digital voltmeters.

Signal Generators, Function generator, Signal conditioners – Instrumentation amplifiers, voltage–current converters, voltage-frequency converters, analog multiplexers and de-multiplexers.

Textbooks:

1. *A. K. Sawhney, 'A Course in Electrical and Electronic Measurements and Instrumentation', Dhanpat Rai & Co., 9th Edition, 2015.*
2. *Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th Reprint (2008).*
3. *Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rd Edition, 2010.*
4. *Deobelin, 'Measurements Systems', Tata McGraw Hill Publications, 2nd Edition, 2010.*
5. *David A. Bell, 'Electronic Instrumentation and Measurements' Oxford University Press, 3rd Edition, 2013.*

Reference Books:

1. *W. D. Cooper, 'Electronic Instrumentation and Measurement Techniques', Prentice Hall of India Publications, 1st Edition, 2009.*
2. *Rangan C.S., 'Instruments Devices and System', Tata McGraw Hill Publications, 2nd Edition, 2009.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Describe the working principle of analog measuring instruments.
2. Describe the working principle of digital measuring instruments.
3. Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.
4. Analyse the operation and usage of oscilloscopes and signal generators for practical applications.

EEPC24 - POWER SYSTEM PROTECTION AND SWITCHGEAR

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC18
No. of Credits: 4

Course Objectives:

To give a broad coverage on all types of protective relays, circuit breakers and provide a strong background for working in a practical power system protection.

Course Content:

Relays – General classification, Principle of operation, types, characteristics, Torque equation, Relaying Schemes, Relay Co-ordination.

Apparatus and line protection – Line Protection – Distance, Differential protection and Carrier current protection. Generator protection – protection against abnormal condition, stator and rotor protection Transformer Protection – Incipient fault–Differential protection, Feeder and Bus bar protection.

Introduction to substation architecture, automation and protection - Protection against over voltages – Causes of over voltage, Ground wires, Surge absorbers and diverters. Earthing - types. Insulation co-ordination.

Theory of arcing and arc quenching circuit breakers-types – rating and comparison, RRRV, Resistor switching and capacitor switching.

Introduction to Static relays – Digital relays - Microprocessor based relays – Apparatus and line protection – Basics of Numerical relays.

Textbooks:

1. *Badri Ram and Vishwakarma, D.N., 'Power System Protection and Switchgear', Tata McGraw Hill Publishing Company Ltd., 2nd Edition, 2011.*
2. *Ravindranath B., and Chander, N., 'Power Systems Protection and Switch Gear', Wiley Eastern Ltd., 1st Edition, 1977.*

Reference Books:

1. *Sunil S. Rao, 'Protective Switch Gear', Khanna Publishers, New Delhi, 13th Edition, 2008.*
2. *Y. G. Paithangar, 'Fundamentals of Power System Protection', PHI Learning Private Limited, 2nd Edition, 2010.*
3. *C.L. Wadhwa, 'Electrical Power Systems', Wiley-Blackwell, 6th Edition, 2007.*
4. *Ramesh Bansal, "Power System Protection in Smart Grid Environment", CRC Press, 1st Edition, 2019*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Classify and describe the working of various relaying schemes.
2. Identify and implement an appropriate relaying scheme for different power apparatus.
3. Illustrate the function of various CBs and related switching issues.
4. Describe the causes of overvoltage and protection against overvoltage.

ESSENTIAL LABORATORY REQUIREMENT

EELR10 - CIRCUITS AND DIGITAL LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC10
No. of Credits: 2

Course Objectives:

- To understand and analyze the basic theorems of Circuit theory
- Understand and analyze series & parallel circuits and measurement of single and three-phase power.
- Understand and analyze different applications of combinational circuits.
- Understand the basics of digital design sequential circuits

List of Experiments

- Characteristics of CB and CE configuration of BJT.
- Verification of Thevenin and Maximum Power Transfer Theorem.
- Verification of Superposition Theorem.
- Verification of Kirchhoff's Current and Voltage law.
- Transient characteristics of RC/RL/R-L-C circuit.
- Design of combinatorial logic circuits
- Design of synchronous sequential logic circuits
- Design of asynchronous sequential logic circuits

Mini-Project

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Verify the network theorems and operation of typical electrical and electronic circuits.
2. Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.
3. Prepare the technical report on the experiments carried.
4. Design basic digital logic circuits

EELR11 - DC MACHINES AND TRANSFORMERS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC12
No. of Credits: 2

Course Objectives:

The main objective of the course is to give the students an insight into the constructional details of dc machines and transformers with a view for better understanding of their working principles. The course also equips the students to test and evaluate the performance of various dc machines and Single-phase transformers by conducting appropriate experiments.

List of Experiments

A demonstration of the static and rotational electrical machines (constructional details) is ought to be done in an introductory class.

- Open circuit and load characteristics of DC shunt/compound generator
- Swinburne's test and Speed control of DC shunt motor
- Load test on DC shunt motor
- Load test on DC series motor
- Open circuit and short circuit test on single-phase transformer
- Sumpner's test
- Parallel operation of single-phase transformer
- Electrical braking in DC shunt motor
- Three-phase transformer connections

Mini-Project

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Interpret the constructional details of the DC machines and Transformers and also understand the significance of different connections of three-phase transformers.
2. Estimate or test the performance of any DC machine (shunt, series or compound) and single-phase transformer, by conducting suitable experiments and report the results.
3. Experiment and analyze the various speed control and braking techniques for DC motors.
4. Develop simulation models and prototype modules in view of implementing any control technique upon dc motors and single-phase transformers for various applications.

EELR12 - ELECTRONIC CIRCUITS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC13
No. of Credits: 2

Course Objectives:

Design of amplifiers and other electronic systems to satisfy specifications.

List of Experiments

- Frequency analysis of Common Emitter amplifier.
- Measurement of input/output impedance of Common Collector amplifier.
- Design and verification of characteristics of RC oscillators.
- Design and characterization of Monostable multivibrator.
- Design and characterization of Astable multivibrator.
- Characteristics of UJT and applications of UJT oscillator.
- Frequency analysis of FET Amplifier.
- Frequency response of series voltage negative feedback Amplifier.
- Square waveform generation using transistor based Schmitt trigger.
- Design and characterization of Bistable Multivibrator.

Mini-Project.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Design a complete electronic circuit using a top-down approach which starts from specifications.
2. Design and analyze electronic circuits using BJT and FET.
3. Design and characterization of electronic circuits using UJT.
4. Waveform generator circuit design using electronic devices.
5. Prepare the technical report and provide solutions to real time problems.

EELR13 - SYNCHRONOUS AND INDUCTION MACHINES LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC15
No. of Credits: 2

Course Objectives:

The main objective of the course is to give the students an insight into the constructional details of the induction and synchronous machines with a view for better understanding of their working principles. The course also equips the students to test and evaluate the performance of induction and synchronous machines by conducting appropriate experiments.

List of Experiments

A demonstration of the static and rotational electrical machines (constructional details) is ought to be done in an introductory class.

- Load test on three-phase induction motor
- No-load and blocked rotor test on three-phase induction motor
- Load test on grid connected induction generator
- Load test on self-excited induction generator
- Load test on single-phase induction motor
- Regulation of three-phase alternator by E.M.F and M.M.F methods
- Load test on three-phase alternator
- Synchronization of three-phase alternator with infinite bus bar
- V and inverted V-curves of synchronous motor
- Speed Control on three-phase induction motor

Mini-project

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Estimate or test the performance of induction and synchronous machines by conducting suitable experiments and report the results.
2. Experiment and analyze the speed control techniques for three-phase induction motors.
3. Evaluate the different modes of operating the induction generators and justify their usage in wind power generation.
4. Experiment synchronization of alternators and power exchange with the grid to get convinced with their usage at conventional power generation stations.
5. Develop simulation models and prototype modules in view of implementing any control technique upon Single-phase and three-phase induction motors for various applications.

EELR14 - INTEGRATED CIRCUITS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisite:*** EEPC21
No. of Credits: 2

Course Objectives:

To enrich the students' knowledge on practical circuit design using analog and digital ICs.

List of Experiments

- Understanding of Op-Amp Imperfections
- Linear Applications of Op-Amp
- Non-Linear Applications of Op-Amp
- Design of Active filters using Op-Amp
- Analog-to-Digital Conversion
- Digital-to-Analog conversion
- Timing circuits using 555 Timer
- Combinational and Sequential logic circuits
- Design of Code converter with seven-segment display

Mini-Project

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the non-ideal behaviour of Op-amp.
2. Analyze and prepare the technical report on the experiments carried out.
3. Design application-oriented circuits using Op-amp and 555 timer ICs.
4. Create and demonstrate live project using ICs.

EELR15 - POWER ELECTRONICS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC19
No. of Credits: 2

Course Objectives:

To enable the students to develop hands-on experience in analyzing, designing and carrying out experiments on various electrical networks by make use of power electronic components. It aims to familiarize the switching devices, power converters and their applications in various systems for power control.

List of Experiments

- Characteristics of SCR, IGBT, MOSFET
- Single-phase Fully Controlled SCR Converter
- Buck Converter using MOSFET
- Boost Converter using MOSFET
- Buck-Boost Converter using IGBT
- Single-phase Inverter using IGBT
- Single-phase step-down Cyclo-converter
- Speed Control of single-phase A.C Motor
- Single-phase Half Controlled SCR Converter
- Illumination Control of Lamp
- Speed Control of single-phase Capacitor Run Induction Motor
  Mini-Project

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the characteristics of various switching devices and appreciate its applications in various electrical networks/systems.
2. Analyze and design the operation of power switching converters.
3. Develop practical control circuits for various real time applications.
4. Analyze and prepare the technical report on the experiments carried out.

EELR16 – MICRO-CONTROLLER LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC22
No. of Credits: 2

Course Objectives:

To train the students to use micro-controller for computational and logical applications. Also, this course prepares the students to provide solutions to real-time problems.

List of Experiments

1. An assembly language program to add, subtract, multiply and divide.
2. An assembly language program to generate 10 KHz square wave.
3. Study and interface display devices like LCD, LED and 7-Segment display.
4. Study of implementation of steeper motor angle control.
5. Study of implementation of DC Motor control using PWM method.
6. Study and observation of Position control of Servo Motor.
7. Study of Programming and Transmission and Reception of data through serial port.
8. To study implementation and programming of Pressure measurement.
9. To study implementation and programming of Temperature measurement.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Accomplish arithmetic and logical operations with micro-controllers.
2. Generate firing pulses for various control applications related to electrical machines and power electronics.
3. Illustrate various interfacing techniques related to real-time applications using micro-controllers.
4. Design and implement control circuitry using micro-controllers for any engineering and real world problems.

EELR17 - POWER SYSTEMS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC18
No. of Credits: 2

Course Objectives:

To enhance the analyzing and problem-solving skills of the students in power system through computer programming and simulation.

List of Experiments

- Real and Reactive Power Computation
- Transmission Line Parameter Calculation
- Bus Admittance Matrix Formulation
- Load Flow Analysis
- Z-bus Formation
- Symmetrical Fault Analysis
- Unsymmetrical Fault Analysis

Mini-Project

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Develop computer programs for power system studies.
2. Design, simulate and analyze power systems using simulation packages.
3. Prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.

ELECTIVES

EEPE10 – POWER GENERATION SYSTEMS

Course Type: Programme Elective (PE) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

To understand the working of different types of power generation systems and to realize the necessity for interconnected operation of different power stations.

Course Content:

Hydro-electric power plants – selection of site, elements of power plant, classification, water turbines, governor action, hydro-electric generator, plant layout, pumped storage plants.

Thermal steam power plants – selection of site, elements and operational circuits of the power plant, turbo-alternators, plant layout, steam turbines, controls and auxiliaries.

Nuclear power plants – selection of site, nuclear reaction – fission process and chain reaction, constituents of power plant and layout, nuclear reactor – working, classification, control, shielding and waste disposal.

Renewable power plants – Solar power generation – Photo-voltaic and solar thermal generation – solar concentrators, Wind power generation – types of windmills, wind generators, tidal, biomass, geothermal and magneto-hydro dynamic power generation, micro-hydel power plants, fuel cells and diesel and gas power plants

Combined operation of power plants – plant selection, choice of size and number of generator units, interconnected systems, real and reactive power exchange among interconnected systems. Major electrical equipment in power plants, DC systems in power plants, station control - switch yard and control room. Economic considerations – types of costs, tariff and consumers.

Textbooks:

1. *Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., 'A Text Book on Power Systems Engg', Dhanpat Rai and Sons, New Delhi, 2nd Revised Edition, 2010.*
2. *J.B.Gupta, 'A Course in Power Systems', S.K.Kataria and Sons, Reprint 2010-2011.*
3. *B.R.Gupta, 'Generation of Electrical Energy', S. Chand Limited, 2009*

Reference Books:

1. *Wadhwa, C.L., 'Generation Distribution and Utilisation of Electrical Energy', New Age International Publishers, 3rd Edition, 2010.*
2. *Deshpande M.V, `Elements of Electrical Power Systems Design', Pitman, New Delhi, PHI Learning Private Limited, 1st Edition, 2009.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Appreciate the different types of tariff, consumers and different types of power generation plants.
2. Determine the significance of various components of the power generation plants.
3. Correlate the importance of interconnected operation of different power generation systems.
4. Plan an appropriate scheduling of electric power to satisfy the demand constraint.

EEPE11 / EEOE10 – ELECTRICAL SAFETY

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

To provide a comprehensive exposure to electrical hazards, various grounding techniques, safety procedures and various electrical maintenance techniques.

Course Content:

Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags, locking devices- voltage measuring instruments- proximity and contact testers-safety electrical one line diagram- electrician's safety kit.

General requirements for grounding and bonding- definitions- grounding of electrical equipment- bonding of electrically conducting materials and other equipment-connection of grounding and bonding equipment- system grounding- purpose of system grounding- grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage and high voltage systems.

The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation and approach distances- calculating the required level of arc protection-safety equipment , procedure for low, medium and high voltage systems- the one minute safety audit

Electrical safety programme structure, development- company safety team- safety policy- programme implementation- employee electrical safety teams- safety meetings- safety audit- accident prevention- first aid- rescue techniques-accident investigation

Safety related case for electrical maintenance- reliability centered maintenance (RCM) - eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards, Indian Electricity Acts related to Electrical Safety.

Textbooks:

1. *John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield ,'Electrical Safety Handbook', McGraw-Hill Education, 4th Edition, 2012.*

Reference Books:

1. *Maxwell Adams.J, 'Electrical Safety- a guide to the causes and prevention of electric hazards', The Institution of Electric Engineers, IET 1994.*
2. *Ray A. Jones, Jane G. Jones, 'Electrical Safety in the Workplace', Jones & Bartlett Learning, 2000.*

COURSE OUTCOMES:

Upon completion of the course, the students would be able to

1. Describe electrical hazards and safety equipment.
2. Analyze and apply various grounding and bonding techniques.
3. Select appropriate safety method for low, medium and high voltage equipment.
4. Participate in a safety team.
5. Carry out proper maintenance of electrical equipment by understanding various standards.

EEPE12 - THERMODYNAMICS AND MECHANICS OF FLUIDS#

Course Type: Programme Elective (PE)

No. of Credits: 3

Pre-requisites: Concepts and principles dealing with conservation laws, fluid properties, thermodynamic aspects of fluid flow, Basic knowledge of mathematics.

Course Objectives:

- To achieve an understanding of the principles of thermodynamics and to be able to use it in accounting for the bulk behavior of simple physical systems.
- To provide in-depth study of thermodynamic properties of various working fluids.
- To enlighten the basic concepts of energy interacting devices through various thermodynamic cycles.
- To provide basic awareness about fluid behaviour under rest and dynamic conditions.
- To impart knowledge about hydraulic machines.

Course Content:

Basic concepts: Thermodynamic equilibrium, quasi-static process, Temperature and zeroth law, work and heat interactions, properties of pure substances, phase equilibrium diagrams. First law for closed and open systems

Heat engine, second law statements, reversibility, Carnot theorem, Clausius inequality, entropy principle. Available energy: Availability and irreversibility.

Otto, diesel and dual cycles, Brayton cycle with regeneration, inter-cooling reheat, Joule- Thompson effect, Rankine cycle, reheat and regenerative cycle, properties of ideal gas, Stirling and Ericson cycles.

Classification of fluids and their physical properties, Fluid statics, manometers, pressure on submerged bodies - Vapour Pressure – Pressure at a point its variation – Measurement with Piezo meter, manometers and gauges - Continuity equation in one dimension – Bernoulli's equation – Venturi meters and Orifice meters.

Pumps – General principles of displacement and Centrifugal pumps – Efficiency and Performance Curves of Pumps – Cavitation in Pumps – Turbines – Efficiency – Governing of turbines.

Reference Books:

1. *Gordan Van Wylen, Richard Sonntag., 'Fundamentals of Classical Thermodynamics', John Wiley and Sons, 1994.*
2. *Yunus A.Cengel and Michel A.Boles, 'Thermodynamics: An Engineering Approach', McGraw-Hill Higher Education, 2006.*
3. *T.R.Banga and S.C.Sharma, 'Hydraulic Machines', Khanna Publishers, 2004.*
4. *Kothandaraman. C.P., `A Course in Thermodynamics and Heat Engines', Dhanpat, Rai and Sons, 1992.*
5. *Nag, P.K., `Engineering Thermodynamics', Tata McGraw Hill, 1997.*
6. *R.K.Rajput, 'Thermal Engineering', Laxmi Publications, 2006.*
7. *Nagarathnam, S. 'Fluid Mechanics', Khanna Publishers, New Delhi, 1995.*
8. *Dr.R.K.Bansal, 'A Text Book of Fluid Mechanics and Hydraulic Machines', Laxmi Publications(P) Ltd, 2005.*

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

1. Understand the fundamentals of first and second laws of thermodynamics and their application to a wide range of systems.
2. Familiarize with calculations of the efficiencies of heat engines and other engineering devices.
3. Familiarize the construction and principles governing the form of simple and complex one-component phase diagrams such as pressure-temperature, volume-temperature & and pressure-volume and the steam tables in the analysis of engineering devices and systems.
4. Calculate various fluid flow parameters.

Determine the optimum working conditions for hydraulic machines

Will be offered by the Department of Mechanical Engineering.

EEPE13 / EEOE11 – FUZZY SYSTEMS AND GENETIC ALGORITHMS

Course Type: Programme Elective (PE) / Open Elective(OE) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

- This course aims to expose students to the fundamental principles of fuzzy logic systems.
- Enable the students to apply fuzzy logic concepts to existing and new applications.

Course Content:

Different faces of imprecision – inexactness, ambiguity, undecidability, Fuzziness and certainty, Fuzzy sets and crisp sets.

Intersection of Fuzzy sets, Union of Fuzzy sets - the complement of Fuzzy sets-Fuzzy reasoning.

Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference- Methods of decompositions and defuzzification.

Methodology of fuzzy design- Direct & Indirect methods with single and multiple experts, Applications– Fuzzy controllers – Control and Estimation.

Genetic Algorithms- basic structure-coding steps of GA, convergence characteristics, applications.

Textbooks:

1. *Zimmermann H.J., 'Fuzzy Set Theory - and its Applications', Springer Netherlands, 2nd Edition, Illustrated, 2014.*
2. *Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', John Wiley & Sons Ltd Publications, 3rd Edition, 2011.*
3. *M. Mitchell, 'Introduction to Genetic Algorithms", Indian Reprint, MIT press Cambridge, 2nd Edition, 2014.*

Reference Books:

1. *John Yen, Reza Langari, 'Fuzzy Logic, Intelligence, Control & Information', Pearson Education Inc., India, 2007.*
2. *Zdenko Kovacic, Stjepan Bogdan, 'Fuzzy Controller Design Theory and Applications', CRC Press, 1st Edition, 2006.*
3. *Riza C. Berkaan, Sheldon L. Trubatch, 'Fuzzy Systems Design Principles – Building Fuzzy IF THEN Rule Based', IEEE Press, 1997.*

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

1. Understand the fundamentals of Fuzzy logic theory.
2. Employ fuzzy logic principles to existing engineering applications and compare the results with existing methods.
3. Design Fuzzy logic Systems for engineering applications.

EEPE14 – INDUSTRIAL AUTOMATION

Course Type: Programme Elective (PE) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

The contents aim to develop the knowledge of the student in the field of automation in industries. This will be compromising knowledge of PLC, DCS and SCADA systems. They will also get familiar with different industrial standard protocols.

Course Content:

Process Control: Introduction, Process Control block diagram, Control System Evaluation, and Digital Control: Supervisory Control, Direct Digital Control, Networked Control Systems, and Distributed Digital Control. Smart Sensor. Definitions of the terms used to describe process control. Data Acquisition Systems: DAS Hardware, DAS Software. Data Logger.

Controller Principles: Process Characteristics: Process Equation, Process Load, Process Lag, Self- Regulation. Control System parameters: Error, Variable Range, Control parameter Range, Control Lag, Dead Time, Cycling, Controller Modes. Discontinuous Controller Mode: Two Position Mode, Multiposition Mode, Floating Control Mode. Continuous Control Mode: Proportional Control Mode, Integral Control Mode, Derivative Control Mode. Composite Control Modes: PI Control, PD Control, PID Control.

Analog Controllers: Introduction, Electronic Controllers: Error Detector, Single Controller Modes, Composite Controller Modes. Pneumatic Controllers: General features, Mode Implementation.

Programmable Logic Controller: Evaluation of PLC, PLC Architecture, Basic Structure. PLC Programming: Ladder Diagram – Ladder diagram symbols, Ladder diagram circuits. PLC Communications and Networking, PLC Selection: I/O quantity and Type, Memory size and type, Programmer Units. PLC Installation, Advantages of using PLCs.

Distributed Control System: Introduction, Overview of Distributed Control System, DCS Software configuration, DCS Communication, DCS Supervisory Computer Tasks, DCS Integration with PLCs and Computers, Features of DCS, Advantages of DCS.

Textbooks:

1. *C.D. Johnson, 'Process Control Instrumentation Technology', PHI, 8th Edition, 2013.*
2. *S.K. Singh, 'Computer Aided Process Control', PHI, 2004.*
3. *Thomas E. Kissell, 'Industrial Electronics', PHI, 3rd Edition, 2003.*

Reference Books:

1. *Noel M. Morris, 'Control Engg', McGraw-Hill, 4th Edition, 1992.*
2. *Lukcas M.P., 'Distributed Control Systems', Van Nostrand Reinhold Co, Illustrated, 1986.*
3. *Huges T, 'Programmable Controllers', ISA press, 4th Edition Illustrated, 2005.*
4. *A.K. Ghosh, 'Introduction to Instrumentation & Control', PHI Learning Pvt. Ltd, 2004.*
5. *George C. Barney, 'Intelligent Instrumentation', Prentice Hall India.*

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Implement low cost automation systems using pneumatic and electrical means.
2. Learn about the modern techniques and devices used for the monitoring and control of manufacturing systems including programming of programmable logic controllers and their interfacing with various sensors and actuators.
3. Design automated assembly system for industrial applications.

EEPE15 – HIGH VOLTAGE ENGINEERING

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC10
No. of Credits: 3

Course Objectives:

To dispense an overview of various generation, measurement and testing methodologies of high DC and AC voltages and currents and also to edify the background of various breakdowns.

Course Content:

Causes and types of over voltages, effects of over voltages on power system components, Surge diverters, EMI and EMC protection against over voltages; Insulation coordination.

Generation of high AC, DC, impulse and switching voltages; Generation of high impulse currents.

Measurement of high AC, DC, impulse voltages using sphere gaps, peak voltmeters, potential dividers, High speed CRO and digital techniques. Measurement of high currents.

Dielectric breakdown - break down in gases, liquids and solids; partial discharges and corona discharges.

High Voltage Testing- testing of circuit breakers, insulators, bushings and surge diverters. Standards and specifications.

Textbooks:

1. *Wadhwa,C.L., ' High Voltage Engineering', 3rd Edition, New Age International Publishers Ltd., New Delhi, 2010.*
2. *Naidu, M.S. and Kamaraju,V., 'High Voltage Engineering', 4th Edition, Tata McGraw-Hill Publishing Company, New Delhi,4th Edition, 2009.*
3. *E. Kuffel, W. S. Zaengl, J. Kuffel, 'High Voltage Engineering: Fundamentals', Butterworth-Heinemann, 2nd Edition, 2000.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Describe the causes and types of overvoltage.
2. Illustrate different methods of generating and measuring various high voltages and currents.
3. Explain various breakdown phenomena occurring in gaseous, liquid and solid dielectrics.
4. Identify appropriate testing method(s) for various high voltage apparatus.

EEPE16 – COMPUTER ORGANIZATION AND ARCHITECTURE

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC14
No. of Credits: 3

Course Objectives:

This course will render the basic structure of computers, their control design, memory organizations and an introduction to parallel processing.

Course Content:

Computer – Functional units, Addressing modes, Instruction formats, Stacks and Subroutines. Processing Unit – Execution of instructions - Control step sequence.

Control Design - Hardwired control- design - multiplier control unit - CPU control unit and Micro programmed control – microinstructions - Sequencing - prefecting.

Arithmetic and Logic Unit-Fixed point and floating-point numbers and operations. Design of arithmetic units.

Memories - cache memories - virtual memories. Input-Output Organization - Data transfer-synchronization-Interrupt handling-I/O interfaces

Introduction to parallel processing- Generation of computer systems – Parallelism in uniprocessor system – Parallel computer structures- architectural classification schemes.

Textbooks:

1. *David A. Patterson and John L. Hennessy, 'Computer Organization and Design: The Hardware/Software Interface', 4th Edition, Elsevier, 2009.*
2. *Morris Mano.M., 'Computer System Architecture', Prentice Hall India, 3rd Edition 2008.*
3. *William Stallings, 'Computer Organization and Architecture – Designing for Performance', 8th Edition, Pearson Education, 2010.*

Reference Books:

1. *Behrooz Parhami, 'Computer Architecture from up to Super Computer', Oxford press, Reprinted 2014.*
2. *John P. Hayes, 'Computer Architecture and Organization', Tata McGraw-Hill, 3rd Edition, 1998.*
3. *Carl Hamachar, Zvonkoran Vranesic, Safwatzaky, 'Computer Organization', Tata McGraw-Hill, 6th Revised Edition, 2011.*

COURSE OUTCOMES:

Upon completion of this course, students will

1. Describe the general architecture of computers.
2. Be familiar with the history and development of modern computers, the Von Neumann architecture and functional units of the processor such as the register file and arithmetic logical unit.
3. Understand the major components of a computer including CPU, memory, I/O and storage, how computer hardware has evolved to meet the needs of multi-processing systems, the uses for cache memory, parallelism both in terms of a single processor and multiple processors.
4. Design principles in instruction set design including RISC architectures.
5. Analyze and design computer hardware components.

EEPE17 – DIGITAL SYSTEM DESIGN AND HDLS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC14
No. of Credits: 3

Course Objectives:

To impart the concepts of Digital systems and hardware description languages.

Course Content:

Finite State machines - Mealy and Moore, state assignments, design and examples – Asynchronous finite state machines – design and examples – multi-input system controller design.

Programmable Devices: Simple and Complex Programmable logic devices (SPLD and CPLDs), Field Programmable Gate Arrays (FPGAs), Internal components of FPGA, Case study: A CPLD and a 10 million gates type of FPGA.

VHDL- Modeling styles – structural – Behavioral – Dataflow - Design of simple/ complex combinational and sequential circuits using VHDL – Data types – Test bench and simulation. Case study on system design.

Verilog HDL - Modeling styles – structural – Behavioral – Dataflow - Design of simple/ complex combinational and sequential circuits using Verilog – Test bench and simulation – case study on system design.

Fault classes and models – Stuck at faults, Bridging faults - Transition and Intermittent faults. Fault Diagnosis of combination circuits by conventional methods - Path sensitization technique - Boolean different method and Kohavi algorithm.

Textbooks:

1. *William I. Fletcher, 'An Engineering Approach to Digital Design', Prentice Hall, 2009.*
2. *Donald D.Givone, 'Digital Principles and Design', Tata McGraw-Hill, 1st Edition, 2003.*
3. *Morris Mano, 'Digital Design', PHI, 3rd Edition, 2005.*
4. *J. Bhaskar, 'Verilog HDL Primer', BPB publications, 2000.*

Reference Books:

1. *Samuel C. Lee, 'Digital Circuits and Logic Design', PHI Learning, 1st Edition, 2008.*

COURSE OUTCOMES:

On completion of the course the students would be able to

1. Understand the insights of the finite state machines.
2. Appreciate and classify the programmable logic devices and FPGA.
3. Design the logic circuits using VHDL.
4. Develop the systems using Verilog HDL.
5. Test the circuits for different faults.

EEPE18 – DIGITAL SIGNAL PROCESSING

Course Type: Programme Elective (PE)

Pre-requisites: MAIR32, EEPC14

No. of Credits: 3

Course Objectives:

To explore the basic concepts of digital signal processing in a simple and easy-to-understand manner.

Course Content:

Classification of discrete-time systems and elementary sequences, Unit sample response characterization, convolution summation, linear difference equations with constant coefficients and their solution using Z-transform, System function-concept.

Discrete-time Fourier Transform and its properties, Discrete Fourier Transform and its properties, Circular convolution, Linear convolution of two finite length sequences through circular convolution, Sectioned convolutions, Relationship between Z Transform, DTFT and the DFT, Introduction to radix-2 FFT, decimation-in-time and decimation-in-frequency radix-2 algorithm.

Concept of filtering, Characteristics of Linear phase filters, Amplitude and phase response of FIR filters, Design of linear phase FIR filters- Windowing, Frequency sampling technique, Introduction to optimal filters.

Properties of IIR digital filters, Design of IIR filters from continuous time filters – Impulse invariance and Bilinear transformation technique, Frequency transformation techniques, Finite Word Length Effects

Architecture and features of signal processor and applications.

Textbooks:

1. *Oppenheim and Schaffer, 'Discrete Time Signal processing', Pearson Education Publications, 3rd Edition, 2010.*
2. *John G Proakis, Dimitris K Manolakis, 'Digital Signal Processing', Prentice Hall International, 4th Edition, 2007.*
3. *Ludemann L. C., 'Fundamentals of Digital Signal Processing', Harper and Row Publications, 1st Edition, 1992.*

Reference Books:

1. *Rabiner & Gold, 'Theory and Applications of Digital Signal Processing', PHI Learning Publications, 1st Edition, 2009.*
2. *Hamid A.Toliyat and Steven G. Campbell, 'DSP Based Electro Mechanical Motion Control', CRC Press, 1st Edition, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the operations on digital signals.
2. Analyze the signal processing concepts.
3. Design the systems required for digital signal processing.

EEPE19 / EEOE12 – ARTIFICIAL NEURAL NETWORKS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites*:*** MAIR32
No. of Credits: 3

Course Objectives:

To learn the fundamentals of ANN and its application to electrical systems.

Course Content:

Introduction to Neural Networks - Biological Inspiration- Biological Neural Networks to Artificial Neural Networks – Classification of ANN Networks – Development of neural network models – Perceptron Network – Linear Separability.

Adaline Network – Madaline Network – Back propagation Neural Networks – Kohenen Neural Network – Learning Vector Quantization – Hamming Neural Network-applications

Adaptive Resonance Theory Neural Networks – Boltzmann Machine Neural Networks – Radial Basis Function Neural Networks – Bi-directional Associative Memory-applications

Hopfield Neural Networks – Support Vector Machines – Introduction to Spiking Neural Networks – Spike Neuron Models – Hybrid Neural Networks-applications

Deep Neural Networks- Recurrent Neural Networks- Backpropagation through time (BPTT)- Vanishing and Exploding Gradients- Truncated BPTT-LSTM (Long Short Term Memory) -Bilinear LSTM- Gated Recurrent Units-applications

Textbooks:

1. *Hagan, Demuth, Beale, 'Neural Network Design', PWS Publishing Company, 1st Edition, 2002.*
2. *Freeman, J.A and Skapura, D.M., 'Neural Networks - Algorithms, Applications and Programming Techniques', Addison Wesley Publications, Digitized Reprint (2007), 1991.*
3. *Andrew Glassner, "Deep Learning: From Basics to Practice" Vol-2, The Imaginary Institute, Seattle, WA, February 20, 2018*

Reference Books:

1. *Satish Kumar, 'Neural Networks–A Classroom Approach', Tata McGraw-Hill Publishing Company Limited, 2013.*
2. *N.P. Padhy, S.P. Simon, 'Soft Computing with MATLAB Programming', Oxford University Press, 2015.*
3. *Simon Haykins, 'Neural Networks: A Comprehensive Foundation', Prentice-Hall Inc., 3rd Edition, 2008.*
4. *Andrew Glassner, "Deep Learning: From Basics to Practice" Vol-1, The Imaginary Institute, Seattle, WA, February 20, 2018*

COURSE OUTCOMES:

Upon completion of the course, students will be able to

1. Describe the development of artificial neural networks (ANN) and classify various ANN models.
2. Solve and design various ANN models.
3. Apply and construct ANN models to various applications of electrical systems.

EEPE20 – DESIGN OF ELECTRICAL APPARATUS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15
No. of Credits: 3

Course Objectives:

This course offers the preliminary instructions and techniques to design the main dimensions and other major part of the transformer and DC and AC rotating machines. The course also provides the students with an ability to understand the step-by-step procedure for the complete design of electrical machines.

Course Content:

General concepts in the design of rotating machines-output equation-Magnetic and electric loadings-Common design features of all rotating machines-Conducting, insulating and magnetic materials used in electrical apparatus - mmf calculation for the magnetic circuit of rotating machines-Leakage reactance calculation.

Armature winding –output equation-Choice of specific loadings-Choice of poles-design of conductors, winding, slot, air gap, field poles and field coils, commutator and brush-Predetermination of efficiency, temperature rise and open circuit characteristics from design data (qualitative treatment only).

Output equation-Design of core and coils for single phase and three phase transformers-Design of tank and cooling tubes-Predetermination of circuit parameters, magnetising current, losses, efficiency, temperature rise and regulation from design data (qualitative treatment only).

Output equation-Choice of specific loadings-Design of stator-Design of squirrel cage and slip ring rotors-Stator and rotor winding designs-Predetermination of circuit parameters, magnetising current, efficiency and temperature rise from design data (qualitative treatment only).

Constructional features of synchronous machines-SCR-Output equation-specific loadings-Main dimensions-Stator design-Design of salient pole field coil.

Textbooks:

1. *Sawhney, A.K., 'A Course in Electrical Machines Design', Dhanpat Rai and Sons Publications, 4th Edition, 2010.*

Reference Books:

1. *Sen, S.K., 'Principles of Electrical Machine Design with Computer Programmes', Oxford and I.B.H Publishing Co. Pvt. Ltd, 2nd Edition, 2006.*
2. *Rai, H.M., 'Principles of Electrical Machines Design', Sathya Prakash Publications, 3rd Edition, 1994.*

COURSE OUTCOMES:

Upon completion of the course, the student will be

1. Able to understand the design of main dimensions and other major part of the transformer and DC and AC rotating machines.
2. Capable of evaluating the procedure for the design of main dimensions and other major part of the transformer and DC and AC rotating machines.
3. Equipped to apply in-depth knowledge related to the design of electrical machines.

EEPE21 – UTILIZATION OF ELECTRICAL ENERGY

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15
No. of Credits: 3

Course Objectives:

To design illumination systems, choose appropriate motors for any drive application, to debug a domestic refrigerator circuit and to design battery charging circuitry for specific applications.

Course Content:

Illumination – Terminology, Laws of illumination, Photometry, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps. Design of lighting schemes - factory lighting - flood lighting – street lighting.

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air conditioning system and their applications, smart air conditioning units - Energy Efficient motors: Standard motor efficiency, need for more efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.

Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF line UPS, Batteries. Power quality aspects – nonlinear and domestic loads. Earthing – domestic, industrial and sub-station.

Electric Heating- Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding, Electrolytic processes – electro-metallurgy and electro-plating.

Traction system – power supply, traction drives, electric braking, tractive effort calculations and speed-time characteristics. Locomotives and train - recent trend in electric traction.

Textbooks:

1. *Dr. Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi, 15th Edition, 2014.*
2. *Gupta, J.B., 'Utilisation of Electrical Energy and Electric Traction', S. K. Kataria and Sons, 10th Edition, 2012.*
3. *Rajput R.K., 'Utilisation of Electrical Power', Laxmi Publications, 1st Edition, 2006.*

Reference Books:

1. *N. V. Suryanarayana, 'Utilisation of Electrical Power', New Age International Publishers, Reprinted 2005.*
2. *C. L. Wadhwa, 'Generation Distribution and Utilization of Electrical Energy', New Age International Publishers, 4th Edition, 2011.*
3. *H. Partab, 'Modern Electric Traction', Dhanpat Rai & Co., 3rd Edition, 2012.*
4. *Energy Efficiency in Electrical Utilities, BEE Guide Book, 2010.*

COURSE OUTCOMES:

Upon completion of the course the students would be able to

1. Develop a clear idea on various illumination techniques and hence design lighting scheme for specific applications.
2. Identify an appropriate method of heating for any particular industrial application.

3. Evaluate domestic wiring connection and debug any faults occurred.
4. Construct an electric connection for any domestic appliance like refrigerator as well as to design a battery charging circuit for a specific household application.
5. Realize appropriate type of electric supply system and to evaluate the performance of traction unit.

EEPE22 – COMPUTER NETWORKS

Course Type: Programme Elective (PE) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

To know about different network architectures and network protocols, data communications and different IEEE standards.

Course Content:

Introduction - Architecture, Network hardware and software. Physical layer- Guided transmission media -Cable television.

Data Link Layer –Design issues–Channel allocation problem –Multiple access protocols - Ethernet – Wireless LAN -802.11architecture.

Network Layer - Design issues – Routing algorithms - Congestion control algorithms -Quality of Service – Internet working.

Transport Layer - Transport service -Elements of transport protocols-User Datagram Protocol-Transmission Control Protocol.

Application Layer – DNS – Electronic mail – World Wide Web – Multimedia – Network security.

Textbooks:

1. *Behrouz A. Foruzan, 'Data Communication and Networking', Tata McGraw Hill, 5th Edition, 2013.*
2. *W.Stallings, 'Data and Computer Communications', Pearson Education, 8th Edition, 2007.*
3. *James F. Kurose, Keith W. Ross, 'Computer Networking', Pearson Education, 6th Edition, 2012.*
4. *A. S. Tanenbaum, 'Computer Networks', Pearson Education, 4th Edition, 2003.*

Reference Books:

1. *Douglas E.Comer, 'Computer Networks and Internets', Pearson education, 4th Edition, 2008.*
2. *Larry L. Peterson and Bruce S. Davie, 'Computer Networks - A Systems Approach', Harcourt Asia/Morgan Kaufmann, 5th Edition, 2011.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Understand of the fundamental network issues.
2. Analyze the significance of the network layers and their functions.
3. Gain knowledge about the basic network protocols.
4. Have a basic understanding of TCP / IP.

EEPE23 / EEOE13 – MODERN CONTROL SYSTEMS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites*:*** EEPC20
No. of Credits: 3

Course Objectives:

Apply modern control techniques to electrical systems.

Course Content:

Modelling of physical system in state space format- Definition of state- Basic properties of state- transition matrix - solution to vector differential equation.

Concept of controllability and observability - Concept of stabilizability and detectability - Kalman decomposition.

Pole placement design of controller - Observer design - Stability of controller design based on the observer using separation principle.

Introduction to non-linear systems - Phase plane analysis - Multiple equilibrium points.

Stability analysis of non-linear system using Lyapunov direct method - Instability theorem - Lasalle's invariance principle.

Textbooks:

1. *Chi-Tsong Chen, 'Linear System Theory and Design', Oxford University Press, 4th Edition, 2012.*
2. *Khalil H.K., 'Nonlinear Systems', Prentice Hall Publications, 3rd Edition, 2002.*

Reference books:

1. *Stanley M. Shiners, 'Modern Control System theory and Design', John Wiley and Sons Publications, 2nd Edition, 1998.*
2. *Ogata K. 'Modern Control Engineering', Prentice Hall Publications, 5th Edition, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the concepts of modern control theory using state-space approach.
2. Compare and analyse the classical control system with modern control system.
3. Develop advanced controllers to the existing system using modern control design techniques.

**Pre-requisite not required for registration as Open Elective*

EEPE24 – FUNDAMENTALS OF FACTS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC11, EEPC19
No. of Credits: 3

Course Objectives:

To familiarize the students with the basic concepts, different types, scope and applications of FACTS controllers in power transmission.

Course Content:

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

Principles of shunt compensation – Variable Impedance type & switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

Principles of static series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).

Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters-power circuit configurations.

UPFC-Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

Textbooks:

1. *Hingorani, L. Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', Standard Publishers Distributors, 1st Edition, 2011.*
2. *R.M. Mathur and R.K. Varma, 'Thyristor-Based FACTS Controllers for Electrical Transmission Systems', Wiley India Pvt. Limited Publications, 1st Edition, 2011.*

References:

1. *K. R. Padiyar, 'FACTS Controllers in Power Transmission and Distribution', New Age International Publications, 1st Edition, 2009.*
2. *Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pérez, César Angeles-Camacho, 'FACTS: Modelling and Simulation in Power Networks', John Wiley & Sons, 2004.*
3. *Enrique Acha, Vassilios Agelidis, Olimpo Anaya, T.J.E.Miller, 'Power Electronic Control in Electrical Systems', Newness Power Engineering Series, 2002.*
4. *T.J.E.Miller, 'Reactive Power Control in Electric Systems', Wiley Publications, 1982.*

COURSE OUTCOMES:

Upon completion of the course, the students shall be able to

1. Understand various Power flow control issues in transmission lines, for the purpose of identifying the scope and for selection of specific FACTS controllers.
2. Apply the concepts in solving problems of simple power systems with FACTS controllers.
3. Design simple FACTS controllers.

EEPE25 – SPECIAL ELECTRICAL MACHINES

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15, EEPC19
No. of Credits: 3

Course Objectives:

To expose the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of basic electrical machines.

Course Content:

Constructional features – Types – Axial and Radial flux motors – Operating principles –Variable Reluctance and Hybrid Motors – SYNREL Motors – Voltage and Torque Equations – Phasor diagram - Characteristics.

Constructional features–Principle of operation–Variable reluctance motor –Hybrid motor–Single and multi-stack configurations –Torque equations – Modes of excitations–Characteristics–Drive circuits–Microprocessor control of stepping motors – Closed loop control.

Constructional features–Rotary and Linear SRMs-Principle of operation–Torque production– Steady state performance prediction – Analytical method – Power Converters and their controllers– Methods of Rotor position sensing–Sensor less operation–Closed loop control of SRM- Characteristics.

Permanent Magnet materials–Magnetic Characteristics –Permeance coefficient-Principle of operation–Types–Magnetic circuit analysis–EMF and torque equations –Commutation- Power controllers–Motor characteristics and control.

Principle of operation–Ideal PMSM – EMF and Torque equations – Armature reaction MMF– Synchronous Reactance – Sinewave motor with practical windings - Phasor diagram – Torque/speed characteristics- Power controllers- Converter Volt-ampere requirements.

Textbooks:

1. *T.J.E.Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1993.*
2. *T.Kenjo, 'Stepping Motor and Their Microprocessor Controls', Clarendon Press London, 1995.*

Reference Books:

1. *R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.*
2. *P.P.Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 2002.*
3. *T.Kenjo and S.Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.*

COURSE OUTCOMES:

Upon completion of the course the students would be able to understand the construction, principle of operation and performance of

1. Synchronous Reluctance motors
2. Stepping motors
3. Switched Reluctance motors
4. Permanent Magnet Brushless D.C. motors
5. Permanent Magnet Synchronous motors.

EEPE26 – WIND AND SOLAR ELECTRICAL SYSTEMS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15, EEPC19
No. of Credits: 3

Course Objectives:

To familiarize the students with basics of solar and wind energy systems and various techniques for the conversion of solar and wind energy into electrical energy.

Course Content:

Basic characteristics of sunlight – solar spectrum – insolation specifics– irradiance and irradiation- pyranometer – solar energy statics- Solar PV cell – I-V characteristics –P-V characteristics– fill factor- Modeling of solar cell– maximum power point tracking.

PV module – blocking diode and bypass diodes– composite characteristics of PV module – PV array– PV system –PV-powered fan–PV fan with battery backup–PV-powered pumping system –PV powered lighting systems– grid- connected PV systems.

Wind source–wind statistics-energy in the wind –turbine power characteristics - aerodynamics – rotor types – parts of wind turbines– braking systems–tower- control and monitoring system.

General characteristics of induction generators– grid-connected and self-excited–steady- state equivalent circuit-performance predetermination–PMSG–steady-state performance.

Power electronic converters for interfacing wind electric generators – power quality issues-hybrid systems- wind-diesel systems – wind-solar systems.

Textbooks:

1. *S N Bhadra, S Banerjee and D Kastha, 'Wind Electrical Systems', Oxford University Press, 1st Edition, 2005.*
2. *Chetan Singh Solanki, 'Solar Photovoltaics: Fundamentals, Technologies and Applications' PHI Learning Publications, 2nd Edition, 2011.*

Reference Books:

1. *Roger A. Messenger and Jerry Ventre, 'Photovoltaic Systems Engineering', Taylor and Francis Group Publications, 2nd Edition, 2003.*
2. *M. Godoy Simoes and Felix A. Farret, 'Alternative Energy Systems: Design and Analysis with Induction Generators', CRC Press, 2nd Edition, 2008.*
3. *Ion Boldea, 'The Electric Generators Handbook- Variable Speed Generators', CRC Press, 2010.*
4. *Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, 'Power Conversion and Control of Wind Energy Systems', IEEE Press Series on Power Engineering, John Wiley & Sons, 2011.*
5. *S. Sumathi,L. Ashok Kumar,P. Surekha ,'Solar PV and Wind Energy Conversion Systems', Springer 2015.*

COURSE OUTCOMES:

Upon completion of this course students will be able to

1. Describe the solar radiation, measurements and characteristics of solar PV cell.
2. Develop the model of a PV system and its applications.
3. Describe the basic types and mechanical characteristics and model of wind turbine.
4. Analyze the electrical characteristics and operation of various wind-driven electrical generators.
5. Understand various power electronic converters used for hybrid system.

EEPE27 – SOLID STATE DRIVES

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15, EEPC19
No. of Credits: 3

Course Objectives:

- To understand the basic concept of DC and AC Drives.
- To understand the various control techniques involved with both DC and AC Drives.
- To brief about the working principle of Special Electrical Drives.

Course Content:

Introduction to solid state drives, various components – power converters, motors, loads, coupling mechanisms – Stability of drive.

Modeling of DC motor drives – Transfer function and state-space models - Experimental determination of drive parameters – Speed control using AC to DC converters- Input performance parameters, Speed reversal schemes.

Chopper fed DC motor drives – Four quadrant operation, Input filters design – Dynamic braking with DC chopper - Type-C chopper fed regenerative braking - Operation with non-receptive lines.

Power converters for induction motor speed control - Harmonic behavior of induction motors-harmonic currents and harmonic torques using per phase equivalent circuit – Stator voltage control schemes - Speed control of wound type motors.

State-space modeling of induction motors – Voltage source-Inverter fed operation - Field oriented control schemes – Current source-inverter drives – Principle of vector control.

Textbooks:

1. *P.C.Sen, 'Thyristor DC Drives' John Wiley & Sons Publishers, New York, 2008.*
2. *R .Krishnan, 'Electric Motor Drives - Modeling, Analysis, and Control', Pearson Education Publishers, 1st Edition, 2011.*
3. *B.K.Bose, 'Modern Power Electronics and AC Drives', Pearson Education Publications, 2nd Edition, 2005.*

Reference Books:

1. *G.K. Dubey, 'Fundamentals of Electrical Drives', Narosa Publishing House, 2nd Edition, 2008.*
2. *T. Wildi, 'Electrical Machines Drives and Power Systems', Pearson Education Publications, 6th Edition, 2013.*
3. *Mohamed A. El-Sharkawi, 'Fundamentals of Electric Drives', Brooks/Cole, 2000.*

COURSE OUTCOMES:

Upon completion of this course, the student

1. Learns the fundamental concepts of power electronic converter fed DC and AC machines.
2. Can analyze the converter fed motor under different torque/speed conditions.
3. Will be able to design converter fed drives with existing/new control techniques.

EEPE28 – EMBEDDED SYSTEM DESIGN

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC22
No. of Credits: 3

Course Objectives:

To enable the learner to design a system with combination of hardware and software for a specific application.

Course Content:

Embedded System Architectures – ARM processor and SHARC processor - architectural design - memory organization -data operation-bus configurations. System on-chip, scalable bus architectures, Design example: Alarm clock, hybrid architectures.

Sensor and Actuator I/O – ADC, DAC, timers, Servos, Relays, stepper motors, H-Bridge, CODECs, FPGA, ASIC, diagnostic port.

Real time operating systems (RTOS) – real time kernel – OS tasks – task states – task scheduling – interrupt processing – clocking communication and synchronization – control blocks – memory requirements and control – kernel services.

Embedded Networks – Distributed Embedded Architecture – Hardware and Software Architectures, Networks for embedded systems– I2C, CAN Bus, Ethernet, Internet, Network-based design– Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

System Design – Specification, Requirements and Architectural design of PBX systems, Set-top box, Ink-jet printer, Laser printer, Personal digital Assistants.

Textbooks:

1. *Wayne Wolf, 'Computers as Components: Principles of Embedded Computing System Design', Morgan Kaufman Publishers, 2nd Edition, 2010.*
2. *C.M Krishna, Kang G. Shin, 'Real time systems', Mc-Graw Hill, 1st Edition, 2010.*
3. *GaIski D. Vahid F., Narayan S., 'Specification and Design of Embedded Systems', Prentice Hall, 1st Impression, 2007.*

Reference Books:

1. *Herma K., 'Real Time Systems: Design for Distributed Embedded Applications', Springer, 2nd Edition, 2011.*
2. *William Hohl, 'ARM Assembly Language, Fundamentals and Techniques', CRC Press, 2009.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Remember the concepts of process and controllers.
2. Apply the concepts for real-time applications.
3. Create a real-time system for particular applications.

EEPE29 - POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC20 EEPC18

No. of Credits: 3

Course Objectives:

- To understand the economics of power system operation and planning.
- To realize the requirements and methods of real and reactive power control in power system.
- To recognize the recent advancements in power system operation.

Course Content:

Load curves and forecasting – load factor, demand factor, diversity factor, capacity factor, utilization factor - Types of Electrical Tariff – Economic decision making in power system planning

Restructuring of power system – spot and derivative markets – economics of microgrids and distributed generation

Economic Dispatch and Unit Commitment - General problem formulation and constraints - Offer and locational marginal pricing-based dispatch - Solution methods.

Load frequency control of single area and two area systems - Tie line bias control - Automatic Voltage Regulator and its dynamics

Reactive power and Voltage control – General concepts of series and shunt compensation – Introduction to FACTS

Textbooks:

1. *Allen J. Wood, Bruce F. Wollenberg and Gerald B Sheble, 'Power Generation, Operation, and Control', John Wiley and Sons, 3rd Edition, 2014.*
2. *Steven Stoft, 'Power system economics', Wiley India, 2002*
3. *Abhijit Chakrabarti & Sunita Halder, 'Power System Analysis- Operation & Control', PHI New Delhi, 3rd Edition, 2010.*
4. *Daniel Kirschen and Goran Strbac, 'Fundamentals of Power System Economics', John Wiley, 2004*

Reference Books:

1. *Robert H.Miller, James H.Malinowski, 'Power System Operation', Tata McGraw-Hill, 2nd Edition, 2009.*
2. *Nikos Hatziargyrio, 'Microgrids – Architectures and Control', Wiley-IEEE Press, 2014*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Calculate various factors such as load factor, demand factor, etc. and interpret different tariff and pricing structures.
2. Develop generation dispatching schemes for conventional and restructured power systems.
3. Apply frequency, voltage and reactive power control schemes on power system.

EEPE30 / EEOE14 – DIGITAL CONTROL SYSTEMS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites*:*** EEPC20
No. of Credits: 3

Course Objectives:

To learn the digital control design techniques.

Course Content:

Introduction- Comparison between analog and digital control-Importance of digital control- Structure of digital control- Examples of digital control system- Difference equations- Z-transform- MATLAB examples. Frequency response of discrete-time systems- Properties of frequency response of discrete-time systems-Sampling theorem.

ADC model-DAC model-Transfer function of zero order hold-DAC, Analog Subsystem, and ADC Combination Transfer Function-Closed loop transfer function–Steady state error and its constants (MATLAB commands).

Definitions of stability (Asymptotic stability, exponential stability etc) – stable z-domain pole placement locations-stability conditions-Stability determination (Routh array)-Nyquist criterion.

Root locus-root locus design (P-control, PI -control, PD) - Z-domain root locus- z-domain root locus design-digital implementation of analog controller design (differencing methods forward and backward)- bilinear transformation-direct z- domain controller design-frequency response design-Finite time response settling time.

Concept of state space method-state space representations of discrete time systems- solving discrete time state space equations- Pulse transfer function matrix- Discretization of continuous state space equations-Liapunov stability analysis (discrete time) Controllability – observability-design via pole placement-state observers.

Textbooks:

1. *Kannan M. Moudgalya, 'Digital Control', Wiley Publishers, 1st Illustrated Edition, 2007.*
2. *M.Gopal, 'Digital Control Engineering', New Age International (ltd) Publishers, 1st Edition Reprint (2003), 1998.*

Reference books:

1. *M. Sam Fadalli, 'Digital Control Engineering Analysis and Design', Elsevier Publication, 1st Edition, 2012.*
2. *Katsuhiko Ogata, 'Discrete Time Control Systems', Pearson Education Publications, 2nd Edition, 2005.*

COURSE OUTCOMES:

Upon completion of this course, the students can

1. Understand the fundamental differences between continuous time control and digital control.
2. Analyse the advantages of digital control over the continuous time control.
3. Develop digital controllers explicitly compared to continuous time controller.

**Pre-requisite not required for registration as Open Elective*

EEPE31 - OPERATIONS RESEARCH

Course Type: Programme Elective (PE) ***Pre-requisites:*** MAIR32
No.of Credits: 3

Course Objectives:

To equip students to identify and formulate real life problems using mathematical modeling; devise a solution procedure; analyze and interpret the results; revise for the process based on the actual results.

Course Content:

Linear Programming: Basic concepts – Mathematical formulation of L.P.P – Graphical solution – simplex method – Charnes' Big-M method – Two-phase method – Dual Theory - Dual simplex method.

Sensitivity Analysis - Transportation and Assignment problems: Transportation problem – Assignment problem.

Integer programming and CPM-PERT: Gomory's method – Branch and bound technique – Critical path in networks – CPM – Time and Cost aspects in networks – PERT.

Queueing Theory and Inventory models: Classification of queues – Poisson arrivals – Exponential service time – M/M/1 and M/M/c models – Inventory control – E.O.Q. with uniform demand, with finite rate of replenishment and with shortage – Buffer stock – Inventory with price breaks – Basic probabilistic models.

Dynamic programming: Recursive equation approach – applications to shortest path network, Inventory and production control – solution of LPP by dynamic programming - Travelling salesman problem.

Textbooks:

1. *Hamdy A. Taha, 'Operation Research – An Introduction', Pearson Education, 9th Edition, 2014.*

Reference Books:

1. *Gass, S.I., 'Linear Programming: Methods and Applications', McGraw-Hill Ltd, 1975.*
2. *Hillier, F.S., and Lieberman, G.J., 'Operation Research', McGraw-Hill Ltd, 9th Edition, 2009.*
3. *Harvey. M.Wagner, 'Principles of Operations Research with Applications to Managerial Decisions', Prentice Hall India, 2nd Edition, 1999.*
4. *Gillet, M.N., 'Introduction to Operation Research', Tata McGraw-Hill Education Pvt Ltd, 1st Edition, 2010.*

COURSE OUTCOMES:

Upon completing the course, the student will be able to

1. Increase the analytical skill of identifying and solving engineering problems.
2. Optimizing the resources and input-output process.
3. Devising new techniques for the better understanding of real-life situation.

#Will be offered by the Department of Mathematics.

EEPE32/EEOE15 - ELECTRIC VEHICLE TECHNOLOGY

Course Type: Programme Elective (PE) ***Pre-requisites:*** -
No.of Credits: 3

Course Objectives:

The main objective of this course is to understand the basics of vehicle dynamics, drive train control, energy storage technology and vehicle design

Course Content:

Introduction to vehicle dynamics – Fundamentals of vehicle propulsion and brake – Vehicle Resistance – Dynamic equation of vehicle motion – Tire-Ground Adhesion – Maximum tractive effort – Power train tractive effort – Vehicle power plant characteristics – Transmission characteristics – Vehicle Performance – Gradeability – Acceleration performance – Brake performance

Basic components of electric vehicles – Fundamentals of electric traction – Basic architecture of electric drive trains – Electric vehicle drive train topologies – Configuration and power flow control of series, parallel and hybrid drive trains – Power converters for electric vehicles

Electric vehicle storage technology – Different types of batteries for electric vehicles – Basic battery parameters – Battery modeling and equivalent circuit – Methods of electric vehicle battery charging – Alternative energy sources – Hydrogen storage systems – Reformers – Supercapacitors/Ultracapacitors - Fuel cell powered vehicles – Flywheel technology

Electric propulsion drive systems – DC motor drives and control – Induction motor drives and control – Permanent magnet brushless DC motor drives and control – AC and Switch reluctance motor drives and control – Drive system efficiency

Design specifications – Selection of motor and sizing – Selection of power electronics components and sizing – Inverter technology – Design of battery pack and auxiliary energy storage system – Design of ancillary systems – EV recharging and refueling system design

Reference Books:

1. K. T. Chau, 'Electric vehicle machines and drives: Design, analysis and application', first edition, John Willey and Sons Singapore pte. ltd., 2015.
2. M. Ehsani, Y. Gao and A. Emadi, 'Modern electric, hybrid electric and fuel cell vehicles: Fundamentals, Theory and design', second edition, CRC press, 2011.
3. J. Larminie and J. Lowry, 'Electric vehicle technology explained', second edition, John Willey and Son ltd., 2012.
4. I. Husain, 'Electric and hybrid vehicles: Design fundamentals', CRC press, 2003.

EEPE33/EEOE24 - DESIGN THINKING

Course Type: Programme Elective (PE)/Open Elective ***Pre-requisites:*** -
No.of Credits: 3

Course Objectives:

To understand the design philosophy of growth-oriented business ideas by creative thinking.

Course Content:

Understanding human needs

Creating, Delivering and Sustaining values, empathy and understanding, opportunities.

Concept visualization

Methods and Mind sets – outcome formation – case studies

Strategies

Principles and framework, scalability, Assessing current stage, framing opportunities

Transformation

Enterprise innovation, preparing quests, competency mapping, team charters and articulation

Data Mining and Analysis

Data mining, soft data conversion, creating human archetypes, experience mapping, creating activity systems

Reference Books:

1. Heather M.A. Fraser, *Design Works*, University of Toronto Press, 2012
2. Nigel Cross, *Design Thinking,* Bloomsbury Academic, 2016

COURSE OUTCOMES:

Upon completing the course, the student will be able to

1. Conceive need for an enterprise
2. Carry out strategic planning
3. Evolve methodology for innovative implementation

EEPE34- MACHINE LEARNING AND DEEP LEARNING

Course Type: Programme Elective (PE)

Pre-requisites: MAIR32

No.of Credits: 3

Course Objectives:

1. To get familiarize with the introduction to machine learning and deep learning
2. To analyse and illustrate various categories of learning schemes
3. To develop skills of solving practical applications

Course Content:

Introductions to Machine Learning: Categories, Supervised learning (SL), Classification, Regression-error based learning, examples, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Unsupervised Learning (USL), Application of USL for clustering-noise reduction-Dimensionality Reduction, Semi Supervised learning, Reinforced Learning –Genetic algorithm

Classification and Clustering: k-means clustering, Binary Classification, Multi- Class, Classification Techniques, k-nearest neighbours, Support Vector Machines, Naïve Bayes Classifier-Gaussian based Naïve Bayes, Decision Trees-Binary and Bushy tress-tree building process- Regression trees-Stopping criteria & pruning

Introduction to neural network: Biological Neural networks- Perceptron Learning Algorithm, Linear Separability-Feedforward Networks: Multilayer Perceptron, Gradient Descent; Training Neural Network-validation and testing, Backpropagation neural networks, Empirical Risk Minimization, regularization, autoencoders, model selection, and optimization

Deep Neural Networks: Convolutional Neural networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Recurrent Neural Networks, Long Short-Term Memory, Gate Recurrent Unit, Deep Belief Network, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms

ML and DL Applications: Control, Optimisation, Forecasting, Data mining, Pattern recognition, Deep learning tools, Recent trends.

Textbooks:

1. E. Alpaydin, Introduction to Machine Learning, MIT Press, 2009
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. J.
3. D. Kelleher, B. M. Namee and Aoife D'Arcy, MIT Press, 2015.
4. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.
5. Fundamentals of Neural. Networks: Architectures, Algorithms, and. Applications, Laurene Fausett, Prentice-. Hall, 1994

Reference Books:

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
4. T. M. Mitchell, Machine Learning, McGraw-Hill, 1997
5. P. Harrington, Machine learning in action, Manning Publications Co,2012
6. J. Bell, Machine Learning for Big Data, Wiley 2014.
7. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning. Cambridge University Press. 2017. [SS-2017]
8. P. Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition, Cambridge University Press, 2012.
9. S. J. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. Third Edition, Prentice-Hall, 2010.
10. Y. S. Abu-Mostafa, M. Magdon-Ismail, H.-T. Lin. Learning from Data: A Short Course. First Edition, 2012.
11. Pattern Recognition and Machine Learning, Christopher Bishop, 2007
12. Zbigniew Michalewicz. Genetic Algorithms. + Data Structures. = Evolution Programs,Third Edition 1995.
13. NPTEL and IEEE Journals related to ML and DL.

COURSE OUTCOMES:

Upon completing the course, the student will be able to

1. Remember various types of machine learning and deep learning algorithms
2. Analyse various classification and Clustering methods in ML and DL
3. Apply ML and DL algorithms for solving practical applications related to electrical and electronics engineering

EEPE35– NANO ELECTRONICS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC13
No.of Credits: 3

Course Objectives:

A unique course to explore the nano-electronic devices and its applications.

Course Content:

Limitations of conventional MOSFETS at Nano scales, introductory concepts of Ballistic transport and Quantum confinement, Difference in few electron devices (as analog version) and single Electron Devices (as digital version) of Nano Electronic devices, Quantum Effects in MOSFETS, Double – gate MOSFET, Multi- gate MOSFETs, FIN-FET.

Resonant Tunneling phenomena and applications in diodes & Transistors – principles of single electron Transistor – split- gate transistor, Electron wave Transistor, Electron – spin transistor, Quantum Oscillators, Quantum cellular Automata (QCA), Introduction to Quantum computing devices.

Carbon – Nano tube theory: Structure & nomenclature, Optical properties, electronic structure of graphene, SW & MW CNTs, 1D quantization in nano tubes, CNTFETs, CNT memories, CNT based swiches, Logic gates,

Overview, Characterization of switches and complex molecular devices, poly phenylene based molecular rectifying diode swiches. Polymer electronics, self – assembling circuits, optical molecular memories technologies, Quantum mechanical Tunnel devices, Quantum Dots & Quantum wires.

Introduction to spintronics, principles & concepts, spintronic devices & applications, spin – filters, spin diodes, spin transistors.

Reference Books:

1) Shunri Oda, David Ferry, "*Silicon Nano electronics*", CRC Press, 2006.
2) CNR Rao & A. Govindaraj , "*Nano tubes & nano wires*", RSC publishing, 2005
3) Ben Rogers, Jesse Adams, Sumita Pennathur,"*Nano technology*", CRC Press, 2017.
4) M. Meyyappan, "*Carbon Nanotubes – Science and applications*", CRC Press, 2004.

COURSE OUTCOMES:

Upon completing the course, the student will be able to

1. To enrich the electronic device concepts and operation.
2. To understand the devices made for quantum electronics.
3. To appreciate the concepts of carbon nanotubes and its application to circuits.
4. To apply the nanoelectronics concepts for different applications
5. To enlighten the concepts of spintronics and its use in electronic device

Will be offered by the Department of Electronics and Communication Engineering

EEPE36 - COMMUNICATION SYSTEMS#

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC14, EEPC17
No. of Credits: 3

Course Objectives:

- To develop a fundamental understanding on communication systems with emphasis on analog and digital modulation techniques.
- To get introduced to the basics of error control coding techniques.

Course Content:

Basic blocks of Communication System. Analog Modulation - Principles of Amplitude Modulation, DSB-SC, SSB-SC and VSB-SC. AM transmitters and receivers.

Angle Modulation - Frequency and Phase Modulation. Transmission Bandwidth of FM signals, Methods of generation and detection. FM Transmitters and Receivers.

Sampling theorem - Pulse Modulation Techniques - PAM, PWM and PPM concepts - PCM system - Data transmission using analog carriers (BASK, BFSK, BPSK, QPSK).

Error control coding techniques – Linear block codes- Encoder and decoder. Cyclic codes – Encoder, Syndrome Calculator. Convolution codes.

Modern Communication Systems – Microwave communication systems - Optical communication system - Satellite communication system - Mobile communication system.

Textbooks:

1. *Simon Haykins, 'Communication Systems', John Wiley, 3rd Edition, 1995.*
2. *D.Roddy & J.Coolen, 'Electronic Communications', Prentice Hall of India, 4th Edition, 1999.*
3. *Kennedy G, 'Electronic Communication System', McGraw Hill, 1987.*

Reference Books:

1. *Shulin Daniel, 'Error Control Coding', Pearson, 2nd Edition, 2011.*
2. *B.P. Lathi and Zhi Ding, 'Modern Digital and Analog Communication Systems', OUP USA Publications, 4th Edition, 2009.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Understand the basics of communication system, analog and digital modulation techniques.
2. Apply the knowledge of digital electronics and understand the error control coding techniques.
3. Summarize different types of communication systems and its requirements.

Will be offered by the Department of Electronics and Communication Engineering

EEPE37 - DATA STRUCTURES AND ALGORITHMS

Course Type: Programme Elective (PE) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

To obtain knowledge on data structures, their storage representation, and their usage in an algorithmic perspective.

Course Content:

Algorithms – Algorithmic Notation, Statements and Control Structures, Operations and Expressions, Functions, Procedures, Time, and Space requirement Analysis. Information - nature, storage and transmission of information, Primitive Data structures.

Linear Data structures and their sequential storage representation – arrays, hash, structures and array of structures, stacks, queues; their storage representation and applications. Strings – storage representation and string manipulation applications.

Linear Data structures and their linked storage representation – pointers, linked allocation- single, double and circular linked list and their applications.

Nonlinear data structures – Trees, storage representation and operation on binary trees, application of trees; Graphs- representations and applications of graphs.

Sorting and searching – Selection Sort – Bubble Sort – Merge Sort – Tree Sort – Partition-Exchange Sort. Searching – Sequential Searching – Binary Searching- Search trees, Hash-Table methods.

File Structures - External Storage Devices, Record Organization, File types and their structure. Exercises covering topics of functions, arrays, stacks, queues, linked lists and trees.

Textbooks:

1. *Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C++', Pearson, 4th Edition, 2013.*
2. *Debasis Samanta, 'Classic Data Structures', 2nd Edition, PHI learning, 2009.*
3. *Adam Drozdek-Duquesne, 'Data Structures and Algorithms in C++', Thomson Press, 3rd Edition, India Ltd., 2006.*

Reference Books:

1. *Michael T. Goodrich, Roberto Tamassia, David M. Mount, 'Data Structures and Algorithms in C++', 2nd Edition, Wiley, 2011.*
2. *John R.Hubbard, 'Schaum's Outline of Theory and Problems of Data Structures with C++', McGraw-Hill, New Delhi, 2000.*
3. *Jean Paul Tremblay and Paul.G.Sorenson, 'An Introduction to Data Structures with Applications', Tata McGraw Hill, 2nd Edition, 2008.*

COURSE OUTCOMES:

Upon completion of the course, the student will have

1. Knowledge on algorithmic notations and concepts; basic algorithmic complexity and primitive data structures.

2. Familiarity with linked linear and non-linear data structures and operations on such data structures.
3. Ability to program data structures and use them in implementations of abstract data types
4. Identify appropriate data structures and algorithms for problems and to justify that choice
5. Summarize various sorting , searching techniques and file structures

EEPE38– ELECTRIC POWER QUALITY

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC17, EEPC18

No. of Credits: 3

Course objective:

- To impart knowledge about various electric power quality phenomenon, causes and consequences.
- To familiarize the students to monitoring methods and essential mitigation techniques.

Course Content:

Electric power quality phenomena: Introduction to power quality, IEEE and IEC - EMC standards, overview of power quality disturbances - voltage variations, interruptions, transients, waveform distortion and power frequency variations.

Power quality indices and monitoring: Power definitions and power quality indices for single-phase, three-phase balanced and unbalanced systems under sinusoidal and nonsinusoidal conditions – importance and introduction to power quality monitoring.

Voltage variations: Definitions, sources, measurement, impact on equipment and mitigation of voltage sag, swell, interruption and voltage fluctuation.

Harmonics: Harmonic sources, measurement of harmonic distortion, current and voltage limits of distortion, harmonic analysis using Fourier transform, effects of harmonic distortion and harmonic filters – passive, active and hybrid.

Custom Power Devices: Introduction to shunt and series compensators, DSTATCOM, Dynamic Voltage Restorer (DVR) and Unified Power Quality Conditioner (UPQC).

Textbooks:

1. Dugan R. C., Mc Granaghan M. F. Surya Santoso, and Beaty H. W., 'Electrical Power System Quality', McGraw-Hill 2003.
2. Math H. Bollen, 'Understanding Power Quality Problems: Voltage sags and interruptions', IEEE Press, New York, 2000.
3. Ghosh, Arindam, and Gerard Ledwich, 'Power quality enhancement using custom power devices' Springer Science & Business Media, 2012.

Reference Books:

1. Math H. Bollen, Irene Gu, 'Signal Processing of Power Quality Disturbances' Wiley-IEEE Press, 2006.
2. J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', Wiley, 2011.

Course Outcomes:

Upon completion of the course, the students will be able to

1. Understand different types of power quality problems with their source of generation.
2. Interpret results of power quality monitoring equipment and classify the power quality disturbances.
3. Recommend viable solutions for mitigation of the power quality problems
4. Design active & passive filters for harmonic elimination.

EEPE39 - VLSI DESIGN

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC14, EEPC21

No. of Credits: 3

Course Objectives:

To enrich the student with the concepts of VLSI devices and its fabrication and also to develop different electronic circuits.

Course Content:

MOS characteristics: NMOS characteristics, inverter action – CMOS characteristics, inverter action - models and second order effects of MOS transistors – Current equation – MOSFET Capacitances - MOS as Switch, Diode/ resistor – current source and sink – Current mirror.

CMOS Fabrication – n-well, p-well, twin-tub processes – fabrication steps – crystal growth – photolithography – oxidation – diffusion – Ion implantation – etching – metallization.

CMOS Logic Circuits: Implementation of logic circuits using nMOS and CMOS, Pass transistor and transmission gates – Implementation of combinational circuits – parity generator – magnitude comparator – stick diagram – layout design.

Memory design – SRAM cell – 6T SRAM – DRAM – 1T, 3T, 4T cells, CMOS Sequential circuits: Static and Dynamic circuits – True Single-phase clocked registers – Clocking schemes.

ASIC - Types of ASICs - Design flow – Design Entry – Simulation – Synthesis – Floor planning – Placement – Routing - Circuit extraction – Programmable ASICs.

Textbooks:

1. *Neil Weste, David Harris, 'CMOS VLSI Design: A Circuits and Systems Perspective', Addison-Wesley, 4th Edition, 2010.*
2. *Debaprasad Das, 'VLSI Design', Oxford University Press, 2010.*
3. *Ken Martin, 'Digital Integrated Circuits', Oxford University Press, 1999.*
4. *Peter Van, 'Microchip Fabrication', Mc-Graw Hill Professional, 6th Edition, 2014.*

Reference Books:

1. *M. J. S. Smith, 'Application Specific Integrated Circuits', Addison Wesley, 1997.*
2. *Uyemura, 'Introduction to VLSI Circuits and Systems', Wiley, 1st Edition, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. To understand the insights of the MOS devices and its characteristics.
2. To appreciate the different VLSI process technologies.
3. To design the CMOS combinational logic circuits and its layout.
4. To develop the sequential circuits and clocking schemes.
5. To realize the Design flow of application-specific Integrated circuit.

EEPE40 – POWER SYSTEM RESTRUCTURING

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC18
No. of Credits: 3

Course Objectives:

To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.

Course Content:

Introduction – Market Models–Entities– Key issues in regulated and deregulated power markets; Market equilibrium- Market clearing price- Electricity markets around the world

Operational and planning activities of a GENCO -Electricity Pricing and Forecasting -Price Based Unit Commitment Design - Security Constrained Unit Commitment design – Ancillary Services - Automatic Generation Control (AGC).

Introduction-Components of restructured system-Transmission pricing in Open-access system - Open transmission system operation; Congestion management in Open-access transmission systems- FACTS in congestion management-Open-access Coordination Strategies; Power Wheeling- Transmission Cost Allocation Methods

Open Access Distribution – Changes in Distribution Operations-The Development of Competition–Maintaining Distribution Planning

Power Market Development – Electricity Act, 2003 - Key issues and solution; Developing power exchanges suited to the Indian market - Challenges and synergies in the use of IT in power- Competition- Indian power market- Indian energy exchange- Indian power exchange- Infrastructure model for power exchanges-Congestion Management-Day Ahead Market- Online power trading.

Textbooks:

1. *Daniel S. Kirschen, Goran Strbac, 'Fundamentals of Power System Economics, Wiley, 2018.*
2. *Mohammad Shahidehpour, Hatim Yamin, 'Market Operations in Electric Power Systems', John Wiley & Sons Inc., 2002.*
3. *Lorrin Philipson, H. Lee Willis, 'Understanding Electric Utilities and Deregulation', Taylor & Francis, New York, 2nd Edition, 2006.*

Reference Books:

1. *Mohammad Shahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems', Marcel Dekker, INC., New York, 1st Edition, 2001.*

Useful web links:

1. Indian Energy Exchange: http://www.iexindia.com/
2. Power Exchange India Limited: http://www.powerexindia.com/
3. Indian Electricity Regulations: http://www.cercind.gov.in/

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Upon completion of the course the students would be able to
2. Explain and differentiate the key issues involved in the regulated and de-regulated power markets.
3. Describe the operational activities in Generation, Transmission and Distribution system in the restructured environment.
4. Illustrate and solve problems in the de-regulated power System.
5. Explain and analyze the restructuring activities in Indian Power System.

EEPE41 – ECONOMIC EVALUATION OF POWER PROJECTS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC17
No. of Credits: 3

Course Objectives:

To assess the feasibility of power projects from business, financial, and sustainability perspectives.

Course Content:

Considerations in Project Evaluation – Project Selection and Evaluation – Project Development – Pre-investment stage – Investment Stage – Operational Stage – Post Operational Phase

Evaluation of Power Generation Projects – Cost of Power Generation – Levelized Cost of Energy – Generation Planning – Investment Analysis– Time Value of Money – Net Present Value – Benefit/cost Ratio – Payback Period - Profit/investment Ratio – Business Economic Feasibility Study – Power Purchase Agreements

Investing in Transmission – The Nature of the Transmission Business – Cost-Based Transmission Expansion – Value-Based Transmission Expansion – TSO economics

Distribution System Finance – Tariff and Energy Bills – Financing Distributed Generation Projects – Net Metering – Net Feed-in - Rooftop Solar PV Business models – Grid-Connected and Stand-alone PV systems - Customer Savings Analysis – Grid Parity – Utility and DSO economics

Case Studies – Evaluation of Renewable and Non-Renewable Energy projects

Textbooks:

1. *Hisham Khatib, 'Economic Evaluation of Projects in the Electricity Supply Industry', 3rd edition, IET, 2014.*
2. *Marcelino Madrigal and Steven Stoft, 'Transmission Expansion for Renewable Energy Scale-Up', 2012, Washington DC, World Bank.*
3. *Santosh Raikar, Seabron Adamson, 'Renewable Energy Finance: Theory and Practice', Elsevier, 2019.*

Reference Books:

1. *Daniel S. Kirschen, Goran Strbac, 'Fundamentals of Power System Economics, Wiley, 2018.*
2. *Steven Stoft, 'Power System Economics: Designing Markets for Electricity', Wiley-IEEE Press, 2002.*
3. *Contemporary Research Papers, Project Reports and Allied Materials*

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

- do a basic cost-benefit analysis of power projects in generation, transmission, and distribution
- study the different business models in power systems
- study the different metering techniques
- analyze and evaluate the economics of power projects

EEPE42 – INTRODUCTION TO SWITCHED MODE POWER SUPPLIES

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC19
No. of Credits: 3

Course Objectives:

To understand the concepts and design of switched mode power converters for real world applications

Course Content:

Linear power supplies, Shunt Regulators, concept of switched mode power supplies, ideal characteristics of switch, realization of ideal switch characteristics from semiconductor switches, current bidirectional switch realization, voltage bidirectional switch realization, four quadrant switch realization, Volt- second balance, charge second balance, small ripple approximation.

Steady state analysis of basic non-isolated converters, Continuous conduction mode operation, Analysis of basic converters in discontinuous conduction mode, selection of components-switches, Diodes, Inductor, capacitor.

Steady state analysis of isolated converters, forward converter, Core resetting techniques in forward converters, flyback converter, flyback converter with RCD clamp, Two switch flyback converter, Half bridge and full bridge DC/DC converter.

Gate Driver Design, Capacitors for Power supplies, Magnetic materials for Power Electronics, high frequency Inductor design, high-frequency Transformer design, Heat sink design, Snubber circuit design.

Applications of switched mode power supplies in consumable electronics, fuel cell power generation system, solar PV systems, Data centre power system, EV onboard and offboard battery charging systems, microgrid.

Textbooks:

1. *Ned Mohan "Power Electronics: A First Course,", First edition, Wiley Publication, 2011.*
2. *Robert Erickson, Dragan Maksimovic "Fundamentals of power electronics", Springer publications, 2001.*

Reference Books:

1. *Simon S. Ang, Alejandro Oliva, "Power-Switching Converters" CRC Press Publications, 3rd edition,2010.*
2. *Daniel Hart "Power Electronics" McGraw Hill; 1st edition, 2010.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. realize various ideal switching characteristics from semiconductor switches
2. analyse various non-isolated and isolated power converters
3. analyse and design the HF inductor, transformer, gate drivers
4. apply the knowledge to real world applications

EEPE43 / EEOE25– OPTIMAL AND ROBUST CONTROL

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites:*** EEPC20/Control Systems

No. of Credits: 3

Course Objectives:

To understand the basic characteristics of system dynamics and control
To characterize model uncertainties in dynamic systems
To determine robustness through stability margins
To parameterize the stabilizing controllers and interpret stabilizing solutions
To understand standard LQR problems and stability margin

Course Content:

Linear dynamical system – concept of observers – observers-based controllers – state space realizations for transfer matrices – Lyapunov equations – Balanced realizations – Hidden modes and pole zero cancellation – multivariable system poles and zeros

Normed spaces, Hilbert spaces - Hardly spaces - power and spectral signals – induced system gains – computing norms - feedback structure - well-posedness of feedback loop – Internal stability – Coprime factorization – concept of loop shaping – weighted performance

Model reduction by balanced truncation – frequency and weighted balanced model reduction – relative and multiplicative model reduction – optimal Hankel norm approximation – Toeplitz operators – Nehari's theorem – Model uncertainty – small gain theorem – stability under stable unstructured uncertainties - unstructured robust performance

Structure singular value – structured robust stability and performance – overview on μ synthesis – existence stabilizing controllers – parametrization of all stabilizing controllers – Youla parameterization – co-prime factorization – stabilizing solutions – Riccati equation

Regulator problem – standard LQR problem – Extended LQR problem – Guaranteed stability margins of LQR – standard H_2 problems- separation theory – output feed H_∞ control – disturbance feedback – optimal controller H_∞ loop shaping – controller order reduction – discrete time control

Textbooks:

Robust and Optimal Control, K. Zhou, J. Doyle, and K. Glover, Prentice Hall, 1st edition, 1995, ISBN-13: 978-0134565675.
Optimal Control, F. L. Lewis, D. Vrabie, V. L. Syrmos, Wiley, 3rd edition, 2012, ISBN-10: 0136024580.

Reference Books:

Optimal Control Theory for Applications, D. G. Hull, Springer, 2010, ISBN-13: 9781441922991.
Donald E. Kirk, Optimal Control Theory, An introduction, Prentice Hall Inc., 2004.
A.P. Sage, Optimum Systems Control, Prentice Hall, 1977.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

perform problem formulation, performance measure and mathematicaltreatment of optimal control problems so as to apply the same to engineering control problemswith the possibility to do further research in this area.
Solve optimal control design problems by taking into consideration the physical constraints on practical control

systems.

Produce optimal solutions to controller design problems taking into consideration the limitation on control energy and robustness in the real practical world.

EEPE44 / EEOE26 – ROBOTICS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

- To introduce the functional elements of robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

Course Content:

Robot classifications - Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance - Joint space technique - Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler Formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

Sensors Classification, sensor characterization, wheel/motor encoders, heading/orientation sensors, ground based beacons, active ranging, motion/speed sensors, vision-based sensors. Low level control, Control architectures, software frameworks, Robot Learning, case studies of learning robots.

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Textbooks:

1. *R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.*
2. *JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.*

Reference Books:

1. *M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- understand basic concept of robotics.
- analyze instrumentation systems and their applications to various robot model.
- choose different sensors and measuring devices according to the applications.
- explain about the differential motion add statics in robotics
- model various path planning techniques.
- explain about the dynamics and control in robotics industries.

EEPE45 / EEOE27 – BATTERY MANAGEMENT SYSTEMS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites:*** -
No. of Credits: 3

Course Objectives:

- To understand the basic operation and parameters associated with a battery.
- To know the functions of Battery Management System.
- To differentiate different types of Battery Management System.
- To analyze the battery performance and fault.
- To understand the protection mechanisms of Battery Management System.

Course Content:

Basic battery parameters -Cells & Batteries -Nominal voltage and capacity - C rate - State of Charge - State of Health - Energy and power – series and parallel operation - Charging and Discharging Process - Overcharge and Undercharge - Modes of Charging - Equivalent-circuit models.

Introduction and BMS functionality - Battery pack topology - BMS Functionality - Voltage Sensing - Temperature Sensing - Current Sensing - High-voltage contactor control - Isolation sensing - Thermal control – Protection - Communication Interface - Range estimation - State-of-charge estimation - Cell Balancing - Cell total energy - cell total power.

Battery state of charge estimation - voltage-based methods to estimate of charge – Model based state estimation - Battery State of Health Estimation - Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode.

Types of BMS - Centralized BMS - Modular BMS - Master-Slave BMS - Distributed BMS -Comparison of the different topology.

Protection of BMS - Thermal management - Types of thermal management system - Thermal management impact on battery performance - Cell Balancing - Types of Cell balancing - External Communication of BMS.

Textbooks:

1. *Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs"Artech House, 2010*
2. *Plett, Gregory L. Battery management systems, Volume I: Battery modeling. ArtechHouse, 2015.*
3. *Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuitmethods. Artech House, 2015.*

Reference Books:

1. *Bergveld, H.J., Kraits, W.S., Notten, P.H.L "Battery Management Systems -Design byModelling" Philips Research Book Series 2002.*
2. *Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication forbattery-powered applications. Vol. 9. Springer Science & Business Media, 2008.*
3. *Halil S. Hamut, Nader Javani, Ibrahim Dinçer "Thermal Management of Electric Vehicle Battery Systems" John Wiley & Sons, 29-Dec-2016.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- Interpret the role of battery management system
- Identify the requirements of Battery Management System
- Interpret the concept associated with battery charging / discharging process
- Calculate the various parameters of battery and battery pack
- Design the model of battery pack

EEPE46 – POWER SYSTEM RELIABILITY

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC17
No. of Credits: 3

Course Objectives: To understand theoretical foundations of reliability analysis and to apply them on power system reliability evaluation

Course Contents:

Introduction to Probability and Statistics: introduction to probability, probability density function, probability distribution function, Expectation, Variance, Covariance and Correlation and stochastic processes, Bernoulli Random Variable, Binomial Random Variable, Poisson Random Variable, Uniform Random Variable, Exponential Random Variable, Normal Random Variable, Weibull Random Variable

General reliability modeling and evaluation: system modeling for reliability; methods of reliability assessment: state space, cut-set and tie-set analysis, decomposition; Markov Approach

Reliability modeling and analysis of electric power systems: bulk power systems, distribution systems, and industrial systems. Component modeling: generator modeling, transmission line modeling, load modeling; capacity outage table; probability and frequency distributions; unit addition algorithm; load modelling algorithm. Generation adequacy assessment using discrete convolution: discrete convolution of generation and load models; generation reserve model; determination of LOLP, LOLF, EUE.

Reliability of multi-node systems: methods for multi-area and composite system analysis; contingency enumeration/ranking; equivalent assistance; stochastic/ probabilistic load flow; state space decomposition; Monte Carlo simulation, Analysis of risk in power systems; understanding of causes and remedial measures; Modelling of variable energy resources

Textbooks:

1. *Chanan Singh, Panida Jirutitijaroen, Joydeep Mitra, 'Electric Power Grid Reliability Evaluation: Models and Methods', 1st edition, Wiley-IEEE Press, 2018.*
2. *Marko Čepin, 'Assessment of Power System Reliability: methods and Applications', 1st edition, Springer, 2011.*
3. *G.F. Kovalev, L.M. Lebedeva, 'Reliability of Power Systems', 1st edition, Springer, 2019.*

Reference Books:

1. *Wenyuan Li, 'Risk Assessment of Power Systems: Models, Methods, and Applications', 2nd edition, Wiley-IEEE Press, 2014.*
2. *Roy Billington, Ronald N Allan, 'Reliability Evaluation of Power Systems', 2nd edition, Springer, 1996*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Model and assess reliability of systems undergoing stochastic events
2. Apply probabilistic models to evaluation of power system reliability
3. Model variations in load demand and output of renewable energy sources

MINOR

EEMI10 / EEOE16 - BASICS OF ELECTRICAL CIRCUITS

Course Type: Minor (MI)/Open Elective (OE) ***Pre-requisites:*** --
No. of Credits: 3

Course Objectives:

The practical application of electricity involves the flow of electric current in a closed path under the influence of a driving force. A complete path, typically through conductors such as wires and through circuit elements, namely, resistor (R), inductor (L) and capacitor(C) is called an electrical circuit. In fact, electrical circuits are everywhere, from tiny ones in integrated circuits in mobile phones and music players, to giant ones that carry power to our homes. This course deals with analysis techniques that can be applied to all such circuits. After completion of this course, one should be able to analyze any linear circuit comprising of circuit elements, R, L and C along with the voltage and current sources.

Course Content:

Review of Electrical elements and circuits, Kirchhoff's laws, voltage and current sources, controlled sources, RMS and average values for typical waveforms, power and energy in electrical elements, phasor representation, series and parallel RLC circuits -simple examples.

Self and mutual inductance, coefficient of coupling, Capacitance, Series-parallel combination of inductance and capacitance, Series and parallel resonant circuits.

Circuit analysis using Node voltage and Mesh current methods, analysis with dependent source and special case.

Equivalent circuits, star-delta transformation, source transformation, Thevenin, Norton, Superposition and Maximum power transfer theorems.

Three-phase circuits, balanced three-phase voltages, analysis of three-phase star and delta connected circuits, balanced and unbalanced systems, power calculations, power measurement using two wattmeter method.

Reference Books:

1. *James W. Nilsson and Susan A. Riedel, "Electric Circuits", International Edition Adapted by Lalit Goel, Pearson Education, 8th Edition, Seventh Impression, 2012.*
2. *A. Sudhakar and Shyammohan S Pillai, "Circuits and Networks", Tata McGraw Hill, New Delhi, 4th Edition, 2010.*
3. *William H. Hayt, Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th Edition, 2012.*
4. *Mahmood Nahvi, Joseph Edminister, "Schaum's Outline of Electric Circuits", McGraw Hill Education, 6th Edition, 2014.*

COURSE OUTCOMES:

After completion of this course, the student will be able to

1. Understand the concept of phasors, waveforms and behaviour of basic circuit components.
2. Obtain the equivalent inductance and capacitance and understand the operation of resonant circuits.
3. Use node voltage and mesh current methods to solve electrical circuits.
4. Obtain the equivalent circuit and apply network theorems to circuits.
5. Analyze the three-phase system.

EEMI11 / EEOE17 - ELECTRICAL MACHINES

Course Type: Minor (MI)/Open Elective (OE)
No. of Credits: 3
Pre-requisites: Basic Electrical and Electronics Engineering

Course Objectives:

To disseminate an overview of various electric machines used in industries, power generation and home appliances with a technical know-how on the control techniques.

Course Content:

DC motors: Construction and working principle, emf equation, torque equation, starting and running characteristics, speed control, braking, duty of operation, choice of motors.

Transformers: Construction and working principle, equivalent circuit, regulation and efficiency, auto-transformers, industrial applications – welding transformer and furnace transformer.

Three-phase induction machines: Construction and working principle. Induction motors - torque-equation, torque–slip characteristics, starting and running characteristics, speed control, braking, choice of motor for industrial applications and traction.

Synchronous Machines: Construction, principle of operation and types, various types of excitation systems, stand alone and grid connected modes of operation, voltage and frequency control.

Fractional horse power machines: Single phase induction motors – Construction and principle of operation, types, applications in home appliances. Construction, operation and applications of Brushless DC motors, Stepper motors, Servomotors and AC Series motors.

Reference Books:

1. D.P.Kothari and I.J.Nagrath, 'Electric Machines', McGraw Hill Education Private Limited, 4th Edition, 2010.
2. Gopal K. Dubey, 'Fundamentals of Electrical Drives', Narosa publishing house, 2nd Edition, 2011.
3. A Fitzgerald , Charles Kingsley , Stephen Umans, 'Electric Machinery', McGraw Hill Education Private Limited, 6th Edition, 2002.
4. K. Murugesh Kumar, 'Induction & Synchronous Machines', Vikas Publishing House Pvt Ltd., 2009.
5. Edward Hughes, 'Electrical and Electronic Technology', Dorling Kindersley (India) Pvt. Ltd., 10th Edition, 2011.
6. Ashfaq Husain, 'Electric machines', Dhanpat Rai & Company, 2nd Edition, 2002.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

1. Understand the constructional details and principle of operation of DC motors, induction machines, alternators, transformers and fractional horse-power motors.
2. Evaluate the performance of starting and operating characteristics of various electrical machines used in industrial and domestic applications.
3. Choose an appropriate method of speed control and braking for the drive motors.

EEMI12 / EEOE18 - CONTROL SYSTEMS ENGINEERING

Course Type: Minor (MI)/Open Elective (OE) **Pre-requisites:** -
No. of Credits: 3

Course Objectives:

To equip the students with the fundamental concepts in control systems.

Course Content:

Modelling of physical systems – Time-domain specifications - Generalised error series – various test signals and its importance- Routh-Hurwitz stability criterion

Root Locus Technique – Definitions - Root locus diagram - Rules for construction of root loci - Effect of pole zero additions on the root loci - root contours.

Frequency domain analysis – Bode plot - Polar plot - Nyquist plot.

Phase margin - gain margin - Nyquist stability criterion.

Controller design - P, PI, PID, lag, lead, lead-lag compensator design.

Textbooks:

1. Katsuhiko Ogata, 'Modern Control Engineering', Pearson Education Publishers, 5th Edition, 2010.
2. Nagrath I.J. and Gopal M, 'Control Systems Engineering', New Age International Publications, 5th Edition, 2010.

Reference Books:

1. Richard C. Dorf and Robert H. Bishop. 'Modern Control Systems', Pearson Prentice Hall Publications, 12th Edition, 2010.
2. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, 'Feedback Control of Dynamic Systems', Pearson Education India Publications, 6th Edition, 2008.
3. Benjamin C.Kuo and Farid Golnaraghi, 'Automatic Control Systems', John Wiley & Sons Publications, 8th Edition, 2002.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the concepts of closed loop control systems.
2. Analyse the stability of closed loop systems.
3. Apply the control techniques to any electrical systems.
4. Design the classical controllers such as P, PI, etc., for electrical systems.

EEMI13 / EEOE19 – ANALOG AND DIGITAL ELECTRONICS

Course Type: Minor (MI)/Open Elective (OE) **Pre-requisites*:** EEMI10
No. of Credits: 3

Course Objectives:

- To understand the concepts of analog and digital circuits.
- To impart knowledge on signal generation and measuring equipment.

Course Content:

Review of analog devices – Rectifier circuits - Wave shaping circuits - Clippers and Clampers – Regulators - Zener and op-amp based regulator circuits - Introduction to switched mode power supplies.

Review of digital components - Code converters- Programmable logic devices- CPLDs and FPGAs- Introduction to hardware description languages.

Oscillators & signal generator circuits - Function generator circuit - Pulse generator circuit - AM/FM signal generator circuit – Qualitative analysis.

Display Units - optoelectronic devices – Seven-segment displays - LCD and LED display units and applications.

Special electronic circuits – UJT Sawtooth generator circuit – Schmitt trigger – Analog-to-digital converter – Digital-to-analog converter circuits.

Reference Books:

1. David A Bell, 'Fundamentals of Electronic Devices and Circuits', Oxford University Press, Incorporated, 25- Jun-2009.
2. Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th Reprint (2008).
3. Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rdEdition, 2010.
4. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rdEdition, 2005.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Design and develop circuits using analog and digital components.
2. Understand the different generators and analyzers.
3. Appreciate the use of display units.
4. Identify the suitable oscilloscope for measurement.

**Pre-requisites not required when registering as open elective.*

EEMI14 / EEOE20 - POWER ELECTRONIC SYSTEMS

Course Type: Minor (MI)/Open elective (OE) **Pre-requisites*:** EEMI11
No. of Credits: 3

Course Objectives:

To introduce characteristics of power electronic devices, design of various power converter circuits and speed control concepts of AC and DC drives.

Course Content:

Power Semiconductor Devices –power diodes, power transistors, SCRs, TRIAC, GTO, power MOSFETs, IGBTs- Principle of operation, characteristics, ratings, protection and gate drive circuits.

Power Converters – AC to DC, AC to AC converters.

PWM based Power Converters: DC to DC, DC to AC converters.

Introduction to motor drives – Solid-state speed control of DC motor drive system.

Solid-state speed control of induction motor drive system.

Reference Books:

1. Rashid, M.H, ‘Power Electronics - Circuits, Devices and Applications’, Prentice Hall Publications, 3rd Edition, 2003.
2. P.C Sen, ‘Thyristor DC Drives’, John Wiley and Sons, New York, 1991.
3. R. Krishnan, ‘Electric Motor Drives – Modeling, Analysis and Control’, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
4. P.S. Bhimbra, ‘Power Electronics’, Khanna Publishers, 4th Edition, 2010.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Identify various power electronic devices and plot their switching characteristics.
2. Design DC power conversion circuits for simple applications.
3. Analyze inverter and cyclo-converter circuits.
4. Perform speed control of dc and induction motors.

**Pre-requisites not required when registering as open elective.*

EEMI15 / EEOE21 - POWER SYSTEMS ENGINEERING

Course Type: Minor (MI)/Open Elective (OE) **Pre-requisites*:** EEMI11
No. of Credits: 3

Course Objectives:

To impart knowledge on power generation, transmission, distribution and protection systems, and overview of power system economics and regulations.

Course Content:

Overview of generation systems: Sources of Energy, Steam, Diesel, Nuclear and Hydro power plants – site selection - Layout – essential components and operation.

Modes of Transmission and Distribution: HVAC and HVDC Transmission system – over-head lines – towers, conductors and insulators, underground cables – types – laying methods and fault location, comparison of over-head and underground systems, distribution system – classification – components, power factor correction.

Basic protection and switchgears: System faults and abnormal conditions, system grounding, need for protection system, overview of apparatus protection, switch gear mechanisms – fuse, switch, isolator and circuit breakers.

Economics on power systems: Factors affecting cost of generation – load curve – load factor – diversity, base load and peak load stations – reduction of generation cost by interconnection of stations, price of electricity – types of tariff for HT and LT consumers.

Regulation / Electricity Act: Evolution of Indian electricity act – regulator commissions, grid code, Introduction to restructuring of power system – GenCo, TransCo and DisCo, Independent power producers, Introduction to smart grid.

Reference Books:

1. R K Rajput, 'Power System Engineering', Laxmi Publications Ltd., 2006.
2. A Chakrabarti, M L Soni, P V Gupta and U S Bhatnagar, ' Power System Engineering', Dhanpat Rai & Co., Ltd., 2010.
3. S N Singh. 'Electric Power Generation, Transmission and Distribution', PHI Publications, 2008.
4. B.R. Gupta, 'Power System Analysis and Design', S. Chand Limited, 5th Edition, 2008.

COURSE OUTCOMES:

Upon the completion of this course the student will be able to

1. Illustrate the layout and operation of various power plants.
2. Infer the modes of transmission and distribution of electrical energy.
3. Select the appropriate protection scheme for various power apparatus.
4. Identify tariff structure and calculate the energy pricing.
5. Discuss about Indian electricity act and regulations.

**Pre-requisites not required when registering as open elective.*

EEMI16 / EEOE22 - ELECTRIC POWER UTILIZATION

Course Type: Minor (MI)/Open Elective (OE) **Pre-requisites*:** EEMI11
No. of Credits: 3

Course Objectives:

To understand the principles of operation and utilization of power in domestic and industrial appliances.

Course Content:

Illumination – Terminology, Laws of illumination, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps, Design of lighting schemes - factory lighting - flood lighting – street lighting.

Refrigeration - Domestic refrigerator and Air coolers, Air-Conditioner – circuit diagram, types and principle of operation.

Domestic utilization of electrical energy – House wiring, Induction based appliances, Online and OFF line UPS, Earthing – domestic, industrial and sub-station.

Electric Heating - Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding.

Electric Drives and Traction System – Type of drives and loads, Rating and heating of the motors, Types of Traction, Speed-Time curves, recent trends in traction.

Reference Books:

1. Dr. Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi, 2009.
2. Rajput R.K.,'Utilisation of Electrical Power', Laxmi Publications, 1st Edition, 2007.
3. N.V Suryanarayana, 'Utilization of Electric Power' New Age International Publishers, Reprinted 2005.
4. C.L.Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', New Age International Publishers, 4th Edition, 2011.
5. Gupta, J.B., 'Utilisation of Electrical Energy and Electric Traction', S.K.Kataria and Sons, 10th Edition, 1990.
6. H. Pratab, 'Modern Electric Traction', Dhanpat Rai & Co., 3rd Edition, 2012.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Develop a clear idea on various illumination techniques and hence design lightening scheme for specific applications.
2. Construct an electric connection for any domestic appliance like refrigerator and air conditioner units.
3. Evaluate domestic wiring connection and debug any faults occurred.
4. Identify an appropriate method of heating and welding for any particular industrial application.
5. Realize the appropriate type of electrical supply system as to evaluate the performance of tractions and electrical drives.

**Pre-requisites not required when registering as open elective.*

EEMI17 – INTRODUCTION TO MICRO-CONTROLLERS

Course Type: Minor (MI)/Open Elective (OE) **Pre-requisites*:** EEMI13
No. of Credits: 3

Course Objectives:

To impart knowledge on different micro-computing systems and its use in real time.

Course Content:

8051 Micro controller – Architecture - Addressing modes - Instruction set - Interfacing with real time peripherals.

PIC Micro controller – PIC16F7X series- Architecture- Instruction set- Programs for pulse generation.

Motivation for MSP430 microcontrollers – Main characteristics of a MSP430 microcontroller, Main features of the MSP430X RISC CPU architecture.

Addressing modes & Instruction set of MSP 430 - Double operand instructions, Single operand instructions, Program flow control – Jumps, Emulated instructions and programming

Controllers for Motor control – stepper motor and servo motor control – Case study: Industrial Controllers using 8051/ PIC16F7X/ MSP 430.

Reference Books:

1. Kenneth Ayala, 'The 8051 Microcontroller', Cengage Learning Publications, 3rd Edition, 2007.
2. John H Davies, "MSP430 Microcontroller Basics", Newnes Publications, 2008
3. Chris Nagy, "Embedded systems Design using TI MSP430 Series", Newnes, 2003.
4. John B. Peatman, 'Design with PIC Microcontrollers', Pearson Education Publications, 1st Edition, 2008.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the real time functioning of 8051.
2. Appreciate the functions of PIC microcontroller.
3. Develop systems using MSP430 Microcontroller.

**Pre-requisites not required when registering as open elective.*

EEMI18 / EEOE23 - RENEWABLE POWER GENERATION SYSTEMS

Course Type: Minor (MI)/Open Elective (OE) ***Pre-requisites*:*** EEMI14
No. of Credits: 3

Course Objectives:

To impart the knowledge on various forms of renewable energy sources and the process of electric energy conversion.

Course Content:

Environmental aspects of electric power generation from conventional sources: Limitation of fossil fuels - Atmospheric pollution – effects of hydro-electric projects – disposal of nuclear waste – GHG emission from various energy sources and its effects – need for renewable energy sources.

Solar Photo-Voltaic system: Solar radiation and its measurement – Angle of sun rays on solar collector – optimal angle for fixed collector – sun tracking, an introduction to solar cell, solar PV module, PV system design and applications – stand-alone and grid connected systems, environmental impacts.

Wind power generation: Wind energy, classification of wind turbines – aerodynamic operation of wind turbine, extraction of wind turbine power, wind turbine power curve, horizontal axis wind turbine generator – modes of wind power generation – stand-alone and grid connected system, environmental impacts.

Fuel cell system: Principle of operation of fuel cell, technical parameters of fuel cell, Type of fuel cell – advantages of fuel cell power plants, energy output, efficiency and emf of fuel cell – operating characteristics, applications and environmental impacts.

Hybrid energy systems: Need for hybrid systems, types, configuration and coordination, electrical interface – PV-Diesel, Wind-diesel, wind-PV, wind-PV- fuel cell.

Reference Books:

1. *G D Rai, 'Non-conventional Energy sources', Khanna Publishers, 5th Edition, 2014.*
2. *D P Kothari, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies' 2nd Edition, 2012.*
3. *C S Solanki, 'Solar Photo-voltaics – Fundamentals, Technologies and Applications', PHI Pvt., Ltd., 2nd Edition, 2011.*
4. *S N Bhadra, D Kastha and S Banerjee, 'Wind Electric Systems', Oxford Publications, 2nd Edition, 2007.*

COURSE OUTCOMES:

Upon the completion of this course the student will be able to:

1. Apprise the environmental impacts of conventional energy sources and the need of renewable energy.
2. Explain the process of PV generation and design stand-alone and grid connected system.
3. Explain the process of wind power generation and choose stand-alone and grid connected configuration.
4. Explain the process of fuel cell power generation and its applications.
5. Suggest and configure the various hybrid systems.

**Pre-requisites not required when registering as open elective.*

HONOUR

EEHO10 – DISTRIBUTION SYSTEM AUTOMATION

Course Type: Honours (HO) ***Pre-requisites:*** EEPC11
No. of Credits: 3

Course Objectives:

To understand and appreciate the basic control techniques involved in distribution automation and also get introduced to the various communication systems involved in distribution automation. Also the objective of the course is to enable the students capable of analyzing the economics behind the automation of distribution system automation.

Course Content:

Introduction to Distribution Automation, Control System Interfaces, Control and Data requirements, Centralized (Vs) Decentralized Control, Distribution Automation System, DAS Hardware, DAS Software, DA Capabilities, Automation system computer facilities.

Layout of substations and feeders - design considerations. Distribution system load flow - optimal siting and sizing of substations - optimal capacitor placement. Distribution system monitoring and control - SCADA, Remote metering and load control strategies - Optimum feeder switching

DA Communication Requirements - reliability, Cost Effectiveness, Data Rate Requirements, Two Way Capability - outages and faults, Ease of operation and maintenance - Communication Systems used - Distribution line carrier (Power line carrier), Telephone, Cable TV, Radio, AM Broadcast, FM SCA, VHF Radio, UHF Radio etc.

DA Benefit Categories - Capital Deferred Savings - Operation and Maintenance Savings - Interruption Related Savings - Customer-related Savings - Operational savings. Improved operation - Function Benefits.

Economic impacts - Automation on Distribution Systems, Integration of benefits into economic evaluation. Development and Evaluation of Alternate plans - Operation and Maintenance Cost Evaluation, Evaluation of Alternatives.

Textbooks:

1. *Momoh A. Momoh, James A. Momoh., 'Electric Power Distribution, Automation, Protection, and Control', CRC Press, 2007.*
2. *Gonen., 'Electric Power Distribution System Engineering', BSP Books, Pvt. Ltd, 2007.*

Reference Books:

1. *D. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, 'Tutorial Course: Distribution Automation', IEEE Tutorial Publication 88EH0280-8-PWR, 1988.*
2. *IEEE Working Group on 'Distribution Automation'.*

COURSE OUTCOMES:

Upon completion of the course the students would be able to

1. Understand the Distribution Automation Systems and the Control techniques involved.
2. Develop a clear idea on the layout of the substations and feeders and also on the various management techniques viz., load management and voltage management.
3. Identify an appropriate method of communication for any particular distribution system with a view of automation.
4. Evaluate the economic aspects of any distribution system with automation.

EEHO11 – EHV AC AND DC TRANSMISSION

Course Type: Honours(HO) ***Pre-requisites:*** EEPC11
No. of Credits: 3

Course Objectives:

- To understand and analyze the HVAC and HVDC transmission systems.
- To plan an appropriate transmission system between two destinations based on the load requirement and anticipated technical performance of power transmission.

Course Content:

Design aspects of HVAC – conductor, tower, insulator and substation structure design, mechanical design - sag-tension calculations, design of EHVAC lines based on steady state limits and transient over voltages - design of extra HV cables - XLPE cables and gas insulated cables.

Real and reactive power flows in HVAC systems – reactive power compensation, FACTS devices in EHV Transmission, short circuit level & real power transfer capacity. Stability- voltage stability and control. Theory of travelling and stationary waves.

Introduction to HVDC transmission - Bridge converters – rectifier and inverter operation, equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

Basic HVDC controllers, converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over voltage protection.

Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters. Introduction to Hybrid HVDC and Off-shore wind power evacuation schemes.

Textbooks:

1. *S.Rao, 'EHV-AC, HVDC Transmission and Distribution Engineering', Khanna Publishers, 3rd Edition, 2012.*
2. *Rakosh Das Begamudre, 'Extra High Voltage AC Transmission Engineering', New Age International Publishers, 3rd Edition, 2009.*

Reference Books:

1. *Padiyar K.R., 'HVDC Transmission Systems', New Age International Publishers, 2nd Revised Edition, 2012.*

Useful web links:

1. http://nptel.iitm.ac.in/courses/108104013

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Distinguish between the usage of EHVAC and HVDC transmission systems.
2. Judge when and where to use EHAV / HVDC transmission systems in practice.
3. Design implementation circuitry for various controllers used in HVDC transmission systems.
4. Plan an appropriate electric power transmission system between two destinations to satisfy the pre-defined load requirement without compromising the technical performance.

EEHO12 – NON-LINEAR CONTROL SYSTEMS

Course Type: Honours(HO) ***Pre-requisites:*** EEPC20
No. of Credits: 4

Course Objectives:

The aim of this course is to introduce the concept of non-linear controller design to the undergraduate student.

Course Content:

Open and closed sets, compact set, dense set, Continuity of functions, Lipschitz condition, smooth functions, Vector space, norm of a vector, normed linear space, inner product space.

Mathematical modeling of simple mechanical and electrical systems, concept of equilibrium points, isolated equilibrium points and limit cycles.

Stability analysis of nonlinear systems – Lyapunov stability, asymptotic stability, relative stability, finite-time stability and exponential stability. Lasalles invariance principle.

Feedback linearization- dynamic feedback linearization, flatness and back stepping controllers design.

Sliding mode controller design, Lyapunov redesign and energy-based controller design.

Textbooks:

1. *Khalil H.K., 'Nonlinear Systems', Prentice Hall, 3rd Edition, 2002.*
2. *Vidyasagar M., 'Nonlinear System Analysis', Prentice Hall, 2nd Edition, 2002.*
3. *A. Isidori, 'Nonlinear Control Systems', Communications and Control Engineering, Springer Science & Business Media, 3rd Edition, 2013.*

Reference Books:

1. *Jean - Jacques. E. Slotine and W. Li, 'Applied Nonlinear Control', Prentice Hall, Englewood Cliffs, NJ, 1991.*
2. *Zhihua Qu, 'Robust Control of Nonlinear Uncertain Systems', John Wiley & Sons, Interscience Division, New York, 1998.*
3. *H. Nijmeijer and A. J. van der Schaft, 'Nonlinear Dynamical Control Systems', Springer New York, 2016.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the concept of non-linear system.
2. Design non-linear controller for electrical system.

EEHO13 – POWER SWITCHING CONVERTERS

Course Type: Honours (HO) ***Pre-requisites:*** EEPC19
No. of Credits: 4

Course Objectives:

This course aims at modeling, analysis and control of various power converter circuits.

Course Content:

Basic converter topologies: Buck, Boost, Buck-Boost converter, steady state converter analysis - Equivalent circuit modelling.

State space averaging of converters- Transfer function of converters- Design of feedback compensators-voltage and current loop.

Design constraints of reactive elements in Power Electronic Systems: Design of inductor, transformer and capacitors for power electronic applications, Input filter requirement.

Isolated converters: forward converter, push-pull converter, fly back converter, half bridge and full bridge converter-operating principles.

Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current switching converters, multi-resonant converters and Load resonant converters-operating principles.

Textbooks:

1. *Simon Ang, Alejandro Oliva, 'Power Switching Converters', Taylor & Francis, 3rd Edition, 2010.*
2. *Robert W. Erickson, Dragan Maksimovic, 'Fundamentals of Power Electronics', Springer Science & Business Media, 2nd Edition, 2007.*

Reference Books:

1. *Ned Mohan, Tore M. Undeland, and William P.Robbins, 'Power Electronics: Converters, Applications, and Design', 3rd Edition, Wiley Publishers, 2002.*
2. *M. Rashid, 'Power Electronics: Circuits, Devices, and Applications', Pearson Education, 4th Edition 2013.*

COURSE OUTCOMES:

Upon completion of this course the students will be able to

1. Understand the classification and operation of different types of DC-DC converters.
2. Analyze the Steady-state operation of DC-DC converter circuits.
3. Develop the transfer function of DC-DC converter circuits.
4. Design the compensator and reactive elements of DC-DC converter circuits.
5. Illustrate different soft switching techniques in DC-DC converter circuits.

EEHO14 – VEHICULAR ELECTRIC POWER SYSTEMS

Course Type: Honours (HO) ***Pre-requisites:*** EEPC15, EEPC19
No. of Credits: 4

Course Objectives:

This course introduces the fundamental concepts, principles and analysis of hybrid and electric vehicles.

Course Content:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drivetrains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance, Capabilities, Automation system computer facilities.

Introduction to electric components used in hybrid and electric vehicles- Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switched Reluctance Motor drives- drive system efficiency.

Energy storage technologies in hybrid vehicles-flywheel, hydraulic, fuel cell and hybrid fuel cell energy storage system-ultra capacitors- comparison- battery charging control.

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

Electrical power system in aircraft, sea and undersea vehicles, space vehicles-hybrid vehicle control strategies-supporting subsystem.

Textbooks:

1. *Ali Emadi, Mehrdad Ehsani, John M. Miller, 'Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles', CRC Press, 2003.*

Reference Books:

1. *Ion Boldea and S.A Nasar, 'Electric drives', CRC Press, 2005.*
2. *Sandeep Dhameja, 'Electric Vehicle Battery Systems', Newnes, 2002.*
3. *Chris Mi, M. Abul Masrur, David Wenzhong Gao, 'Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives', Wiley, 2011.*
4. *Iqbal Husain, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2nd Edition, 2010.*

COURSE OUTCOMES:

On completion of the course, the student would be able to

1. Understand the various aspects of hybrid and electric vehicles.
2. Plan the selection of electrical machines for hybrid and electric vehicles.
3. Select various energy storage technologies for hybrid and electric vehicles.
4. Implement energy management techniques for hybrid and electric vehicles.
5. Demonstrate the power system of various vehicular system.

EEHO15 – POWER SYSTEM DYNAMICS

Course Type: Honours (HO) ***Pre-requisites:*** EEPC18
No. of Credits: 4

Course Objectives:

- To explain the power system stability problem.
- To understand the behavior of synchronous and induction machines during disturbance.
- To employ mathematical tools for power system stability analysis.

Course Content:

Synchronous machines – Modeling torque, magnetization and induced emf – Clarke's and Park's transformation – Modeling of excitation system – Modeling of prime-movers - Load modeling concepts

Stability considerations – Dynamic modeling requirements – Angle stability – Critical fault clearing time and angle – Numerical integration techniques – Transient energy function approach

Small Signal stability – State space representation – Eigen value analysis - Modal matrices – Single machine infinite bus system

Voltage stability – V-Q sensitivity analysis, Q-V modal analysis – Loadability limits – PV curve – QV curve

Sub-synchronous oscillations – Resonance – Tortional frequencies and mode shapes

Textbooks:

1. *Prabha S. Kundur, Om P Malik, 'Power System Stability and Control', McGraw-Hill, New York, 2nd edition, 2022.*
2. *Vijay Vittal, James D McCalley, 'Power System Control and Stability', 3rd Edition, Wiley IEEE Press, 2020.*
3. *Jan Machowski, Zbigniew Lubosny, Janusz W Bialek, 'Power System Dynamics, Stability and Control, 3rd Edition, John Wiley, 2020.*

Reference Books:

1. *Krause P.C., 'Analysis of Electric Machinery', McGraw-Hill, 3rd Revised Edition, 2013.*

COURSE OUTCOMES:

Upon completion of the course, the students will have acquired

1. Understanding of the dynamic phenomena of the power system operation.
2. Knowledge to employ modeling techniques for investigating the response of system during disturbance.
3. Ability to interpret results coming from the simulation of differential - algebraic systems.

EEHO16– MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS

Course Type: Honours (HO) ***Pre-requisites:*** EEPC18
No. of Credits: 4

Course Objectives:

To learn the concepts and techniques of evolutionary and optimization techniques in power system applications.

Course Content:

Definition-Classification of optimization problems-Unconstrained and Constrained Optimization-Optimality Conditions-Classical Optimization techniques (Linear and nonlinear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory).

Evolution in nature-Fundamentals of Evolutionary Algorithms-Working Principles of Genetic Algorithm-Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation- GA based Economic Dispatch Solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation.

Fundamental principle - Velocity Updating - Advanced operators - Parameter selection - Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues - Convergence issues - PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

Simulated annealing algorithm- Tabu search algorithm - SA and TS for unit commitment - Ant colony optimization - Bacteria Foraging optimization.

Concept of pareto optimality - Conventional approaches for MOOP - Multi objective GA - Fitness assignment - Sharing function - Economic Emission dispatch using MOGA – Multi objective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO) – Multi objective OPF problem.

Textbooks:

1. *Soliman Abdel Hady, Abdel Aal Hassan Mantawy, "Modern Optimization Techniques with Applications in Electric Power Systems", Springer, 2012.*
2. *D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2nd Edition, PHI Learning Private Limited, 2010.*

Reference Books:

1. *Kalyanmoy Deb, "Multi Objective Optimization using Evolutionary Algorithms", Wiley India Pvt ltd, 2010.*
2. *Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, 2nd Edition, 2012.*

COURSE OUTCOMES:

Upon completion of this course the students will be able to

1. Understand the concept of optimization techniques.
2. Apply evolutionary algorithms for unit commitment and economic dispatch problems.
3. Interpret hybrid approach for power system reliability and security.

EEHO17– COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT

Course Type: Honours (HO) ***Pre-requisites:*** EEPC24
No. of Credits: 3

Course Objectives:

- To understand and analyze the basic architecture of Digital Relay.
- Understand the basics of Phasor Measurement unit (PMU).
- Applications of PMUs in power system.

Course Content:

Mathematical background to protection algorithms-Finite difference technique-Numerical Differentiation-Least Squares Method-Fourier analysis-Fourier analysis of analog signals- Fourier analysis of discrete signals-Walsh function analysis.

Basic elements of digital protection-Signal conditioning subsystem-Transducers-Surge protection circuits-Analog Filtering-Analog Multiplexers-Conversion Subsystem-Sampling theorem-Signal aliasing error-Sample and hold circuit-Digital multiplexing-Digital-to-Analog Conversion-Analog-to-Digital Conversion-Processor-Data and Program memory-Digital relay hardware unit.

Phasor Measurement Unit– Introduction- Phasor representation of sinusoids- Phasor Estimation of Nominal Frequency Signals- Formulas for updating phasors – Non recursive updates-Recursive updates- Frequency Estimation.

Phasor Measurement Applications-State Estimation-History- Operator's load flow- Weighted least square -Linear weighted least squares; Nonlinear weighted least squares- Static state estimation- State estimation with Phasor measurements- linear state estimation.

Adaptive protection- Differential and distance protection of transmission lines- Adaptive out-of-step protection.

Textbooks:

1. *Arun G. Phadke, James S. Thorp, 'Computer Relaying for Power Systems', A John Wiley and Sons Ltd., Research Studies Press Limited, 2009.*
2. *A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer, 2008.*

Reference Books:

1. *A. T. Johns and S. K. Salman, 'Digital Protection for Power Systems', Peter Peregrinus Ltd, 1997.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the operation of computer relay.
2. Understand the basics of phasor measurement unit.
3. Understand the different applications of PMUs in power systems.

EEHO18 – ELECTRICITY MARKETS

Course Type: Honours(HO) ***Pre-requisites:*** EEPC18
No. of Credits: 4

Course Objectives:

To understand the principles and working of restructured power systems and electricity markets around the world

Course Content:

Power market fundamentals – Why deregulate? – What to deregulate – Pricing power, energy, and capacity - Power supply and demand – Market structure and architecture – Spot market – Day ahead market – Real time market – Reserve market – Ancillary services

Electricity pricing – Concept of marginal cost **-** Market equilibrium – Market clearing price – Congestion pricing fundamentals – Locational marginal pricing – Operating reserve pricing – Value-of-lost-load pricing – Pricing losses on lines - Pricing losses at nodes

Markets around the world – US and European market evolution **-** Reforms in Indian power sector **-** IEX India – Power purchase agreements in India

Derivative markets – Hedging risk – Contract for difference **-** Forwards **-** Futures – Options – Swaps

Local energy markets – Virtual power plant and microgrids – Microgrid prosumer consortium – Peer-to-Peer transactive energy markets – Role of DSO – Business models

Textbooks:

1. *Steven Stoft, 'Power System Economics: Designing Markets for Electricity', Wiley-IEEE Press, 2002.*
2. *Daniel S. Kirschen, Goran Strbac, 'Fundamentals of Power System Economics, Wiley, 2018.*
3. *Mohammad Shahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems: Operation: Trading, and Volatility', Marcel Dekker Inc., 2001.*

Reference Books:

1. *Mohammad Shahidehpour, Hatim Yamin, Zuyi Li, 'Market Operations in Electric Power Systems: Forecasting, Scheduling, and Risk Management', IEEE Press, 2002.*

Useful web links:

1. *Indian Energy Exchange: http://www.iexindia.com/*
2. *Power Exchange India Limited: http://www.powerexindia.com/*
3. *Indian Electricity Regulations: http://www.cercind.gov.in/*

COURSE OUTCOMES:

Upon completion of the course the students would be able to

1. Illustrate and solve problems in the de-regulated power system.
2. Explain how electricity is priced in deregulated power markets.
3. Explain the working of various electricity markets around the world.

EEHO19 – DESIGN WITH PIC MICROCONTROLLERS

Course Type: **HO** ***Pre-requisites:*** EEPC14
No. of Credits: 4

Course Objectives:

To understand the internal structure and operation of PIC16F876 microcontroller, assembly language programming with MPLAB and PICSTART plus and design methodology for software and hardware applications.

Course Content:

Introduction to PIC microcontrollers - PIC 16F876 microcontroller – device overview-pin diagrams-memory organisation.

Special Function Registers - I/O ports - Timers – Capture/Compare/PWM modules (CCP) – Analog-to-digital converter module - selection – reset – interrupts - watchdog timer.

Instruction set - instruction description – PIC16F876 assembly language programming – simple programs.

Introduction to MPLABIDE and PICSTART plus – Device Programming using MPLAB and PICSTART plus.

Assembly language programming for – Zero crossing detectors - square wave generation –pulse generation for typical applications - ADC program – hardware demonstration.

Textbooks:

1. *PIC16F87X datasheet, 28/40- pin 8 bit CMOS Flash Microcontrollers, Microchip Technology Inc, 2001.*
2. *Myke Predko, 'Programming and Customizing the PIC Microcontroller', Tata McGraw-Hill Publications, 1st Edition, 2007.*
3. *John B. Peatman, 'Design with PIC Microcontrollers', Pearson Education Publications, 1st Edition, 2008.*

References Books:

1. *MPLABIDE Quick Start Guide Microchip Technology Inc., 2007.*
2. *M. D. Singh and K. B. Khanchandani, 'Power Electronics', Tata McGraw Hill Publishing Company Limited, 2nd Edition, 2006.*

COURSE OUTCOMES:

Upon completion of this course, students will

1. Understand the architecture of PIC 16F876 microcontroller and its instruction set.
2. Be able to develop assembly language program.
3. Be able to develop the program using MPLAB and download it to the microcontroller chip using suitable developer.
4. Be able to design and generate pulses for typical applications.

EEHO20 – AIRCRAFT ELECTRONIC SYSTEMS

Course Type: Honours (HO) ***Pre-requisites:*** EEPC22
No. of Credits: 3

Course Objectives:

To inculcate the habit of applying theory in practical electronic systems.

Course Content:

Basic flight instruments – Electronic flight instrument systems – primary flight display – navigation display – Display processor unit - Electronic attitude and direction indicator (EADI) – Electronic Horizontal situation indicator (EHSI) – Multi-function processor unit.

Electronic centralized aircraft Monitor - Engine indicating and crew alerting system - Flight management system – cockpit layouts.

Electrostatic sensitive devices (ESD) – Different devices and its features - tribo-electric series – handling and transporting ESDs - Electromagnetic compatibility – EMI generation – EMC and avionics equipment – spectrum analysis.

Airframe control and indicating systems - Landing gear - Trailing edge flaps - Control surfaces - Electronic indicating systems – Terrain awareness warning systems.

Flight data and cockpit voice recorders - Health and usage monitoring system (HUMS) - Aircraft Communication Addressing and Reporting System - Fly-by-wire (FBW).

Textbooks:

1. *Mike Tooley, 'Aircraft Digital Electronic and Computer Systems: Principles, Operation and Maintenance', 1st Edition, Elsevier, 2007.*
2. *Mike Tooley and David Wyatt, 'Aircraft Electrical and Electronic Systems: Principles, Operation and Maintenance', Elsevier, 2009.*

Reference Books:

1. *IEEE Guide for Aircraft Electric Systems, 1976.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the insights of the flight instruments.
2. Appreciate and classify the monitoring and management systems.
3. Differentiate electrostatic and electromagnetic effects.
4. List the control and indicating systems in aircraft.
5. Enrich about recording and reporting systems in aircraft.