B. Tech. Degree

in

ELECTRICAL AND ELECTRONICS ENGINEERING

SYLLABUS FOR

FLEXIBLE CURRICULUM

(For students admitted in 2015-16 onwards)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI – 620 015

TAMIL NADU, INDIA.

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INSTITUTE VISION

To provide valuable resources for industry and society through excellence in technical education and research

INSTITUTE MISSION

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes. To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

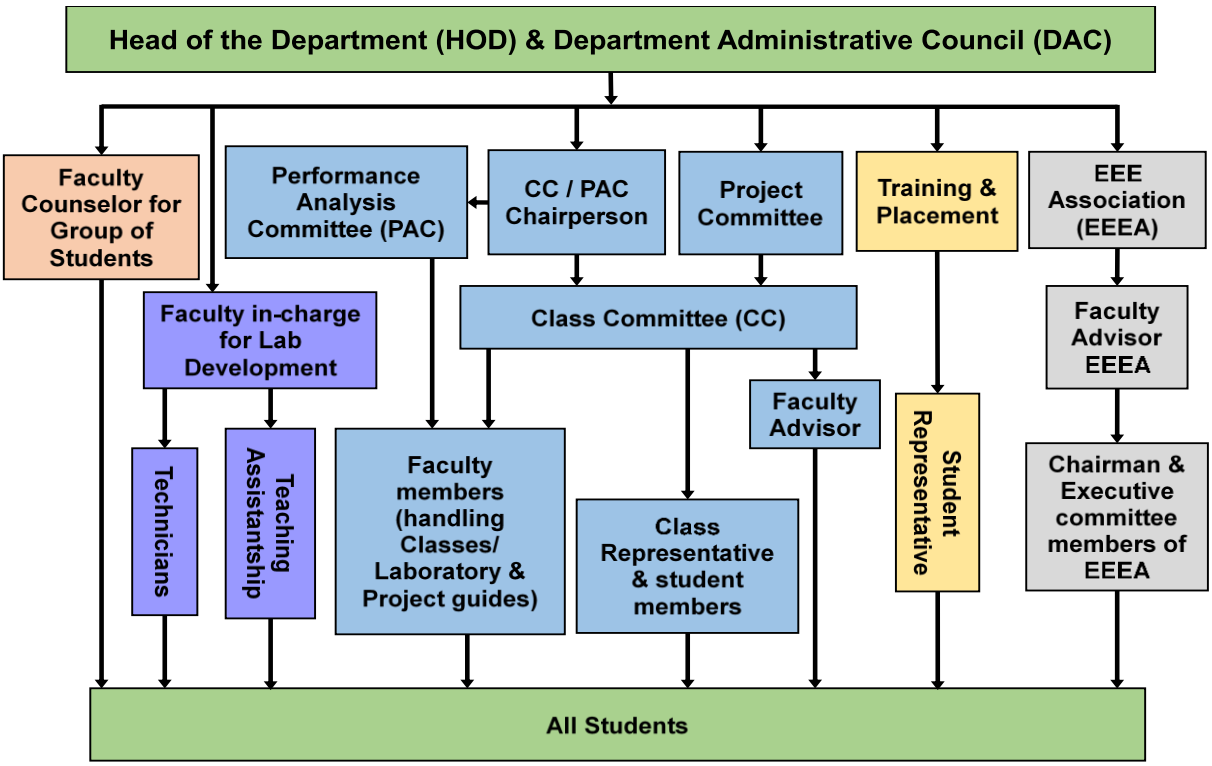
DEPARTMENT VISION

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.

Organisation 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

Programme Outcomes (POs)

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

1. will have an ability to apply knowledge of mathematics and science in EEE systems.
2. will have an ability to provide solutions for EEE problems by designing and conducting experiments, interpreting and analysing data, and reporting the results.
3. will have comprehensive understanding of the entire range of electronic devices, analog and digital circuits with added state-of art knowledge on advanced electronic systems.
4. will have knowledge and exposure on different power electronic circuits and drives for industrial applications.
5. will have in-depth knowledge in transmission and distribution systems, power system analysis and protection systems to pursue a career in the power sector.
6. will have a good knowledge in microprocessors/microcontrollers, data structures, computer programming and simulation software.
7. will be able to develop mathematical modelling, analysis and design of control systems and associated instrumentation for EEE.
8. will be able to systematically carry out projects related to EEE.
9. will have an ability to participate as members in various professional bodies as well as multidisciplinary design teams.
10. will demonstrate the ability to choose and apply appropriate resource management techniques so as to optimally utilize the available resources.
11. will be proficient in English language in both verbal and written forms which will enable them to compete globally.
12. will have confidence to apply engineering solutions with professional, ethical and social responsibilities.
13. will be able to excel in their professional endeavours through self-education.
14. will be able to design and build renewable energy systems for developing clean energy and sustainable technologies.

CURRICULUM

The total minimum credits required for completing the B.Tech. Programme in Electrical and Electronics Engineering is **179**, [68 + 111].

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES:

S.No.	COURSE CATEGORY	NO. OF COURSES	NO. OF CREDITS
1.	GENERAL INSTITUTE REQUIREMENT (GIR)	23	68
2.	PROGRAMME CORE (PC)	19	65
3.	ESSENTIAL PROGRAMME LABORATORY (ELR)	8	16
4.	ELECTIVE COURSES (PE+OE+MI)	10	30
		TOTAL	**179**

Programme Electives (PE) are offered by the Department of Electrical and Electronics Engineering for students of B.Tech. in Electrical and Electronics Engineering programme. A minimum of 9 credits out of the 30 credits allotted for Electives category must be earned from the courses listed in the PE section.

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 offered by any other Department within National Institute of Technology, Tiruchchirappalli. In addition to the above, if a student has registered for courses under B.Tech. (Minor) programme of any other Department, they will be considered under Elective Course category.

I. GENERAL INSTITUTE REQUIREMENT (GIR)

1. MATHEMATICS

S.No.	COURSE CODE	COURSE TITLE	CREDITS
1	MAIR11	MATHEMATICS I	4
2	MAIR21	MATHEMATICS II	4
3	MAIR32	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	3
4	MAIR42	NUMERICAL METHODS FOR ELECTRICAL ENGINEERS	3
		Total	**14**

2. PHYSICS

S.No.	COURSE CODE	COURSE TITLE	CREDITS
1	PHIR11	PHYSICS I	3
2	PHIR13	PHYSICS II	4
		Total	**7**

3. CHEMISTRY

S.No.	COURSE CODE	COURSE TITLE	CREDITS
1	CHIR11	CHEMISTRY I	3
2	CHIR13	CHEMISTRY II	4
		Total	**7**

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	3
2	HSIR12	PROFESSIONAL COMMUNICATION	3
		Total	**6**

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 AND HUMAN VALUES	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	CSIR11	BASICS OF PROGRAMMING	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	INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT (2 to 3 months duration during summer vacation)	2
		Total	**2**

The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of III year. Attachment with an academic institution within the country (CFTIs such as IISc / IITs / NITs / IIITs, etc.) or university abroad is also permitted instead of industrial training. The course will be evaluated at the beginning of IV Year by assessing the report and seminar presentations.

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	3
		Total	**3**

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

16. INDUSTRIAL LECTURE

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.

17. NSS / NCC / NSO

S.No.	COURSE CODE	COURSE TITLE	CREDITS
1	SWIR11	NSS / NCC / NSO	0
		Total	**0**

II. PROGRAMME CORE (PC)

LIST OF ESSENTIAL PROGRAMME CORE COURSES				
S.No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQ.**	**CREDITS**
1.	EEPC10	ELECTRON DEVICES	-	3
2.	EEPC11	CIRCUIT THEORY	MAIR21	4
3.	EEPC12	DC MACHINES AND TRANSFORMERS	-	4
4.	EEPC13	DATA STRUCTURES AND ALGORITHMS	CSIR11	4
5.	EEPC14	ANALOG ELECTRONIC CIRCUITS	EEPC10	3
6.	EEPC15	DIGITAL ELECTRONICS	EEPC10	3
7.	EEPC16	TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY	EEPC11	3
8.	EEPC17	LINEAR INTEGRATED CIRCUITS	EEPC11	3
9.	EEPC18	AC MACHINES	EEPC12	4
10.	EEPC19	NETWORKS AND LINEAR SYSTEMS	MAIR32 EEPC11	4
11.	EEPC20	CONTROL SYSTEMS	MAIR32	4
12.	EEPC21	POWER ELECTRONICS	MAIR32 EEPC10 EEPC11	3
13.	EEPC22	MICROPROCESSORS AND MICROCONTROLLERS	EEPC15	3
14.	EEPC23	MEASUREMENTS AND INSTRUMENTATION	EEPC17	4
15.	EEPC24	VLSI DESIGN	EEPC15 EEPC17	3
16.	EEPC25	POWER SYSTEM ANALYSIS	MAIR42 EEPC16	4
17.	EEPC26	POWER SYSTEM PROTECTION AND SWITCHGEAR	EEPC25	3
18.	EEPC27[#]	COMMUNICATION SYSTEMS	EEPC15, EEPC19	3
19.	EEPC28[##]	THERMODYNAMICS AND MECHANICS OF FLUIDS	--	3
			TOTAL	**65**

[#] Will be offered by the Department of Electronics and Communication Engineering.
[##] Will be offered by the Department of Mechanical Engineering.

III. ESSENTIAL PROGRAMME LABORATORY COURSES (ELR)

LIST OF ESSENTIAL PROGRAMME LABORATORY COURSES				
S.No.	**COURSE CODE**	**COURSE TITLE**	**CO-REQ.***	**CREDITS**
1.	EELR10	CIRCUITS AND DEVICES LABORATORY	EEPC11	2
2.	EELR11	DC MACHINES AND TRANSFORMERS LABORATORY	EEPC12	2
3.	EELR12	ELECTRONIC CIRCUITS LABORATORY	EEPC14	2
4.	EELR13	INTEGRATED CIRCUITS LABORATORY	EEPC17	2
5.	EELR14	SYNCHRONOUS AND INDUCTION MACHINES LABORATORY	EEPC18	2
6.	EELR15	POWER ELECTRONICS LABORATORY	EEPC21	2
7.	EELR16	MICRO-COMPUTING AND VLSI DESIGN LABORATORY	EEPC22, EEPC24	2
8.	EELR17	POWER SYSTEMS LABORATORY	EEPC25	2
			TOTAL	**16**

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

IV. ELECTIVES

PROGRAMME ELECTIVES (PE)

Students pursuing B.Tech. in Electrical and Electronics Engineering should complete at least three courses from the Programme Electives listed below.

LIST OF PROGRAMME ELECTIVES (PE)				
S.No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQ.**	**CREDITS**
1.	EEPE10	POWER GENERATION SYSTEMS	-	3
2.	EEPE11	ELECTRICAL SAFETY	-	3
3.	EEPE12	OPERATING SYSTEM CONCEPTS	-	3
4.	EEPE13	FUZZY SYSTEMS AND GENETIC ALGORITHMS	-	3
5.	EEPE14	INDUSTRIAL AUTOMATION	-	3
6.	EEPE15	HIGH VOLTAGE ENGINEERING	EEPC11	3
7.	EEPE16	OBJECT ORIENTED PROGRAMMING USING C++	EEPC13	3
8.	EEPE17	COMPUTER ARCHITECTURE	EEPC15	3
9.	EEPE18	DIGITAL SYSTEM DESIGN AND HDLS	EEPC15	3
10.	EEPE19	DESIGN WITH PIC MICROCONTROLLERS	EEPC15	3
11.	EEPE20	DIGITAL SIGNAL PROCESSING	MAIR32, EEPC15	3
12.	EEPE21	ARTIFICIAL NEURAL NETWORKS	MAIR42	3
13.	EEPE22	DISTRIBUTION SYSTEM AUTOMATION	EEPC16	3
14.	EEPE23	EHV AC AND DC TRANSMISSION	EEPC16	3
15.	EEPE24	DESIGN OF ELECTRICAL APPARATUS	EEPC18	3

S.No.	CODE	COURSE OF STUDY	PRE-REQ.	CREDITS
16.	EEPE25	UTILIZATION OF ELECTRICAL ENERGY	EEPC18	3
17.	EEPE26	COMPUTER NETWORKS	EEPC27	3
18.	EEPE27	NON-LINEAR CONTROL SYSTEMS	EEPC20	3
19.	EEPE28	MODERN CONTROL SYSTEMS	EEPC20	3
20.	EEPE29	POWER SWITCHING CONVERTERS	EEPC21	3
21.	EEPE30	FUNDAMENTALS OF FACTS	EEPC16, EEPC21	3
22.	EEPE31	SPECIAL ELECTRICAL MACHINES	EEPC18, EEPC21	3
23.	EEPE32	WIND AND SOLAR ELECTRICAL SYSTEMS	EEPC18, EEPC21	3
24.	EEPE33	SOLID STATE DRIVES	EEPC18, EEPC21.	3
25.	EEPE34	VEHICULAR ELECTRIC POWER SYSTEMS	EEPC18, EEPC21.	3
26.	EEPE35	EMBEDDED SYSTEM DESIGN	EEPC22	3
27.	EEPE36	LOW POWER MICROCONTROLLER	EEPC22	3
28.	EEPE37	AIRCRAFT ELECTRONIC SYSTEMS	EEPC22	3
29.	EEPE38	APPLIED SIGNAL PROCESSING	EEPC22	3
30.	EEPE39	POWER SYSTEM DYNAMICS	EEPC25	3
31.	EEPE40	MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS	EEPC25	3
32.	EEPE41	POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES	EEPC25	3
33.	EEPE42	COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT	EEPE20	3
34.	EEPE43	DIGITAL CONTROL SYSTEMS	EEPE20	3
35.	EEPE44	POWER SYSTEM RESTRUCTURING	EEPE41	3
36.	EEPE45*	OPERATIONS RESEARCH	MAIR42	3

* Will be offered by the Department of Mathematics.

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.	**CODE**	**COURSE OF STUDY**	**CREDITS**
1.	EEOE10	ELECTRICAL SAFETY	3
2.	EEOE11	FUZZY SYSTEMS AND GENETIC ALGORITHMS	3
3.	EEOE12	ARTIFICIAL NEURAL NETWORKS	3
4.	EEOE13	NON-LINEAR CONTROL SYSTEMS	3
5.	EEOE14	MODERN CONTROL SYSTEMS	3
6.	EEOE15	DIGITAL CONTROL SYSTEMS	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	MICRO-COMPUTING SYSTEMS*	3
15.	EEOE24	RENEWABLE POWER GENERATION SYSTEMS*	3

* Offered for non-circuit Branches only.

LIST OF COURSES FOR B.Tech. (MINOR)

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	MICRO-COMPUTING SYSTEMS	EEMI13	3
9.	EEMI18	RENEWABLE POWER GENERATION SYSTEMS	EEMI14	3

However, the above courses will also be offered as Open Electives for non-circuit branch students.

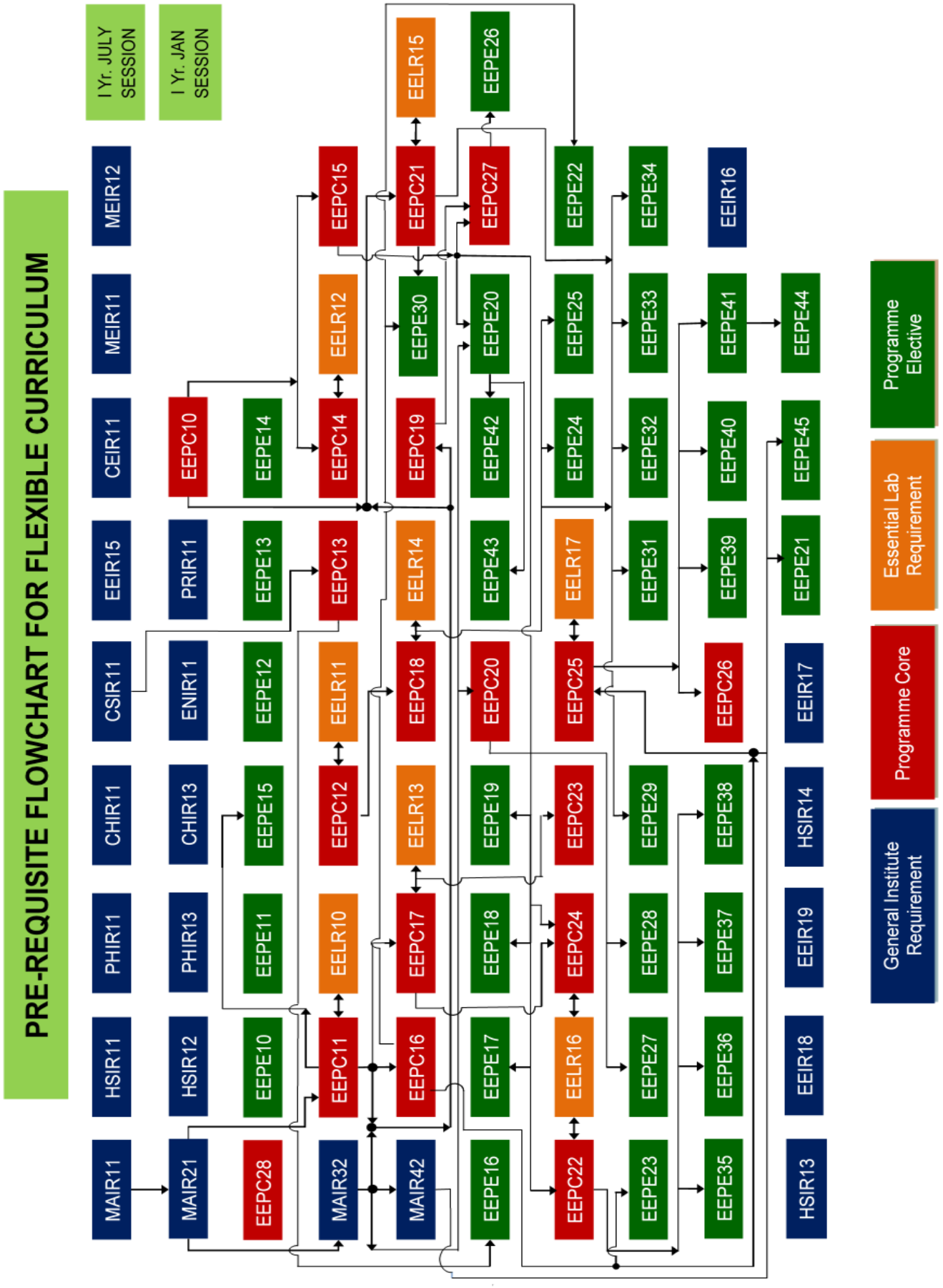
V. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

A student can obtain B.Tech. (Honours) degree provided the student has:

i. Registered at least for 12 theory courses and 2 ELRs in the II year.
ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions, and have applied for B.Tech. (Honours).
iii. Continue to maintain a minimum GPA of 8.5 in the subsequent sessions also (including the Honours courses).
iv. Completed 3 additional theory courses specified for the Honours degree of the programme from III year onwards.
v. Completed all the courses registered, in the first attempt and in four years of study.

LIST OF ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)				
S.No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQ.**	**CREDITS**
1.	EEHO10	DISTRIBUTION SYSTEM AUTOMATION	EEPC16	3
2.	EEHO11	EHV AC AND DC TRANSMISSION	EEPC16	3
3.	EEHO12	NON-LINEAR CONTROL SYSTEMS	EEPC20	3
4.	EEHO13	MODERN CONTROL SYSTEMS	EEPC20	3
5.	EEHO14	POWER SWITCHING CONVERTERS	EEPC21	3
6.	EEHO15	SOLID STATE DRIVES	EEPC18, EEPC21.	3
7.	EEHO16	VEHICULAR ELECTRIC POWER SYSTEMS	EEPC18, EEPC21	3
8.	EEHO17	AIRCRAFT ELECTRONIC SYSTEMS	EEPC22	3
9.	EEHO18	APPLIED SIGNAL PROCESSING	EEPC22	3
10.	EEHO19	POWER SYSTEM DYNAMICS	EEPC25	3
11.	EEHO20	MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS	EEPC25	3
12.	EEHO21	POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES	EEPC25	3
13.	EEHO22	COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT	EEPE20	3
14.	EEHO23	DIGITAL CONTROL SYSTEMS	EEPE20	3
15.	EEHO24	POWER SYSTEM RESTRUCTURING	EEPE41 or EEHO21.	3

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.


PRE-REQUISITE FLOWCHART FOR FLEXIBLE CURRICULUM
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PHIR11
CHIR11
CSIR11
EEIR15
MEIR11
CEIR11
MEIR12
MAIR21
HSIR12
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CHIR13
ENIR11
PRIR11
MAIR32
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EEPC28
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EEPE40
EEPE41
EEIR16
HSIR13
EEIR18
EEIR19
HSIR14
EEIR17
EEPE21
EEPE45
EEPE44
General Institute Requirement
Programme Core
Essential Lab Requirement
Programme Elective

SUBJECT / STREAM	COURSES							
MATHS & HUMANITIES	MAIR32	MAIR42	HSIR13	HSIR14				
1. ELECTRICAL POWER	EEPC11	EEPC12	EEPC16	EEPC18	EEPC19	EEPC21	EEPC25	EEPC26
2. ELECTRONICS AND COMPUTERS	EEPC10	EEPC13	EEPC14	EEPC15	EEPC17	EEPC22	EEPC24	
COMMON TO 1 & 2	EEPC20	EEPC23						
BASICS OF OTHER ENGINEERING	EEPC27	EEPC28						
LABORATORY COURSES	EELR10	EELR11	EELR12	EELR13	EELR14	EELR15	EELR16	EELR17
INTERNSHIP/INDUSTRIAL LECTURES	EEIR16	EEIR19						
COMPREHENSIVE EXAMINATION / PROJECT	EEIR18	EEIR17						

MAIR11 - MATHEMATICS - I

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

Course Objectives:

To acquire fundamental knowledge and apply in engineering disciplines.

Course Content :

Characteristic equation of a matrix –Eigen values and Eigen vectors – Properties of Eigen values – Diagonalization of matrix – Cayley-Hamilton Theorem (without proof) verification – Finding inverse and Power of a matrix using it – Quadratic form – Definite and indefinite forms – Orthogonal reduction of quadratic form to canonical form.

Sequences of real numbers – Limit of a sequence – Convergent and divergent sequences– sub sequence- Cauchy's sequence – monotone convergence theorem (without proof)- Sequence with recurrence relations.

Infinite series - Convergence tests for positive term series – Comparison, Root, Ratio and Raabe's tests - Alternating series – Leibnitz's rule – Absolute and Conditional convergence. Riemann rearrangement theorem (without proof).

Functions of several variables – Partial derivatives and Transformation of variables – Jacobian and its Properties- Maxima and Minima of function of two variables.

Double integral – Changing the order of Integration – Change of variables from cartesian to polar coordinates – Area using double integral in cartesian and polar coordinates – Triple integral – Change of variables from cartesian to spherical and cylindrical coordinates – Volume using double and triple integrals.

Text Books:

1. *Kreyszig, E., 'Advanced Engineering Mathematics', 9th Edition, John Wiley Sons, 2006.*
2. *Grewal, B.S., 'Higher Engineering Mathematics', 42nd Edition, Khanna Publications, Delhi, 2012.*
3. *Venkataraman. M. K., 'Engineering Mathematics', Volume I, 2nd Edition, National Publishing Co., 2003.*

Reference Books:

1. *Apostol, T.M. 'Calculus' Volume I & II, Second Edition, John Wiley & Sons (Asia) 2005.*
2. *Greenberg, M.D. 'Advanced Engineering Mathematics', 2nd Edition, Pearson Education Inc., 2013.*
3. *Strauss. M.J, Bradley, G.L. and Smith, K.J. 'Calculus', 3rd Edition, Prentice Hall, 2002.*
4. *T Veerarajan, 'Engineering Mathematics', Tata McGraw-Hill Education Pvt. Limited, 2007.*

COURSE OUTCOMES:

After completion of the course, students would be able to solve curriculum problems.

MAIR21 - MATHEMATICS - II

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** MAIR11
No. of Credits: 4

Course Objectives:

To learn mathematical concepts and methods.

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 – Gram-Schmidt orthogonalization process.

Basic review of first order differential equation - Higher order linear differential equations with constant coefficients –Particular integrals for $x^n e^{ax}$, $e^{ax}\cos(bx)$, $e^{ax}\sin(bx)$ – Equation reducible to linear equations with constant coefficients using $x = e^t$ - Simultaneous linear equations with constant coefficients – Method of variation of parameters – Applications – Electric circuit problems.

Gradient, Divergence and Curl – Directional Derivative – Tangent plane and normal to surfaces – Angle between surfaces –Solenoidal and Irrotational fields – Line, surface and volume integrals – Green's theorem, Stokes' theorem and Gauss Divergence theorem (all without proof) – Verification and applications of these theorems.

Analytic functions – Cauchy-Riemann equations (cartesian and polar) –Properties of analytic functions – Construction of analytic functions given real or imaginary part – Conformal mapping of standard elementary functions (z^2,e^z, sin z, cos z, $z+\frac{k^2}{z}$) and bilinear transformation.

Cauchy's integral theorem, Cauchy's integral formula and for derivatives– Taylor's and Laurent's expansions (without proof) – Singularities – Residues – Cauchy's residue theorem – Contour integration involving unit circle.

Text Books:

1. *Kreyszig, E., 'Advanced Engineering Mathematics', 9th Edition, John Wiley Sons, 2006.*
2. *Grewal, B.S., 'Higher Engineering Mathematics', 42nd Edition, Khanna Publications, Delhi, 2012.*
3. *Hsiung, C.Y. and Mao, G. Y. 'Linear Algebra', World Scientific Publishing Co. Inc., 1999.*

Reference Books:

1. *Apostol, T.M. 'Calculus' Volume I & II, 2nd Edition, John Wiley & Sons (Asia) 2005.*
2. *Greenberg, M.D. 'Advanced Engineering Mathematics', 2nd Edition, Pearson Education Inc., 2013.*
3. *Strauss. M.J, Bradley, G.L. and Smith, K.J. 'Calculus', 3rd Edition, Prentice Hall, 2002.*
4. *Venkataraman, M. K. 'Linear Algebra', The National Publishing Co., 1999.*

COURSE OUTCOMES:

After completion of the course, students are able to solve industrially applicable problems.

MAIR32 - TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** MAIR21
No. of Credits: 3

Course Objectives:

To study the application of transform techniques to solve linear ordinary and partial differential equations and to solve boundary value problems by using Fourier series.

Course Content :

Laplace Transform of standard functions, Derivatives and Integrals – Inverse Laplace transform – Convolution theorem-Periodic functions – Application to ordinary differential equations and simultaneous equations with constant coefficients and integral equations.

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.

Formation of partial differential equations eliminating arbitrary constants and functions - solution of first order equations - four standard types - Lagrange's equation - Homogeneous and Non-homogeneous type of second order linear differential equation with constant coefficients.

One-dimensional wave equation and one-dimensional heat flow equation - Method of separation of variables - Fourier series solution.

Text Books:

1. *Veerarajan, T., 'Engineering Mathematics', Tata McGraw-Hill India Pvt. Ltd, 2006.*

Reference Books:

1. *Venkataraman, M.K., 'Engineering Mathematics Vol.4', National Publishing Company, 2004.*
2. *Grewal.B.S. 'Higher Engineering Mathematics', Khanna Publishers, 2000.*

COURSE OUTCOMES:

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

1. Understand the basics of transformation techniques.
2. Apply the transform techniques for solving ordinary differential equations and partial differential equations.

MAIR42 – NUMERICAL METHODS FOR ELECTRICAL ENGINEERS

Course Type: General Institute Requirement (GIR) ***Pre-requisites:*** MAIR32
No. of Credits: 3

Course Objectives:

To learn numerical methods and apply to engineering problems

Course Content :

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Doolittle method - Cholesky's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigen value and eigen vector.

Solution of non-linear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method -Order of convergence of these methods - Horner's method - Graeffe's method - Birge-Vieta method - Bairstow's method.

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

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2^{nd} order equations - Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender-Schmidt recurrence relation - Crank-Nicolson method - Solution of one-dimensional wave equation.

Text Books:

1. *Kandasamy, P., Thilagavathy K., and Gunavathy,S., 'Numerical Methods', Chand and Co., 2007.*
2. *Jain, M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', Wiley Eastern, 1992.*

Reference Books:

1. *Gerald,C.F., and Wheatley, P.O., 'Applied Numerical Analysis', Addison Wesley, 1994.*

COURSE OUTCOMES:

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

1. Understand the various methods of solving linear and non-linear equations.
2. Solve ordinary differential equations numerically.
3. Apply the knowledge to real life engineering problems.

PHIR11–PHYSICS - I

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

Course Objectives:

- To make a bridge between the physics in school and engineering courses.
- To introduce the basic concepts of modern science like Photonics, Engineering applications of acoustics, fundamentals of crystal physics and materials science.

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:–Holography- CD-drive – industrial and medical applications.

Fiber Optics

Fermat's principle and Snell's law-optical fiber – principle and construction – acceptance cone - numerical aperture - V-Number - types of fibers, Fabrication: Double Crucible Technique, Vapour phase Oxidation Process – fiber optic communication principle – fiber optic sensors-other applications of optical fibers.

Acoustics

Characteristics of musical sound – loudness – Weber-Fechner law – decibel – absorption coefficient – reverberation – reverberation time – Sabine's formula – acoustics of buildings– ultrasonics – production of ultrasonics using piezoelectric method –magnetostriction method- applications.

Crystallography

Crystalline and amorphous solids – lattice and unit cell – seven crystal system and Bravais lattices – symmetry operation – Miller indices – atomic radius – coordination number – packing factor calculation for sc, bcc, fcc – Bragg's law of X-ray diffraction –Laue Method-powder crystal method.

Magnetic materials, conductors and superconductors

Magnetic materials: Definition of terms–classification of magnetic materials and properties– Domain theory of ferromagnetism- hard and soft magnetic materials – applications.
Conductors: classical free electron theory (Lorentz–Drude theory)–electrical conductivity
Superconductors: definition–Meissner effect–type I & II superconductors–BCS theory (qualitative) – high temperature superconductors - Josephson effect – quantum interference (qualitative) – SQUID – applications.

Text Books:

1. *'A Text Book of Engineering Physics', M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, New Delhi (2009).*
2. *'Engineering Physics', R.K. Gaur and S.L. Gupta, Dhanpat Rai Publications (P) Ltd., 8th Edition., New Delhi (2001).*

Reference Books:

1. *Laser Fundamentals, William T. Silfvast, 2nd Edition, Cambridge University press, New York, 2004.*
2. *Fundamentals of Physics, 6th Edition, D. Halliday, R. Resnick and J. Walker, John Wiley and Sons, New York 2001.*
3. *Introduction to Solid State Physics, 7th Edition, Charls Kittel, Wiley, Delhi 2007.*

COURSE OUTCOMES:

The student will be able to understand many modern devices and technologies based on lasers and optical fibers. Student can also appreciate various material properties which are used in engineering applications and devices.

LABORATORY EXPERIMENTS:

1. Torsional pendulum
2. Numerical aperture of an optical fiber
3. Temperature measurement – Thermocouple
4. Specific rotation of a liquid – Half Shade Polarimeter
5. Thickness of a thin wire – Air Wedge
6. Conversion of galvanometer into ammeter and voltmeter
7. Dispersive power of a prism – Spectrometer
8. Superconductivity- measurement of transition temperature
9. Absorption spectrometer
10. Brewster's Angle measurement
11. Measurement of Young's modulus

Reference Books:

1. *'Practical Physics', R.K. Shukla, Anchal Srivastava, New Age International, 2011.*
2. *'B.Sc. Practical Physics', C.L Arora, S. Chand &Co., 2012.*

PHIR13 – PHYSICS - II

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

Course Objectives:

- To make a bridge between the physics in school and engineering courses.
- To introduce the basic concepts of modern physics like fundamentals of quantum mechanics, nuclear physics and advanced materials.
- To introduce fundamental physics like electrodynamics and semiconductor physics for circuit branch students.

Course Content :

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-lives - application in determining the age of rock and fossils-Stellar nucleosynthesis. Fundamental forces - Particle physics - classification of matter - quark model - neutrino properties and their detection.

Advanced Materials

Nanomaterials: Introduction and properties–synthesis–chemical vapour deposition–ball milling – applications. Carbon nanotubes: structure and properties – synthesis– arc method– Pulsed laser deposition- applications.

Liquid Crystals: Types– Nematic, Cholesteric, Smectic–Modes: Dynamic scattering, Twisted nematic – Display systems.

Shape memory alloys: one way and two way memory effect- pseudo elasticity- applications

Electrodynamics

Electrostatics: Coulomb's law - Gauss's law – proof of Gauss's law- Electrostatic filed in matter - dielectric polarization, polarizability and susceptibility - types of polarization – internal field and Claussius-Mosotti equation. ***Magneto statics:*** Lorentz force -Steady current and equation of continuity - Biot-Savart law – Ampere's law –Magneto static field in matter: torques and forces on magnetic dipoles-Magnetization-Faraday's law of induction – Maxwell's equations: generalization of Ampere's law —- propagation of EM waves in free space.

Semiconductor Physics

Introduction-Direct and indirect band gap semiconductors - Intrinsic semiconductor at 0 K-Intrinsic semiconductor at room temperature-Intrinsic carriers- Electron and Hole concentrations-doping-n-type – p-type-temperature variation of carrier concentration in extrinsic semiconductor-Extrinsic conductivity-Law of Mass action-Charge neutrality-Fermi level in extrinsic semiconductors-Electrical conduction in extrinsic semiconductors-Hall effect.

Text Books:

1. *'A Text Book of Engineering Physics', M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, New Delhi 2009.*
2. *'Engineering Physics', R.K. Gaur and S.L. Gupta, Dhanpat Rai Publications (P) Ltd., 8th Edition., New Delhi 2001.*

Reference Books:

1. *'Concepts of Modern Physics', Arthur Beiser, Tata McGraw-Hill, New Delhi 2010.*
2. *'Semiconductor Physics and Devices: Basic Principle', Donald A. Neamen 4th Ed, McGraw-Hill, New York 2012.*
3. *'Introduction to Electrodynamics', David J. Griffiths, 3rd Edition, Prentice Hall of India, New Delhi 2012.*
4. *'Introduction to Nanotechnology', C.P. Poole and F.J. Owens, Wiley, New Delhi 2007.*
5. *'Introduction to Liquid Crystals Chemistry and Physics', 2nd Edition, Peter J. Collings, Princeton University Press, New Jersey, 2002.*
6. *'Shape Memory Alloys-Modeling and Engineering Applications', Ed. D. C. Lagoudas, Springer, New York 2008.*

COURSE OUTCOMES:

The student will be able to understand fundamentals of electrodynamics and semiconductor physics which is base of many modern devices and technologies. Student will also get an exposure to modern physics topics like nuclear physics, nanotechnology and advanced materials.

CHIR11 - CHEMISTRY - I

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

Course Objectives:

To introduce students to water chemistry, bonding concepts, entropy and basic organic chemistry.

Course Content :

Water

Sources, hard & soft water, estimation of hardness by EDTA method, 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.

Chemical Bonding

Basic concepts, bonding in metals, electron gas theory, physical properties of metals (electrical & thermal conductivity, opaque & lusture, malleability & ductility), Alloy-substitutional alloys, interstitial alloys.

Coordinate bond, EAN rule, 16 & 18 electron rule, crystal field theory, splitting of 'd' orbitals in octahedral, tetrahedral and square planar complexes.

Shape & Intermolecular Interactions

Shape-Lewis dot structures, formal charge, VSEPR method, consequences of shape, dipole moment, valence bond theory; Intermolecular interactions-ion ion interactions, ion-dipole interactions, hydrogen bonding, dipole-dipole interactions, London / dispersion forces, relative strength of intermolecular forces; Consequences-surface tension.

Thermodynamics

Entropy as a thermodynamic quantity, entropy changes in isothermal expansion of an ideal gas, reversible and irreversible processes, physical transformations, work & free energy functions, Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equation, Gibbs-Duhem equation, Clapeyron-Clausius equation & its applications, Van't Hoff isotherm and applications.

Fuels & Lubricants

Fuels - Classification, examples, relative merits, types of coal, determination of calorific value of solid fuels, Bomb calorimeter, theoretical oxygen requirement for combustion, proximate & ultimate analysis of coal, manufacture of metallurgical coke, flue gas analysis, problems. Lubricants - Definition, theories of lubrication, characteristics of lubricants, viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point, additives to lubricants, Solid lubricants.

Text Books:

1. *'Engineering Chemistry', P.C. Jain, M. Jain, Dhanpat Rai Publishing Company, New Delhi, 2005.*
2. *'Physical Chemistry', P. Atkins, J.D. Paula, Oxford University Press, 2002.*

Reference Books:

1. *'Modern Inorganic Chemistry', R.D. Madan, S. Chand & Company Ltd., New Delhi, 2012.*
2. *'Engineering Chemistry', M.J. Shultz, Cengage Learning, New Delhi, 2007.*

COURSE OUTCOMES:

Students will learn about quality of water, bonding theories, entropy change for various processes and basic stereo chemical aspects.

LABORATORY EXPERIMENTS:

1. Estimation of total alkalinity in the given water sample.
2. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
3. Estimation of dissolved oxygen in the given water sample.
4. Determination of the percentage of Fe in the given steel sample.
5. Estimation of Ca in limestone.
6. Estimation of Fe^{3+} by spectrophotometer.

Reference Books:

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

CHIR13 - CHEMISTRY - II

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

Course Objectives:

To introduce the students to basic principles of electrochemistry, cell construction and evaluation, electrochemical power sources, the importance of corrosion in metal/alloy and polymer.

Course Content :

Electrochemistry

Conductivity of electrolytes- Specific, molar and equivalent conductivity, Nernst equation for electrode potential, EMF series, hydrogen electrode, calomel electrode, glass electrode, Electrolytic and galvanic cells, cell EMF, its measurement and applications, Weston standard cell, reversible and irreversible cells, concentration cell, electrode (hydrogen gas electrode) and electrolyte concentration cell, concentration cell with and without transference.

Corrosion

Dry corrosion and wet corrosion, mechanisms, types of corrosion, DMC, DAC, stress, inter granular, atmospheric and soil corrosion, Passivity, Polarization, over potential and its significance, Factors affecting corrosion, protection from corrosion by metallic coatings, electroplating, electroless plating and cathodic protection, Chemical conversion coatings and organic coatings- Paints, enamels.

Batteries

Different types of batteries-Primary, Secondary & Flow battery and Fuel cell. Working principle and uses- Laclanche cell, alkaline battery, nicad battery, lithium battery & Mercury battery. Fuel cell-Theory, working and application. Different types of fuel cells-H_2/O_2, propane-oxygen, PEFC and SOFC. Lead Acid storage cell-charging & discharging principle, operation and uses. Solar battery- its working principle.

Solid State

Types of solids - close packing of atoms and ions - bcc , fcc structures of rock salt - cesium chloride-spinel - normal and inverse spinels, Stoichiometric Defect, controlled valency & Chalcogen semiconductors, Non-elemental semiconducting Materials, Preparation of Semiconductors-steps followed during the preparation of highly pure materials and further treatments. Semiconductor Devices-p-n junction diode.

Polymer

Nomenclature, functionality, classification, methods of polymerization, mechanism of polymerization, molecular weight determination-Viscometry, light scattering methods. Plastics-Moulding constituents of a plastics and moulding of plastics into articles. Important thermoplastics and thermosetting resins-synthesis & applications of PVA, FLUON, PC, Kevlar, ABS polymer, phenolic & amino resins, epoxy resins and polyurethanes. Conductive polymers.

Text Books:

1. *P. C. Jain and M. Jain, 'Engineering Chemistry', Dhanpat Rai Publishing Company, New Delhi, 2005.*
2. *B.R. Puri, L.R. Sharma, M.S. Pathania, 'Principles of Physical Chemistry', Vishal Publishing Company, 2008.*
3. *J. D. Lee, 'Concise Inorganic Chemistry', 5th Edition, Chapman and Hall, London, 1996.*

Reference Books:

1. *S. S. Dara, S. S. Umare, 'A Text Book of Engineering Chemistry', S. Chand Publishing, 2011.*
2. *F.W. Billmayer., 'Textbook of Polymer Science', 3rd Edition, Wiley. N.Y. 1991.*
3. *A.R. West, 'Basic Solid State Chemistry', 2nd Edition, John Wiley and Sons, 1999.*

COURSE OUTCOMES:

Students would become familiar with the important practical applications of electrochemistry, solids, their properties and applications, and the polymer materials.

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: 3

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 :

Communication An introduction - Its role and importance in the corporate world–Tools of communication – Barriers – Levels of communication – English for Specific purposes and English for technical purposes.

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

Reading Introduction of different kinds of reading materials: technical & non-technical–Different reading strategies: skimming, scanning, inferring, predicting and responding to content – Guessing from context – Note making – Vocabulary extension.

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

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

Course Material:

Instruction will be provided through appropriate material – articles from popular magazines, newspapers, technical journals, samples from industries and also text books. Practice in the four language skills necessary for their specific technical requirements will be provided in an integrated manner.

Text Books:

1. *Krishna Mohan and Meenakshi Raman 'Effective English Communication', Tata McGraw Hill, New Delhi, 2000.*
2. *Meenakshi Raman and Sangeetha Sharma 'Technical Communication', Oxford University Press, New Delhi, 2006.*

Reference Books:

1. *M. Ashraf Rizvi 'Effective Technical Communication', Tata McGraw-Hill, New Delhi, 2005.*
2. *Golding S.R. 'Common Errors in English Language', Macmillan, 1978.*
3. *Christopher Turk 'Effective Speaking', E & FN Spon, London, 1985.*

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.

HSIR12 - PROFESSIONAL COMMUNICATION

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

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 their professional needs.

Course Content :

Listening Barriers to listening: Physical & psychological–Steps to overcome them–Purposive listening practice – Active listening and anticipating the speaker – Use of technology in the professional world.

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

Reading Speed reading practice–Use of extensive readers–Trans-coding: verbal and non-verbal – Eye-reading practice – Analytical and critical reading practice- Introduction to ethics & values through case-study materials.

Writing Professional Correspondence–Formal and informal letters–Argument Writing practice – Perspectives in writing – Narrative writing -Different registers - Tone in formal writing – Summary writing practice- Introduction to reports.

Study Skills Reference Skills - Use of dictionary, thesaurus etc–Importance of contents page, cover & back pages – Bibliography.

Course Material:

Instruction will be provided through appropriate material – articles from popular magazines, newspapers, technical journals, samples from industries and also text books. Practice in the four language skills will be provided in an integrated manner.

Reference Books:

1. *Shirley Taylor (1999), 'Communication for Business', Longman, New Delhi.*
2. *Robert Gannon (2000), 'Best Science Writing: Readings and Insights', University Press, Hyderabad.*
3. *Richard A. Boning (1990), 'Multiple Reading Skills', McGraw Hill, Singapore.*
4. *Albert J. Harris, Edward R.Sipay (1990), 'How to Increase Reading Ability', Longman.*
5. *David Martin (1994), 'Tough Talking', University press, Hyderabad.*

COURSE OUTCOMES:

The students will have knowledge of the various uses of English in their professional environment and they will be able to communicate themselves effectively in their chosen profession.

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.

Text 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.*

Reference Books:

1. *Unleashing the Potential of Renewable Energy in India' –World Bank Report.*
2. *Godfrey Boyle, Bob Everett and Janet Ramage. 'Energy Systems and Sustainability, Power for a sustainable future'. Oxford University Press, 2010.*

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.

HSIR14 - PROFESSIONAL ETHICS AND HUMAN VALUES

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.,

Text Books:

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.

Geometrical constructions: Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and hexagon – conic sections – ellipse – parabola – hyperbola - cycloid – trochoid.

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.

Computer aided drafting Introduction to computer aided drafting package to make 2-D drawings.
Self-study only, not to be included in examinations. Demonstration purpose only.

Text Books:

1. *Bhatt, N. D. and Panchal, V.M., 'Engineering Drawing', Pub.: Charotar Publishing House, 2010.*
2. *Natarajan, K. V., 'A Text Book of Engineering Graphics', Pub.: Dhanalakshmi Publishers, Chennai, 2006.*

Reference Books:

1. *Venugopal, K. and Prabhu Raja, V., 'Engineering Drawing and Graphics + AutoCAD', Pub.: New Age International, 2009.*
2. *Jolhe, D. A., 'Engineering drawing', Pub.: Tata McGraw Hill, 2008.*
3. *Shah, M. B. and Rana, B. C., 'Engineering Drawing', Pub.: Pearson Education, 2009.*
4. *Trymbaka Murthy, S., 'Computer Aided Engineering Drawing', Pub.: I.K. International Publishing House, 2009.*

COURSE OUTCOMES:

Towards the end of the course it is expected that the students would be matured to visualize the engineering components. A number of chosen problems will be solved to illustrate the concepts clearly.

PRIR11 - ENGINEERING PRACTICE

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

Course Objectives:

- Introduction to the use of tools and machinery in Carpentry, Welding, Foundry, Fitting and Sheet Metal Working.

Course Content :

Carpentry

Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make

1. Half lap joint
2. Cross lap joint

Welding

Exercise in arc welding for making

1. Lap joint
2. Butt joint

Foundry

Preparation of sand mould for the following

1. Flange
2. Anvil

Fitting

Preparation of joints, markings, cutting and filling for making

1. V-joint
2. T-joint

Sheet metal

Making of small parts using sheet metal

1. Tray
2. Funnel

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.

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.*

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.

MEIR11 - BASIC MECHANICAL ENGINEERING

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

Course Objectives:

- To explain the importance of concepts of mechanical engineering and conservation equations.
- To introduce the techniques for analyzing the forces, momentum and power.
- To introduce the various properties of materials, and the techniques of selection of materials.
- To identify the basic elements of a mechanical system and write their constitutive equations and performance analysis techniques.

Course Content :

Fundamentals: Introduction to mechanical engineering, concepts of thermal engineering, mechanical machine design, industrial engineering, and manufacturing technology.

Thermal Engineering: Laws of thermodynamics, types of systems, concepts and types of I.C. engine, air compressors, principle of turbo machines, properties of steam and steam generators, automobile engineering, introduction to gas turbines and refrigeration & air-conditioning.

Engineering Materials: Types of materials, selection of materials, material properties, introduction to materials structure, machine elements, transmission, fasteners, and support systems.

Manufacturing Technology: Manufacturing, classification, lathe, drilling machines, milling machines, metal joining, metal forming, casting, forging, and introduction to powder metallurgy.

Reference Books:

1. *Lecture notes prepared by Department of Mechanical Engineering, NITT.*
2. *K. Venugopal, 'Basic Mechanical Engineering'.*

COURSE OUTCOMES:

The terminal objectives of the course is that, on successful completion of teaching-learning and evaluation activities, a student would be able to identify, appreciate and analyze the problems by applying the fundamentals of mechanical engineering and to proceed for the development of the mechanical systems.

CSIR11 – BASICS OF 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 – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program.

Algorithms – Characteristics – Flowcharts - Principles of Structured programming – Sequential, selective structures - Repetitive structures –Bounded , Unbounded and Infinite iterations – Examples for each.

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 statement – break statement – continue statement – comma operator – goto statement.

Modular Programming – Functions and Procedures – Examples – Parameter passing methods.

Arrays – Defining an array – Processing an array – Multidimensional arrays-Pointers – Variable definitions and initialization – Pointer operators – Pointer expressions and arithmetic – Pointers and one-dimensional arrays- Functions – Defining a function – Accessing a function – Function prototypes – Passing arguments to a function –Passing arrays to a function – Passing pointers to a function – Recursion.

Text Books:

1. *Byron Gottfried, 'Programming with C', Third Edition, Tata McGraw Hill Education, 2010.*
2. *R.G.Dromey, 'How to Solve it By Computers?', Prentice Hall, 2001.*

Reference Books:

1. *J.R. Hanly and E.B. Koffman, 'Problem Solving and Program Design in C', 6th Edition, Pearson Education, 2009.*
2. *Paul Deital and Harvey Deital, 'C How to Program', Seventh Edition, Prentice Hall, 2012.*
3. *Yashavant Kanetkar, 'Let Us C', 12th Edition, BPB Publications, 2012.*

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

LABORATORY EXPERIMENTS:

1. Programs using sequence construct
2. Programs using selection construct
3. Programs using Iterative construct
4. Programs using nested for loops
5. Programs using functions with Pass by value
6. Programs using functions with Pass by reference
7. Programs using recursive functions
8. Programs using one dimensional Array
9. Programs using two dimensional Arrays
10. Programs using Pointers and functions
11. Programs using Pointers and Arrays

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.

EEPC10 - ELECTRON DEVICES

Course Type: Programme Core (PC) ***Pre-requisites:*** Basic Physics
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.

Text Books:

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.

EEPC11 - CIRCUIT THEORY

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR21
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.

Text Books:

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. Understand the technical representation of common electrical systems.
2. Analyze and compute the time domain behavior of linear (AC and DC) electric circuits with single or multiple power sources.
3. Compute the performance of AC Networks (1-port) which may be 1-Φ or 3-Φ using phasor analysis.
4. Understand the flow of real and reactive power components in AC systems.
5. Analyze simple electro-magnetic circuits.

EEPC12 - DC MACHINES AND TRANSFORMERS

Course Type: Programme Core (PC) ***Pre-requisites:*** Basic Physics
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.

Text Books:

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 the constructional details and principle of operation of DC machines and Transformers.
2. Analyze the performance of the DC Machines under various operating conditions using their various characteristics.
3. Evaluate the performance of Transformers using phasor diagrams and equivalent circuits.
4. Select appropriate DC motor as well as to choose an appropriate method of speed control for any industrial application.

EEPC13 - DATA STRUCTURES AND ALGORITHMS

Course Type: Programme Core (PC) ***Pre-requisites:*** CSIR11
No. of Credits: 4

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.

Text Books:

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; and primitive data structures.
2. Clear understanding of the sequential storage data structures and their applications.
3. Familiarity with linked linear and non-linear data structures and operations on such data structures.
4. The awareness of various sorting, searching algorithms and file structures.
5. The ability to design and develop menu-driven application programs.

EEPC14 - ANALOG ELECTRONIC CIRCUITS

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

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.

Text Books:

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 amplifier, 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 amplifier, oscillator, attenuators and multivibrator circuits.

EEPC15 - DIGITAL ELECTRONICS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC10
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 – Introduction to RTL, DTL, TTL, ECL and MOSL families – wired and operation, characteristics of digital logic family – comparison of different logic families.

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 – code converters, adders, subtractors.

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.

Asynchronous sequential logic circuits-Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – introduction to design – implication table – hazards - programmable logic array and devices.

Text Books:

1. *Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.*
2. *Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2003.*
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.
2. Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplification.
3. Design and analyze combinational and sequential logic circuits.

EEPC16 - TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC11
No. of Credits: 3

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.

Text Books:

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.

EEPC17 - LINEAR INTEGRATED CIRCUITS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC11
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.

Text Books:

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.

EEPC18 - 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.

Text Books:

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 PMBLDC machines.
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.

EEPC19 - NETWORKS AND LINEAR SYSTEMS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR32, EEPC11
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.

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 – Thermal systems.

Time domain analysis: Time-domain specifications - Generalized error series – various test signals and its importance- Routh-Hurwitz stability criterion.

Root Locus Technique: Definitions - Root locus diagram - Rules to construct root loci - Effect of pole-zero additions on the root loci.

Frequency domain analysis: Bode plot - Polar plot - Nyquist plot - phase-margin - gain margin - Nyquist stability criterion.

Controller design: Design of P, PI, PID, lag, lead, lead-lag compensator design.

Text Books:

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.*

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 - POWER ELECTRONICS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR32, EEPC10
No. of Credits: 3 & EEPC11

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.

Text Books:

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.

EEPC22 - MICROPROCESSORS AND MICROCONTROLLERS

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC15
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.

Text Books:

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

COURSE OUTCOMES:

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

1. Have a clear understanding of the architecture and instruction set of 8085 and 8051.
2. Be able to interface peripherals and memories with 8085 and 8051.
3. Be able to understand the application of 8085 and 8051 in waveform generators.

EEPC23 - MEASUREMENTS AND INSTRUMENTATION

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC17
No. of Credits: 4

Course Objectives:

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

Course Content :

Measurements – Errors & classification, Measurement of voltage & current - permanent magnet moving coil and moving iron meters, Digital voltmeters and automation, guarding techniques.

Measurement of power and energy - dynamometer and induction instruments, kVAh and kVARh meters, maximum demand indicators, digital multi-meters. Instrument transformers – Current and Potential transformers. Spectrum Analyzers, Data & Logic Analyzers.

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 – Oscillators, Function generator & pulse generators. Oscilloscopes - CRO, Digital storage and Analog storage Oscilloscope, Digital Phosphor Oscilloscopes. Analog & Digital Recorders and printers.

Signal conditioners – Instrumentation amplifiers, voltage–current converters, voltage-frequency converters, analog multiplexers and de-multiplexers. Microprocessor Based Measurements, Case Studies in Instrumentation.

Text Books:

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.*

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 different measuring instruments.
2. Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.
3. Correlate the significance of different measuring instruments, recorders and oscilloscopes.
4. Develop a micro-processor based measuring unit for any practical application.

EEPC24 - VLSI DESIGN

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC15, EEPC17
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.

Text Books:

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.

EEPC25 - POWER SYSTEM ANALYSIS

Course Type: Programme Core (PC) ***Pre-requisites:*** MAIR42, EEPC16
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.

Text Books:

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.

EEPC26 - POWER SYSTEM PROTECTION AND SWITCHGEAR

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC25
No. of Credits: 3

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.

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.

Text Books:

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.*

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.

EEPC27 - COMMUNICATION SYSTEMS[#]

Course Type: Programme Core (PC) ***Pre-requisites:*** EEPC15, EEPC19
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.

Text Books:

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.*

EEPC28 - THERMODYNAMICS AND MECHANICS OF FLUIDS#

Course Type: Programme Core (PC)

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 a cycle and a process, steady flow processes.

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. Basics of fluid properties - 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.
5. Determine the optimum working conditions for hydraulic machines.

[#] *Will be offered by the Department of Mechanical Engineering.*

EELR10 - CIRCUITS AND DEVICES LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC11
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 diode and characteristics of Transistor.

List of Experiments

- Characteristics of CB and CE configuration of BJT.
- I-V Characteristics of p-channel and n-channel MOSFET.
- Verification of Thevenin and Maximum Power Transfer Theorem.
- Verification of Superposition Theorem.
- Verification of Kirchhoff's Current and Voltage law.
- Transient characteristics of R-L series circuit.
- Transient characteristics of R-C series circuit.
- Transient characteristics of R-L-C series circuit.

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.

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:*** EEPC14
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 - INTEGRATED CIRCUITS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC17
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.

EELR14 - SYNCHRONOUS AND INDUCTION MACHINES LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC18
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.

EELR15 - POWER ELECTRONICS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC21
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-COMPUTING AND VLSI DESIGN LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC22, EEPC24
No. of Credits: 2

Course Objectives:

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

List of Experiments

- Arithmetic operations (8/ 16 bit) using 8085
- Waveform generation using 8085
- Interfacing with 8085 (ADC, DAC)
- Arithmetic operations (16 bit) using 8051
- Firing pulse generation using 8051
- Interfacing with 8051 (Stepper motor/ DC Motor control)
- VHDL programming for PWM pulse generation
- Design and Simulation of Sequence detector circuit using Verilog HDL
- Design and FPGA implementation of 4-bit multiplier unit
- Layout and physical design of a Mod-N counter unit

Mini–Project

COURSE OUTCOMES:

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

1. Accomplish arithmetic and logical operations with micro-processors, micro-controllers and FPGA.
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-processors and micro-controllers.
4. Analyze and document the experiments carried out.
5. Design and implement control circuitry using micro-processors and micro-controllers for any engineering and real world problems.

EELR17 - POWER SYSTEMS LABORATORY

Course Type: Essential Laboratory Requirement (ELR) ***Co-requisites:*** EEPC25
No. of Credits: 2

Course Objectives:

To enhance the analyzing and problem solving skills of the students in the area of power system and power electronics 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 electronics circuits using simulation packages.
3. Prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.

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 wind mills, 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.

Text Books:

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:*** Basic science and electrical engineering
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.

Text Books:

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 – OPERATING SYSTEM CONCEPTS

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

No. of Credits: 3

Course Objectives:

To learn the various aspects of operating systems such as process management, memory management, and I/O management. This course will outline the importance of operating system components, different views and principles of design and implementation.

Course Content :

Operating system concepts-types of OS and OS structure-Processes-Process model –Process scheduling - Scheduling criteria – Scheduling algorithms – Multiple- processor scheduling – Real time scheduling – Algorithm Evaluation.

The critical-section problem –Synchronization hardware – Semaphores – Classic problems of synchronization –critical regions – Monitors. Deadlock: System model –Deadlock characterization – Methods for handling deadlocks – Deadlock prevention – Deadlock avoidance –Deadlock detection – Recovery from deadlock.

Memory Management: Background– Swapping – Contiguous memory allocation – Paging – Segmentation–Segmentation with paging. Virtual Memory: Background – Demand paging – Process creation – Page replacement – Allocation of frames – Thrashing. Case Study: Memory management in Linux.

File-System Interface: File concept – Access methods – Directory structure – File-system mounting – Protection. File-System Implementation: Directory implementation – Allocation methods – Free-space management – efficiency and performance – recovery– log-structured file systems. Case studies: File system in Linux – file system in Windows XP.

I/O Systems – I/O Hardware – Application I/O interface–kernel I/O subsystem–streams–performance. Mass-Storage Structure: Disk scheduling–Disk management – Swap-space management – RAID – disk attachment – stable storage – tertiary storage. Introduction to distributed systems. Case study: I/O in Linux.

Text Books:

1. *Andrew S. Tanenbaum, 'Modern Operating Systems', Prentice Hall of India, 3rd Edition, 2009.*
2. *J. L. Peterson, 'Operating System Concepts', Addison- Wesley Publishing Company, 2nd Edition, 1985.*
3. *A.Silberchatz, P.B.Galvin, 'Operating System Concepts', Addison Wesley, 6th Edition, 2005.*

Reference Books:

1. *W. Stallings, 'Operating Systems', Prentice Hall, 5th Edition, 2005.*
2. *Harvey M. Deitel, 'Operating Systems', 3rd Edition, Pearson Education, 2004.*

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Describe functions, structures and history of operating systems, various process management concepts including scheduling, synchronization, Deadlocks, concepts of memory management including virtual memory, related to file system interface and implementation, disk management.
2. Be familiar with protection and security mechanisms.
3. Be familiar with various types of operating systems including WINDOWS and UNIX.
4. Analyze theory and implementation of processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and file.

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.

Text Books:

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.

Text Books:

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:*** EEPC11
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.

Text books:

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 – OBJECT ORIENTED PROGRAMMING USING C++

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC13

No. of Credits: 3

Course Objectives:

To make the students understand the semantic and logic of programming using C++ so as to facilitate them to develop programs.

Course Content :

Object oriented programming-Traditional approach versus object oriented approach-logical operators, Control Statements, storage classes, library functions. Input and output console operations, namespace, manipulators and user defined manipulators.

Structures and Functions, Parameter passing and return, default arguments, Static functions, Inline functions, Functions with Pointers, Function Overloading, Classes and Objects, Constructors and destructors.

Operator overloading, Type conversion, Inheritance, Types of Inheritance, containership classes, Virtual functions, Friend functions.

Pointers and strings, pointers to pointers, Memory management, pointers to objects, *this* pointer, Virtual Base class, Abstract class, late binding, Templates and exceptions.

Streams and stream classes, File pointers, Disk I/O with member functions, Error handling, Redirection, Command-line arguments, Overloading the extraction and insertion operators.

Text Books:

1. *Robert Lafore, `Object Oriented Programming in Turbo C++', Galgotia Publications, Pvt.Ltd., 2007.*
2. *Stanley B Lippman, Josee Lajoie, Barbara E. Moo, 'C++ Primer, Addison Wesley, 5th Edition, 2015.*
3. *Bjourne Stroustrup, `The C++ Programming Language', Addison Wesley, 3rd Edition, 2013.*

Reference Books:

1. *Ashok N Kamthane, 'Object-Oriented Programming with ANSI and Turbo C++ ', First Edition, Pearson Education, 2003.*
2. *Joyce Farrell, 'Object Oriented Programming Using C++' , Cengage, 2008.*
3. *K. R. Venugopal, B. Rajkumar, T. RaviShankar, 'Mastering C ++', TMH, 1997.*
4. *Balagurusamy, E, 'Object Oriented Programming with C++', Fourth Edition, Tata Mcgraw-Hill, 2008.*

COURSE OUTCOMES:

Upon completion of this course, students will

1. Develop programs using the fundamental concepts of OOPS.
2. Be able to work with files and templates.
3. Develop menu driven programs using Data Structures and OOPS.

EEPE17 – COMPUTER ARCHITECTURE

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15

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.

Text Books:

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.

EEPE18 – DIGITAL SYSTEM DESIGN AND HDLS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15
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.

Text Books:

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.

EEPE19 – DESIGN WITH PIC MICROCONTROLLERS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC15

No. of Credits: 3

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.

Text Books:

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.

EEPE20 – DIGITAL SIGNAL PROCESSING

Course Type: Programme Elective (PE) ***Pre-requisites:*** MAIR32, EEPC15

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 :

Linearity shift - invariance - Unit sample response characterization – Convolution summation, causality, linear difference equations with constant coefficients and their solution using Z-transform –System function-concept.

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

Amplitude and phase response of FIR filters–Linear phase filters – Windowing technique for the design of linear phase FIR filters – Rectangular Hamming and Kaiser windows – 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 – Finite Word Length Effects – Elementary ideas of finite word length effects in digital filters.

Architecture and features of signal processor and motion controller.

Text Books:

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.

EEPE21 / EEOE12 – ARTIFICIAL NEURAL NETWORKS

Course Type: Programme Elective (PE) / Open Elective (OE) ***Pre-requisites*:*** MAIR42
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.

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

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

Neural Network Applications – Pattern Recognition – Forecasting models – Control and Identification – Data Mining – Classification and Clustering.

Text Books:

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.*

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.*

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.

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

EEPE22 / EEHO10 – DISTRIBUTION SYSTEM AUTOMATION

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC16

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.

Text Books:

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.

EEPE23 / EEHO11 – EHV AC AND DC TRANSMISSION

Course Type: Programme Elective (PE) / Honours(HO) ***Pre-requisites:*** EEPC16

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.

Text Books:

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.

EEPE24 – DESIGN OF ELECTRICAL APPARATUS

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

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.

Text Books:

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.

EEPE25 – UTILIZATION OF ELECTRICAL ENERGY

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

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.

Text Books:

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 the appropriate type of electric supply system as well as to evaluate the performance of a traction unit.

EEPE26 – COMPUTER NETWORKS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC27
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.

Text Books:

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.

EEPE27/ EEOE13 / EEHO12 – NON-LINEAR CONTROL SYSTEMS

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

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.

Text Books:

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.

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

EEPE28 / EEOE14/ EEHO13– MODERN CONTROL SYSTEMS

Course Type: Programme Elective (PE) / Open Elective (OE)/Honours(HO) ***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.

Text Books:

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*

EEPE29 / EEHO14 – POWER SWITCHING CONVERTERS

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC21
No. of Credits: 3

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.

Text Books:

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.

EEPE30 – FUNDAMENTALS OF FACTS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC16, EEPC21
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.

Text Books:

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.

EEPE31 – SPECIAL ELECTRICAL MACHINES

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC18, EEPC21
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.

Text Books:

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.

EEPE32 – WIND AND SOLAR ELECTRICAL SYSTEMS

Course Type: Programme Elective (PE) ***Pre-requisites:*** EEPC18, EEPC21
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 systems–steady-state equivalent circuit-performance predetermination–permanent magnet alternators–steady-state performance.

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

Text Books:

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.

EEPE33 / EEHO15 – SOLID STATE DRIVES

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC18, EEPC21
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.

Text Books:

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.

EEPE34 / EEHO16 – VEHICULAR ELECTRIC POWER SYSTEMS

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC18, EEPC21

No. of Credits: 3

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 drive-trains 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 air craft, sea and undersea vehicles, space vehicles-hybrid vehicle control strategies-supporting subsystem.

Text Books:

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.

EEPE35 – 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.

Text Books:

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. *Galski 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.

EEPE36 – LOW POWER MICROCONTROLLER

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

Course Objectives:

To enrich the student with the concepts of low power microcontroller, its architecture, peripherals and applications.

Course Content :

Introduction - Motivation for MSP430 microcontrollers – Low Power embedded systems, Main characteristics of a MSP430 microcontroller, Main features of the MSP430X RISC CPU architecture, Address space, Interrupt vector table, Flash/ROM, Information memory (Flash devices only), Boot memory (Flash devices only), RAM, Peripheral Modules, Special Function Registers (SFRs), Central Processing Unit (MSP430 CPU), Arithmetic Logic Unit (ALU), MSP430, CPU registers, Central Processing Unit (MSP430X CPU), MSP430X CPU registers.

Addressing modes & Instruction set- Double operand instructions, Single operand instructions, Program flow control – Jumps, Emulated instructions and programming.

Device Systems and Operating Modes- system reset, system clock, interrupt management, WDT, WDT+, Basic Timer, Capture/Compare blocks, Timer_A Interrupts, Timer_B special features, Real Time Clock (RTC).

On-Chip Peripherals and General Purpose I/O- Hardware multiplier, ADC, DAC, SD16, LCD, DMA, Registers, Interruptible ports, Flashing LED, Blinking the LED, toggle the LED state by pressing the push button, Enable / disable LED blinking by push button.

Communications: Communications system model, Transmission mode, Synchronous and asynchronous serial communications, Serial Peripheral Interface (SPI) communication protocol, MSP430 communications interfaces, Case Studies of applications of MSP430.

Text Books:

1. *John H Davies, "MSP430 Microcontroller Basics", Newnes Publications, 2008.*
2. *Chris Nagy, "Embedded systems Design using TI MSP430 Series", Newnes, 2003.*

Reference Books:

1. *Teaching MSP430, Manual from Texas Instruments.*

COURSE OUTCOMES:

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

1. Understand the architecture of MSP 430 Microcontroller.
2. Appreciate the different Addressing modes and Instruction set.
3. Identify the device systems and operating modes of MSP 430.
4. Utilize the on-chip peripherals and I/O pins of MSP 430.
5. Construct the applications of MSP 430 and understand the communication interfaces.

EEPE37 / EEHO17 – AIRCRAFT ELECTRONIC SYSTEMS

Course Type: Programme Elective (PE) / 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).

Text Books:

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.

EEPE38 / EEHO18 – APPLIED SIGNAL PROCESSING

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

Course Objectives:

To inculcate the habit of applying theory in practical signal processing in real time systems.

Course Content :

Speech processing in a cell phone conversation - Linear predictive processing of speech – LP model of speech - LP estimation algorithm - LP processing in practice - Linear predictive coders.

Bits played back in an Audio CD - Delta–sigma modulation - Uniform quantization: Bits vs. SNR - Conventional DACs - Oversampling DACs – Noise shaping - Delta–sigma DACs.

Sound processed in a MP3 player - Sub-band and transform coding - Perfect reconstruction filters- Filter banks and lapped transforms - masking properties of the human ear - Audio coders.

Compression of Digital TV programs for broadcasting - Motion estimation - Motion estimation: The block matching algorithm - specificities of video coding standards.

Acoustic echo cancellation - internet phone – guidance and navigation systems – case studies on other real time systems.

Text Books:

1. *Thierry Dutoit, Ferran Marqu´es, 'Applied Signal Processing: A MATLAB-Based Proof of Concept', Springer, 2009.*

Reference Books:

1. *Dimitris G. Manolakis and Vinay K. Ingle, 'Applied Digital Signal Processing', Cambridge University Press, 2011.*
2. *V. Udayashankara, 'Real time Digital Signal Processing', PHI, 2010.*

COURSE OUTCOMES:

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

1. Appreciate the speech processing technique in cell phones.
2. Understand the bits processed in audio CD.
3. Identify the concepts of sound processed in MP3 player.
4. Determine the compression technique used in Digital TV programs.
5. Enrich about different real time signal processing systems.

EEPE39 / EEHO19 – POWER SYSTEM DYNAMICS

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC25
No. of Credits: 3

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 :

Stability considerations – Dynamic modeling requirements- angle stability - equal area criterion- Critical fault clearing time and angle-numerical integration techniques.

Synchronous machines - Park's transformation – flux linkage equations – formulation of normalized equations – state space current model – simplified models of the synchronous machine – turbine, Generator – steady state equations and phasor diagrams.

Dynamics of Synchronous machines - Mechanical relationships – electrical transient relationships – adjustment of machine models – Park's equation in the operational form.

Induction motor equivalent circuits and parameters - free acceleration characteristics – dynamic performance – effect of three phase short circuit and unbalanced faults.

Transient and dynamic stability distinction – linear model of unregulated synchronous machine and its oscillation modes – distribution of power impacts – effects of excitation on stability – supplementary stabilization signals.

Text Books:

1. *P. M. Anderson, 'A A Fouad, 'Power System Control and Stability', John Wiley & Sons, 1st Edition, 2008.*
2. *Yao-Nan Yu, 'Electric Power System Dynamics', Academic Press, 1983*
3. *Ramanujam R, 'Power System Dynamics', PHI Learning Pvt. Ltd., New Delhi, 2009.*
4. *T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1995.*
5. *Kundur P, 'Power System Stability and Control', McGraw-Hill, New York, 1994.*

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.

EEPE40 / EEHO20– MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC25
No. of Credits: 3

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.

Text Books:

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.

EEPE41 / EEHO21 - POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPC25
No. of Credits: 3

Course Objectives:

- To understand the economics of power system operation.
- 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 :

Types of load – components of system loads - load curves – load factor, demand factor, diversity factor, capacity factor, utilization factor, base load and peak load stations- Reserve Capacity and requirements - Load Forecasting-Electrical Tariff-types of tariff.

Economic Load Dispatch-characteristics of generation unit, Co-ordination equations with and without transmission loss, General problem formulation and common constraints-Unit Commitment -Constraints in unit commitment-Solution methods.

Load frequency control-Generator, Prime mover, Governor & Load models – LFC of a single area and two area systems-Tie line bias control-steady state and transient response- Automatic Voltage Regulator – Exciter and Generator models-steady state and transient response.

Reactive power and Voltage control–Load Compensation- power factor correction, voltage regulation, load balancing-Maximum load ability of transmission lines-Line Compensation-Static shunt capacitor / inductor-tap changing transformer, VAR compensators, Introduction to FACTS.

Recent trends in real time control of power systems-Power system control centers with SCADA / EMS –Restructuring of power system – fundamentals and operational restrictions–Introduction to Smart Grid.

Text Books:

1. *Allen J. Wood, Bruce F. Wollenberg, 'Power Generation Operation and Control', Wiley India 2nd Edition, 2009.*
2. *Abhijit Chakrabarti & Sunita Halder, 'Power System Analysis- Operation & Control', PHI New Delhi, 3rd Edition, 2010.*
3. *K Uma Rao, 'Power System Operation & Control', Wiley India 1st Edition, 2013.*

Reference Books:

1. *Robert H.Miller, James H.Malinowski, 'Power System Operation', Tata McGraw-Hill, 2nd Edition, 2009.*

COURSE OUTCOMES:

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

1. Calculate various factors (such as load factor and demand factor, etc.) and interpret different tariff structures.
2. Develop generation dispatching schemes for thermal units.
3. Apply frequency control schemes on power system.
4. Employ reactive power compensation systems.
5. Adopt engineering innovations for improved power system operation.

EEPE42 / EEHO22– COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT

Course Type: Programme Elective (PE) / Honours (HO) ***Pre-requisites:*** EEPE20
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.

Text Books:

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.

EEPE43 / EEOE15 / EEHO23 – DIGITAL CONTROL SYSTEMS

Course Type: Programme Elective (PE) / Open Elective (OE)/Honours (HO) ***Pre-requisites*:*** EEPE20
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.

Text Books:

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*

EEPE44 / EEHO24 – POWER SYSTEM RESTRUCTURING

Course Type: Programme Elective (PE) / Honours(HO) ***Pre-requisites:*** EEPE41

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.

Text Books:

1. *Loi Lei Lai, 'Power System Restructuring and Deregulation', John Wiley& Sons Inc., New York, HRD Edition, 2001.*
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 students would be able to

1. Explain and differentiate the key issues involved in the regulated and de-regulated power markets.
2. Describe the operational activities in Generation, Transmission and Distribution system in the restructured environment.
3. Illustrate and solve problems in the de-regulated power System.
4. Explain and analyze the restructuring activities in Indian Power System.

EEPE45 - OPERATIONS RESEARCH

Course Type: Programme Elective (PE) ***Pre-requisites:*** MAIR42
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.

Text Books:

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.

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.

Text Books:

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/EEOE23 - MICRO-COMPUTING SYSTEMS

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 / EEOE24 - 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.*