Syllabus for B.Tech(Power Engineering) Up to Fourth Year

Revised Syllabus of B.Tech CE (for the students who were admitted in Academic Session 2010-2011)

Course Structure -3rd Semester B.Tech PWE

Theory:

Sl. No.	Sub. Code	Sub. Name	Contact Hrs per week			Total	Credit
			L	T	P		
1	M(CS)301	Numerical methods	2	0	0	2	2
2	M 302	Mathematics-3	3	1	0	4	4
3	ME-302	Strength of Materials	3	0	0	3	3
4	ME-303	Engineering Materials	4	0	0	4	4
5	ME-301	Applied Thermodynamics	3	0	0	3	3
6	EE-301	Electric circuit Theory	4	0	0	4	4
					20		**20**

Practical / Sessional:

Sl. No.	Sub. Code	Sub. Name	Contacts hrs Per weeks			Total	Credits
			L	T	P		
1	M(CS) 391	Numerical methods	0	0	3	3	1
2	ME-393	Engineering Materials	0	0	3	3	2
3	ME-394	Strength of Materials	0	0	3	3	2
4	EE-391	Electric Circuit theory	0	0	3	3	2
5.	HU 381	Technical Report Writing and Lang Lab Practice			3	**3**	**2**
TOTAL OF SEMESTER:						**35**	**29**

Course Structure - 4th Semester B.Tech PWE

Sl. No.	Sub. Code	Sub. Name	Contacts hrs Per weeks				Total
THEORY			L	T	P	Total	
1.	HU-401	Values & ethics in profession	2	0	0	2	2
2.	PH401	Physics-II	3	0	0	3	3
3.	CH-401	Basic environmental Engineering & Biology	3	0	0	3	3
4.	ME-401	Fluid Mechanics and Hydraulic Machines	3	1	0	4	4
5.	EE-402	Electrical & Electronic measurement	3	0	0	3	3
6.	PWE-401	Electrical Machines-I	3	0	0	3	3
PRACTICAL							
1	ME-491	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	3	2
2	EE-492	Electrical & Electronic measurement Lab	0	0	3	3	2
3	PH-491	Physics-II Lab	0	0	3	3	2
TOTAL OF SEMESTER:						**31**	**28**

Syllabus for B.Tech(Power Engineering) Up to Fourth Year

Revised Syllabus of B.Tech CE (for the students who were admitted in Academic Session 2010-2011)

5th Semester Course Structure

A. THEORY							
Sl.No	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Pts**
			L	**T**	**P**	**Total**	
1	**HU-501**	Economics for Engineers	3	0	0	3	3
2	**PWE-501**	Electrical Machines	3	**1**	0	4	4
3	**PWE(ME)-502**	Heat Transfer	3	**1**	0	4	4
4	**PWE-503**	Nuclear & Advance Power Generation Technology	3	0	0	3	3
5	**PWE-504**	Hydro & Renewable Power Generation	3	**1**	0	4	4
6.	**PWE-505A OR PWE-505B**	Refrigeration & Air-conditioning Microprocessor & Digital Electronics	3	**0**	0	3	3
Total of Theory						**22**	**21**
B. PRACTICAL							
	PWE-591	Electrical Machines Lab	0	0	3	3	2
	PWE(ME)-592	Heat Transfer Lab	0	0	3	3	2
	PWE 595A OR PWE 595B	Refrigeration lab Microprocessor & Digital electronics Lab	0	0	3	3	2
Total of Semester						**31**	**27**

6th Semester Course Structure

Sl. No.	**Sub. Code**	**Sub. Name**	**Contact Hrs per week**				**Credit pts.**
THEORY			**L**	**T**	**P**	**Total**	
1.	HU- 601	Principles of Management	2	0	0	2	2
2.	PWE-601	Steam Generator & its Auxiliaries	3	0	0	3	3
3.	PWE-602	Steam Turbine & its Auxiliaries	3	0	0	3	3
4.	PWE-604	Electrical Equipment in Power Generation, Transmission and Distribution	3	1	0	4	4
5.	PWE-603	IC Engines and Gas Turbines	3	0	0	3	3
6.	PWE-605A	Theory of Machines	3	0	0	3	3
	PWE-605B	Power Electronics	3	0	0		
PRACTICAL							
1.	PWE-691	Combustion Lab	0	0	3	3	2
2.	PWE-692	Study of Power Plant & T&D Schemes	0	0	3	3	2
3.	PWE-693	Seminar	0	0	3	3	2

Total of semester: 18 + 6 = 24

Syllabus for B.Tech(Power Engineering) Up to Fourth Year

Revised Syllabus of B.Tech CE (for the students who were admitted in Academic Session 2010-2011)

Course Structure -7th Semester

Sl. No.	Sub. Code	Sub. Name	Contact Hrs per week				Credit pts.
THEORY			**L**	**T**	**P**	**Total**	
1.	PWE-701	Thermal Power Plant Operation and Maintenance	3	1	0	4	4
2.	PWE-702	Instrumentation & Process Control	3	0	0	3	3
3.	PWE-703	Electrical Protection System	3	0	0	3	3
4.	PWE-704	Power System Operation	3	0	0	3	3
5.	PWE-705A	Manufacturing & Industrial Engineering	3	0	0	3	3
	PWE-705B	Electric Drives					
PRACTICAL							
1.	HU-791	Group Discussion	0		3	3	2
2.	PWE 792	Control & Instrumentation Lab.	0	0	3	3	2
3.	PWE-793	Protection Lab.	0	0	3	3	2
SESSIONAL							
1.	**PWE 7810**	Project - I (Mech./ Elect.)	0	0	6	6	2
2.	**PWE 7811**	Industrial Training					2
						31	26

Sl. No	Sub. Code	Sub. Name	Contact Hrs / wk				Cr. pts.
THEORY			**L**	**T**	**P**	**Total**	
1.	PWE(HU)-801	Energy Management	2	0	0	2	2
2.	PWE-802A	Industrial Engg & Operations Research	2	1	0	3	3
3.	PWE-802B	High Voltage Engg.					
4.	PWE-803A	Design of Mechanical Equipments	2	1	0	3	3
5.	PWE-803B	Design of Electrical Equipments					
SESSIONAL							
1	PWE-894	Seminar / Study & presentation of Tech. topic	0	0	3	3	2
2	PWE-895	Design Lab / Industrial practical training	0	0	6	6	4
3	PWE-896	Project-2	0	0	12	12	6
4	PWE-897	Grand Viva					3
Total of Sessional						**21**	**15**
TOTAL OF SEMESTER						**30**	**23**

NUMERICAL METHODS : M(CS) 301
Contacts : 2L+1T
Credits :2

Module	Topics	Contact hrs
	Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.	(4)
	Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.	(5)
	Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.	(3)
	Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method.	(6)
	Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton-Raphson method.	(4)
	Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method.	(6)

Text Books:
1. C.Xavier: C Language and Numerical Methods.
2. Dutta & Jana: Introductory Numerical Analysis.
3. J.B.Scarborough: Numerical Mathematical Analysis.
4. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
References:
1. Balagurusamy: Numerical Methods, Scitech.
2. Baburam: Numerical Methods, Pearson Education.
3. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
4. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
5. Srimanta Pal: Numerical Methods, OUP.

MATHEMATICS - Code: M 302
Contacts: 3L +1T = 4
Credits: 4

Note 1: The entire syllabus has been divided into four modules.
Note 2: Structure of Question Paper
There will be two groups in the paper:
Group A: Ten questions, each of 2 marks, are to be answered out of a total of 15 questions, covering the
entire syllabus.
Group B: Five questions, each carrying 10 marks, are to be answered out of (at least) 8 questions.
Students should answer at least one question from each module.
[At least 2 questions should be set from each of Modules II & IV.
At least 1 question should be set from each of Modules I & III. Sufficient
questions should be set covering the whole syllabus for alternatives.] Syllabus for

Module	Topics	Contact hrs
Module I:	Fourier Series & Fourier Transform	[8L]
	Topic: Fourier Series:	
	Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave.	(1)
	Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions of period $2l$, Dirichlet's conditions, Sum of Fourier series. Examples.	(1)

	Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Parseval's identity statement only). Examples.	(2)
	Topic: Fourier Transform:	
	Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier Cosine & Sine Transforms of elementary functions.	(1)
	Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples. Fourier Transform of Derivatives. Examples.	(1)
	Convolution Theorem (statement only), Inverse of Fourier Transform, Examples.	(2)
Module II :	Calculus of Complex Variable	[13L]
	Introduction to Functions of a Complex Variable. Complex functions, Concept of Limit, Continuity and Differentiability.	(1)
	Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems.	(1)
	Construction of Analytic functions: Milne Thomson method, related problems.	(1)
	Topic: Complex Integration.	
	Sub-Topics: Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Examples.	(2)
	Sub-Topics: Cauchy's theorem (statement only). Cauchy-Goursat theorem (statement only). Examples.	(1)
	Cauchy's integral formula, Cauchy's integral formula for the derivative of an analytic function, Cauchy's integral formula for the successive derivatives of an analytic function.	(2)

	Examples.	
	Taylor's series, Laurent's series. Examples	(1)
	Topic: Zeros and Singularities of an Analytic Function & Residue Theorem.	
	Sub-Topics: Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and nonisolated singularity, essential singularities. Poles: simple pole, pole of order m. Examples on determination of singularities and their nature.	(1)
	Residue, Cauchy's Residue theorem (statement only), problems on finding the residue of a given function, evaluation of definite integrals:	2
	Topic: Introduction to Conformal Mapping.	
	Sub-Topics: Concept of transformation from z-plane to w-plane. Concept of Conformal Mapping. Idea of some standard transformations. Bilinear Transformation and determination of its fixed point.	(1)
Module III:	Probability [8L]	
	Topic: Basic Probability Theory	
	Sub-Topics: Classical definition and its limitations. Axiomatic definition. Some elementary deduction: i) $P(O)=0$, ii) $0 \leq P(A) \leq 1$, iii) $P(A')=1-P(A)$ etc. where the symbols have their usual meanings. Frequency interpretation of probability.	(1)
	Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems. Conditional probability & Independent events. Extension to more than 2 events (pairwise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems.	(3)
	Topic: Random Variable & Probability Distributions. Expectation. Sub-Topics: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples.	(2)

	Some important discrete distributions: Binomial & Poisson distributions and related problems. Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.	(2)
Module IV:	Partial Differential Equation (PDE) and Series solution of Ordinary Differential Equation (ODE) [13L]	
	Topic: Basic concepts of PDE.	
	Sub-Topics: Origin of PDE, its order and degree, concept of solution in PDE. Introduction to different methods of solution: Separation of variables, Laplace & Fourier transform methods.	(1)
	Topic: Solution of Initial Value & Boundary Value PDE's by Separation of variables, Laplace & Fourier transform methods.	
	Sub-Topics: PDE I: One dimensional Wave equation.	(2)
	PDE II: One dimensional Heat equation.	(2)
	PDE III: Two dimensional Laplace equation.	(2)
	Topic: Introduction to series solution of ODE.	
	Sub-Topics: Validity of the series solution of an ordinary differential equation. General method to solve Po y"+P1 y'+P2 y=0 and related problems.	(2)
	Topic: Bessel's equation.	
	Sub-Topics: Series solution, Bessel function, recurrence relations of Bessel's Function of first kind.	(2)
	Topic: Legendre's equation.	
	Sub-Topics: Series solution, Legendre function, recurrence relations and orthogonality relation.	

TOTAL LECTURES : 42

Text Books:

2. Brown J.W and Churchill R.V: Complex Variables and Applications, McGraw-Hill.
3. Das N.G.: Statistical Methods, TMH.
4. Grewal B S: Higher Engineering Mathematics, Khanna Publishers.
5. James G.: Advanced Modern Engineering Mathematics, Pearson Education.

6. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.

References:

1. Bhamra K. S.: Partial Differential Equations: An introductory treatment with applications, PHI
2. Dutta Debashis: Textbook of Engineering Mathematics, New Age International Publishers.
3. Kreyzig E.: Advanced Engineering Mathematics, John Wiley and Sons.
4. Potter M.C, Goldberg J.L and Aboufadel E.F.: Advanced Engineering Mathematics, OUP.
5. Ramana B.V.: Higher Engineering Mathematics, TMH.
6. Spiegel M.R. , Lipschutz S., John J.S., and Spellman D., : Complex Variables, TMH.

CIRCUIT THEORY AND NETWORKS - EE 301
Contacts : 3L +1T
Credits : 4

Module	Topics	Contact hrs
Module I	**Introduction:** Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources, Step, Ramp, Impulse, Sinusoidal, Square, Saw tooth signals.	3 L
	Coupled circuits: Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.	3 L
	Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems	4 L
Module II	**Laplace transforms**: Concept of complex frequency, transformation of step, exponential, overdamped surge, critically damped surge, damped sine, undamped sine functions, properties of Laplace Transform, linearity, real-differentiation, realintegration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, Impulse, Step & Sinusoidal response of RL, RC, and RLC circuits. Transient analysis of different electrical circuits with and without initial conditions. Concept of Convolution theorem and its application. Solution of Problems with DC & AC sources.	10 L
Module III	**Network equations**: Kirchoff's Voltage Law & Current Law, Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Network theorem: Superposition, Thevenin's, Norton's & Maximum power transfer theorem. Millman's theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC & AC sources	6L
	Graph of Network: Concept of Tree, Branch, Tree link,	4L

	junctions, Incident matrix, Tie-set matrix and loop currents, Cut-set matrix and node pair potentials, duality, solution of problems.	
Module IV	**Two port networks analysis**: Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters, Hybrid parameters and their inter relations. Driving point impedance & Admittance. Solution of Problems with DC & AC sources.	4L
	Circuit Transients: DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, AC transients in sinusoidal R-L, R-C, & R-L-C circuits, solution of problems	4 L
	Filter Circuits: Analysis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier. Solution of Problems	2

Books:
1. Network Analysis, M.E.Van Valkenburg (Prentice Hall)
2. Engineering Circuit Analysis, W.H.Hayt, J.E.Kenmerly, S.M.Durbin,(TMH)
3. Network and Systems, Ashfaq Husain,(Khanna Book Publisher)
4. Network and Systems, D.Roychowdhury,(New Age International)
5. Modern Netwok Analysis, F.M.Reza & S.Seely, McGraw Hill.

PAPER NAME : TECHNICAL REPORT WRITING & LANGUAGE LABORATORY PRACTICE
PAPER CODE: HU 481
CONTACT: 1L+2P
CREDIT : 2

Guidelines for Course Execution:
Objectives of this Course: This course has been designed:
1. To inculcate a sense of confidence in the students.
2. To help them become good communicators both socially and professionally.
3. To assist them to enhance their power of Technical Communication.

Detailed Course Outlines:
A. Technical Report Writing : 2L+6P
1. Report Types (Organizational / Commercial / Business / Project)
2. Report Format & Organization of Writing Materials
3. Report Writing (Practice Sessions & Workshops)
B. Language Laboratory Practice

I. Introductory Lecture to help the students get a clear idea of Technical Communication & the need of

Language Laboratory
Practice Sessions 2L
2. Conversation Practice Sessions: (To be done as real life interactions) 2L+4P
a) Training the students by using Language Lab Device/Recommended Texts/cassettes /cd's to get their
Listening Skill & Speaking Skill honed
b) Introducing Role Play & honing over all Communicative Competence
3. Group Discussion Sessions: 2L+6P
a) Teaching Strategies of Group Discussion
b) Introducing Different Models & Topics of Group Discussion
c) Exploring Live /Recorded GD Sessions for mending students' attitude/approach & for taking remedial
measure
Interview Sessions; 2L+6P
a) Training students to face Job Interviews confidently and successfully
b) Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking
Skill in a formal situation for effective communication
4. Presentation: 2L+6P
a) Teaching Presentation as a skill
b) Strategies and Standard Practices of Individual /Group Presentation
c) Media & Means of Presentation: OHP/POWER POINT/ Other Audio-Visual Aids
5. Competitive Examination: 2L+2P
a) Making the students aware of Provincial /National/International Competitive Examinations
b) Strategies/Tactics for success in Competitive Examinations
c) SWOT Analysis and its Application in fixing Target
Books – Recommended:
Nira Konar: English Language Laboratory: A Comprehensive Manual
PHI Learning, 2011
D. Sudharani: Advanced Manual for Communication Laboratories & Technical Report Writing
Pearson Education (W.B. edition), 2011
References:
Adrian Duff et. al. (ed.): Cambridge Skills for Fluency
A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)
B) Listening (Levels 1-4 Audio Cassettes/Handbooks)
Cambridge University Press 1998
Mark Hancock: English Pronunciation in Use
4 Audio Cassettes/CD'S OUP 2004

Physics Lab-2
Code: PH(EE)-491
Contacts: (3P)

Credit: (2)

1. Determination of dielectric constant of a given dielectric material.
2. Determination of thermo electric power at a certain temperature of a given thermocouple.
3. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
4. Determination of Planck constant using photocell.
5. Determination of Lande'g factor using Electron spin resonance spectrometer.
6. Determination of Stefen's radiation constant.
7. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
8. Determination of Rydberg constant by studying Hydrogen –Helium spectrum.
9. Determination of Hall coefficient of semiconductor.
10. Determination of Band gap of semiconductor.
11. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Electrical Measurement & Instrumentation Lab
Code : EI 491
Contacts : 3P
Credits : 2

List of Experiments:

1. Instrument workshop- observe the construction of PMMC, Dynamometer, Electro thermal and Rectifier
type instrument, Oscilloscope and digital multimeter.
2. Calibrate moving iron and electrodynamometer type ammeter/voltmeter by potentiometer
3. Calibrate dynamometer type Wattmeter by potentiometer
4. Calibrate A.C. energy meter.
5. Measure the resistivity of material using Kelvin Double Bridge
6. Measurement of Power using Instrument transformer
7. Measurement of Inductance by Anderson Bridge
8. Measurement of Capacitance by De Sauty Bridge

ME301 : Applied Thermodynamics
Contacts : 4L
Credits : 3

Module No.	Topics	Contact hrs
	Review of fundamentals; Heat and work, First law for unsteady flow system	**1**
	Pure Substance, Properties of pure substance; Phases of pure substances- Phase rule; Phase Change Processes of Pure Substances – triple pt., critical pt.; Property diagrams of Phase change Processes; P-V-T surface for phase change; Property tables of real substances - compressed liquid, saturated, wet & superheated vapour.	**3**

	The 2nd Law of Thermodynamics; the corollaries & their proofs; the property of entropy; entropy change of a pure substance; Tds equations and calculation of entropy change; concept and uses of entropy; the entropy generation principle. The second law of thermodynamics for an open system.	**4**
	Exergy analysis, Reversible work and irreversibility, Exergy change of a system, 2nd Law efficiency	
	Maxwell relations; Clapeyron Equation, Joule Thompson co-efficient	
	I.C.Engine, Air Standard cycles; Otto, Diesel, Dual Combustion. 7. Reciprocating air compressors; the compressor cycle with and without clearance, efficiencies; volumetric efficiency & its effect on performance; multistaging.	
	Vapour power cycles & its modifications, Reheat & Regenerative cycle for steam, Binary cycle and cogeneration.	
	Refrigeration cycles, reversed carnot cycle; components and analysis of simple vapour compression Refrigeration cycle, Actual Refrigeration cycles, Vapour Absorption Refrigeration cycle.	
	Use of psychometric charts & processes for air conditioning	

Total=40L

Books recommended:

1. Engineering Thermodynamics - P.K Chattopadyay, OUP
2. Fundamentals of Thermodynamics - 6e by Sonntag, Borgnakke & Van Wylen, John Wiley.
3. Engineering Thermodynamics-4e by P.K .Nag, TMH
4. Thermodynamics- an Engineering approach - 6e, Cengel & Boles,TMH
5. Engineering Thermodynamics- M. Achyuthan, PHI Syllabus for B.Tech(Mechanical Engineering) up to Third Year
6. Basic Engineering Thermodynamics- R. Joel, 5th ed, Pearson
7. Engineering Thermodynamics (Indian edition) – Russel & Adeliyi, OUP
8. Thermodynamics (Schaum's) – 2nd ed, Potter & Somerton, TMH

ME : Strength of Materials

Contact per week: 3L
Credit: 3

Module	Topics	Contact hrs
1	A. Concept of mechanics of deformable solids; concept of stress developed against external force/pressure; brief review of normal and shearing stress and strain;	**1L**
	B. Deformation of axially loaded members, statically determinate and indeterminate problems.	4L
	C. Strain energy in tension and compression	1L
2	Analysis of Biaxial stresses-Mohr's circle for biaxial stress; concept of normal stress, principal stress and pure shear. Shear strain and shear strain energy. Stresses in thin walled pressure vessels- tangential and Hoop stress. Relation between shear modulus and Young's modulus.	6L
3.	Stresses in beams; shear force (SF), axial force and bending moment (BM); differential relations for BM, SF and load; SF and BM diagrams; bending stresses in straight beams – symmetric loading; stresses in beams of various cross sections; stresses in built-up beams and beams of different materials.	7L
4.	Torsion of a circular shaft, shear energy in torsion. Concept of closed and open coiled helical springs, Stresses and deflection of helical springs under axial pull.	4L
5.	Deflection of statically determinate and indeterminate beams due to bending moment, differential equation of elastic line, Area-moment method, Strain energy method- Catigliano's theorem, superposition method.	7L
6	Theory of columns; eccentric loading of short strut; column buckling: Euler load for columns with pinned ends and other end restraints; Euler's curve; emperical column formulae – (i) straight line, (ii) parabolic and (iii) Rankine Gordon.	6L

Note for Teachers:
1. Stress should be given to clarify different concepts of the subject.
2. Deduction of all relevant equations should be worked out and explained.
3. Sufficient number of problems from each topic should be worked out during class and as home assignment.

Note for examination paper setter:

At least one question should be set from each module.

Books Recommended
1. Elements of Strength of Materials by Timoshenko & Young, 5th Ed.- East west press.
2. Introduction to Solid Mechanics by Shames & Pitarresi, 3rd Ed., Prentice Hall India.
3. Mechanics of Materials by Beer & Johnston, TMH
4. Engineering Mechanics of Solids by E.P. Popov; 2nd Ed., Prentice Hall India
5. Fundamentals of Strength of Materials by Nag & Chanda, Wiley India
6. Strength of Materials by R.Subramanian, 2nd Ed., Oxford Univ. Press
7. Strength of Materials by Ryder, Mcmillan press

ME303 : Engineering materials
Contacts : 3L
Credits : 3

Module	Topics	
1	Introduction: Material Science—its importance in engineering; Classification of Materials—metals, polymers, ceramics, composites; Advanced materials—semiconductors, smart materials, nano-materials; Review atomic structure, Atomic bonding in solids—bonding forces and energies; ionic/covalent/metallic bonding.	**2L**
2.	Crystal Structure: Fundamental concepts; Unit cells; seven crystal systems; single crystal, polycrystalline and non-crystalline materials; Metallic crystal structures—FCC, atomic packing factor, BCC & HCP structures.	**2L**
3.	Imperfections in Metals: Point defects due to vacancy & impurities, alloys, solid solutions; Dislocations—linear defects, interfacial defects, grain boundaries	**2L**
4.	Phase Diagrams: Definition and basic concepts; solubility	**3L**

	limit; Phase equilibria, onecomponent phase diagram, binary phase diagram, interpretation of phase diagrams.	
5.	Iron-carbon System: allotropy of iron, iron-iron carbide phase diagram, properties and uses of plain carbon steel 2	**2L**
6.	Classification of Metals and Alloys- compositions, general properties and uses:	
	6.1 Ferrous alloys: Classification –low carbon steels, medium carbon steels, high carbon steels, stainless steels, alloy steels, tool and die steel, cast irons.	
	6.2 Non-ferrous alloys: Copper & Copper alloys; Aluminum alloys; Zinc alloys; Nickel alloys; Lead & Tin alloys;	
	7. Mechanical Properties of Materials: Elastic properties of materials—tensile and compressive stress and strain, stress-strain behaviour, modulus of elasticity (Young's modulus), yield strength, tensile strength, plastic deformation, true stress and strain; Ductility; Resilience; Toughness, impact tests; Hardness- Brinell, Rockwell and Vickers hardness and their testing procedures, correlation between hardness and tensile strength; Fatigue strength; Effect of temperature on tensile strength & impact properties, creep failure.	**6L**
8	8. Heat Treatment: Definition and purposes; Heat treatment processes for steels—Hardening, structural change during heating and cooling, factors affecting hardening; Tempering; Austempering; Normalizing; Annealing—full annealing, spheroidising annealing, stress–relieving, recrystallisation annealing; Preciptation or Age Hardening of non-ferrous alloys.	**4L**
9	Polymers & Elastomers: Definition; How polymers are made-polymerization; Polymer molecular structures; Thermoplastics & Thermosets; Special characteristics like low sp. gravity, optical, electrical & thermal property, decorative color, easy formability, low corrosion etc; Uses of polymers and elastomers.	**2L**
10.	Ceramic Materials: What is ceramics; common ceramic materials and their characteristics; How ceramics are made—sintering and vitrification process; Ceramic structures; Properties and applications.	**2L**

11.	Composite materials: What is composites; Polymers matrix and their applications; Metal matrix and ceramic matrix composites and their applications; How composites are made.	**2L**
12.	Corrosion and Degradation of Engineering Materials: Definition; Types of corrosion—uniform, pitting, crevice, galvanic, stress corrosion cracking and erosion; Corrosion control — material selection, environment control, proper design.	**2L**
13	Materials Selection Methodology: Selection of material based on required properties, availability and cost of material, environmental issues.	**1L**

Note for Teachers:
1. Stress should be given to clarify different concepts.
2. Industrial examples must be cited regarding use of various materials and the specific properties involved for selection of these materials.

Note for examination paper setter:

1. Question should be set covering all the 13 topics of the syllabus.
2. Marks of questions from each topic should be proportionate to the recommended contact hours allotted, as far as possible.

Books Recommended
1. Materials Science and Engineering by W.D. Callister and adapted by R. Balasubramaniam, Willey India, 2010 Ed.
2. Engineering Materials: properties and selection by Budinski & Budinski, 9th Ed., Prentice Hall India
3. Engineering Materials and Metallurgy by R.Srinivasan, 2nd Ed., Tata McGraw Hill.
4. Materials & Processes in Manufacturing by E.P.Degarmo and adapted by Black & Kosher, 10th Ed., Wiley India.
5. Materials Science and Engineering by V.Raghavan, 5th Ed., Prentice Hall India.

VALUES & ETHICS IN PROFESSION
HU-401
Contracts: 3L
Credits- 3

	Module	**Topics**	
	Effects of	Rapid Technological growth and depletion of resources, Reports of	

	Technological Growth	the Club of Rome. Limits of growth: sustainable development **Energy Crisis**: Renewable Energy Resources Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.	
	Ethics of Profession:	Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.	
	Profession and Human Values:	Values Crisis in contemporary society **Nature of values**: Value Spectrum of a good life **Psychological values**: Integrated personality; mental health **Societal values**: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. **Aesthetic values**: Perception and enjoyment of beauty, simplicity, clarity **Moral and ethical values**: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.	

Science, Technology and Engineering as knowledge and as Social and Professional Activities
Books:
1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Ph 401 : :Physics2
Contacts : 3L + 1T
Credits : 4

	Module 1:	**Vector Calculus**: 1.1 Physical significances of grad, div, curl. Line integral, surface integral, volume integral- physical	2L

		examples in the context of electricity and magnetism and statements of Stokes theorem and Gauss theorem [No Proof]. Expression of grad, div, curl and Laplacian in Spherical and Cylindrical co-ordinates.	
	Module 2 :	**Electricity** 2.1 Coulumbs law in vector form. Electrostatic field and its curl. Gauss's law in integral form and conversion to differential form . Electrostatic potential and field, Poisson's Eqn. Laplace's eqn (Application to Cartesian, Spherically and Cylindrically symmetric systems – effective 1D problems) Electric current, drift velocity, current density, continuity equation, steady current. 2.2 Dielectrics-concept of polarization, the relation $D=\varepsilon_0 E+P$, Polarizability. Electronic polarization and polarization in monoatomic and polyatomic gases.	5L 3L
	Module 3:	Magnetostatics & Time Varying Field: 3. Lorentz force, force on a small current element placed in a magnetic field. Biot-Savart law and its applications, divergence of magnetic field, vector potential, Ampere's law in integral form and conversion to differential form. Faraday's law of electro-magnetic induction in integral form and conversion to differential form. 3L	3L
	Module 4:	Electromagnetic Theory: 4.1 Concept of displacement current Maxwell's field equations, Maxwell's wave equation and its solution for free space. E.M. wave in a charge free conducting media, Skin depth, physical significance of Skin Depth, E.M. energy flow, & Poynting Vector.	6L
	Module 5:	Quantum Mechanics: 5.1 Generalised coordinates, Lagrange's Equation of motion and Lagrangian, generalised force potential, momenta and energy. Hamilton's Equation of motion and Hamiltonian. Properties of Hamilton and Hamilton's equation of motion. 4L *Course should be discussed along with physical problems of 1-D motion* 5.2 Concept of probability and probability density, operators, commutator. Formulation of quantum mechanics and Basic postulates,	4L

		Operator correspondence, Time dependent Schrodinger's equation, formulation of time independent Schrodinger's equation by method of separation of variables, Physical interpretation of wave function ψ (normalization and probability interpretation), Expectation values, Application of Schrodinger equation – Particle in an infinite square well potential (1-D and 3-D potential well), Discussion on degenerate levels.	9L
	Module 6:	**Statistical Mechanics:** 3.1 Concept of energy levels and energy states. Microstates, macrostates and thermodynamic probability, equilibrium macrostate. MB, FD, BE statistics (No deduction necessary), fermions, bosons (definitions in terms of spin, examples), physical significance and application, classical limits of quantum statistics Fermi distribution at zero & non-zero temperature, Calculation of Fermi level in metals, also total energy at absolute zero of temperature and total number of particles, Bose-Einstein statistics – Planck's law of blackbody radiation..	7L

Text Books:

1. Perspectives of Modern Physics: A. Baiser
2. Modern Physics and Quantum Mechanics E.E. Anderson
2. Refresher course in B.Sc. Physics (Vol. III): C.L. Arora
3. Fundamentlas of Physics (Vol. III): Haliday, Resnick & Krane
4. Engineering Physics: R.K. Kar
5. Classical Mechanics:
   a) A.K. Roychaudhuri
   b) R.G. Takwal & P.S. Puranic
6. Quantum Mechanics:
   a) Eisberg & Resnic
   b) A.K. Ghatak & S. Lokanathan
   c) S.N. Ghoshal
7. Statistical Mechanics and Thermal Physics:
   a) Sears and Salinger Syllabus for
   b) Avijit Lahiri
   c) Evelyn Guha
8. Solid Sate Physics:
   a) A.J. Dekker
   b) C. Kittel
   c) Aschroft & Mermin
   d) S.O. Pill

CH401: Basic Environmental Engineering & Elementary Biology
Contacts : 3L
Credits : 3

	General : Basic ideas of environment, basic concepts, man, society & environment, their interrelationship.	1L
	Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development.	2L
	Materials balance: Steady state conservation system, steady state system with non conservative pollutants, step function.	1L
	Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering.	2L
	Ecology : Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function.	1L
	Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web.	2L
	Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur].	1L
	Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.	2L
	Air Pollution and Control: Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause.	1L
	Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.	1L
	Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food.Global warming and its consequence, Control of Global warming. Earth's heat budget.	1L
	Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).	2L
	Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.	2L
	Definition of pollutants and contaminants, Primary and secondary pollutants:	2L

	emission standard, criteria ,pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN.	
	Smog Photochemical smog and London smog: Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification.	1L
	Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference).	1L
	Water Pollution and Control Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds.	2L
	River/Lake/ground water pollution: River: DO, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river[deoxygenation, reaeration], COD, Oil, Greases, pH	2L
	Lake: Eutrophication [Definition, source and effect].	1L
	Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)	1L
	Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition	. 2L
	Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic	1L
	Land Pollution Lithosphere; Internal structure of earth, rock and soil	1L
	Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling.Solid waste management and control (hazardous and biomedical waste).	2L
	Noise Pollution Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise]	1L
	Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, 10 L (18hr Index), Ldn. Noise pollution control.	1L
	Environmental Management Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol.	2L

References/Books

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
2. De, A. K., "Environmental Chemistry", New Age International.

ELECTRICAL & ELECTRONIC MEASUREMENT -EE-402

Credit: 3 3L+1T

	Module-I	Measurements: • Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments. Analog meters: • General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments • Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers.	3 3 3
	Module-II	Instrument transformer: • Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of Current & Potential transformer, errors. Measurement of Power: • Principle of operation of Electrodynamic & Induction type wattmeter. Wattmeter errors. Measurement of resistance: • Measurement of medium, low and high resistances, Megger.	4 3 4
	Module-III	Measurement of Energy: • Construction, theory and application of AC energy meter, testing of energy meters. Potentiometer: • Principle of operation and application of crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer. Application. AC Bridges: • Measurement of Inductance, Capacitance and frequency by AC bridges.	3 4 4
	Module-IV	Cathode ray oscilloscope (CRO): • Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO.	3

		Electronic Instruments: • Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Sensors & Transducers: • Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Flow measurement using magnetic flow measurement. Numerical Problems to be solved in the tutorial classes	4 3

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai & sons.
2. Electrical Measurement & Measuring Instruments, E.W. Golding & F.C. Wides, Wheeler Publishing.
3. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.

Reference Books:

1. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Heltric & W.C. Copper, Wheeler Publication.
4. Instrument transducers, H.K.P. Neubert, Oxford University press.

Fluid mechanics & Hydraulic Machines
Contacts: 4
Credits: 4

	Module	Syllabus	Contact Hrs
		Review of fluid properties and fluid statics. Hydraulic forces on submerged surfaces; forces or vertical, horizontal, inclined and curved surfaces.	
		. Kinematics of fluid flow: fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines.	
		Dynamics of fluid: equations of motion; Euler's equation; Bernoulli's equation; Applications of Bernoulli's equation.	
		Momentum Analysis of flow systems; the linear momentum equation for steady flow, differential approach.	
		Flow through pipes; Darcy – Weisbach equation of friction loss; hydraulic grade line and total energy line	
		Basic principle for flow through orifices, V-notches (rectangular-v), weirs (rectangular). Flow through open channels; use of Chezy's formula.	
		Dimensional Analysis & Model investigation applied to flow systems – Buckingham Pi theorem. Dimensionless numbers in fluid flow.	
		Flow of fluid around submerged bodies; basic concepts of drag and lift.	
		Boundary layer – definition; Boundary layer separation – basic concept.	
		Hydraulic Turbines; Principles and Classifications; Design & working principle of a Pelton Wheel, efficiency and performance curves. Francis Turbine, Kaplan Turbine. Function of Draft Tube. Cavitation in Turbines.	
		Reciprocating Pumps: Components & Principles, Classification, discharge, work done, power requirement.	
		Centrifugal pumps: Components, working principle, head & efficiency. Multistage Centrifugal pumps. Pump characteristics, NPSH & Cavitation.	

Books Recommended

1. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications.
3. Fluid Mechanics & Machinery – C.Ratnam, A.V.Kothapalli, I.K. International Publishing House Ltd, 2010.
4. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH.
5. Fluid Mechanics & Machinery – C.S.P Ojha, R.Berndtsson, P.N. Chandramouli, OUP.
6. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
7. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.

8. Ojha,C S P,Berndtsson. R,Chandramouli. P. N.

ME 491: Fluid mechanics & Hydraulic Machines Lab
Contacts: 3L
Credit: 2

Fluid flow measurements: Determining coefficient of discharge for venturimeter, orificemeter, weirs;
Experiment to verify Bernouli's theorem;
Flow through pipes: Reynold's experiments; Pipe friction in laminar and turbulent flow regimes; Pitot tube experiments on
viscous flow and boundary layer theory;
Determination of metacentric height of a floating vessel;
Experiments on Fluid Machinery : Pumps, jet pumps, Blowers, Compressors;
Experiments on Hydro-Turbines: Francis and Pelton turbines.
(At least six experiments must be conducted)

Physics Lab-2
Code: PH(EE)491
Contacts: (3P)
Credit: (2)

1. Determination of dielectric constant of a given dielectric material.
2. Determination of thermo electric power at a certain temperature of a given thermocouple.
3. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
4. Determination of Planck constant using photocell.
5. Determination of Lande'g factor using Electron spin resonance spectrometer.
6. Determination of Stefen's radiation constant.
7. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
8. Determination of Rydberg constant by studying Hydrogen –Helium spectrum.
9. Determination of Hall coefficient of semiconductor.
10. Determination of Band gap of semiconductor.
11. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

ELECTRIC AND ELECTRONIC MEASUREMENT LABORATORY EE-492
Credit: 2
Cobtact: 3P

List of Experiments:
1. Instrument workshop- Observe the construction of PMMC, Dynamometer, Electrothermal and Rectifier type of instruments, Oscilloscope and Digital multimeter.

2. Calibrate moving iron and electrodynamometer type ammeter/voltmeter by potentiometer.
3. Calibrate dynamometer type wattmeter by potentiometer.
4. Calibrate AC energy meter.
5. Measurement of resistance using Kelvin double bridge.
6. Measurement of power using Instrument transformer.

7. Measurement of power in Polyphase circuits.
8. Measurement of frequency by Wien Bridge.
9. Measurement of Inductance by Anderson bridge
10. Measurement of capacitance by De Sauty Bridge.
11. Measurement of capacitance by Schering Bridge.

PWE 503 : Nuclear & Advance Power Generation Technology
Contacts : 3L
Credits : 3

Introduction of Nuclear Engineering:
Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction, Nuclear Cross – section, Moderation, Fertile Materials and Breeding.

- 4L

Nuclear Reactors:
Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurised Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium) Types of Reactors, Gas-cooled Reactors, Breeder Reactors, Reactor Containment Design, Location of Nuclear Power Plant, Nuclear Power Station in India, India's 3-stage Programme for Nuclear Power Development, Comparison of Nuclear Plants with Thermal Plants.

- 6L

Nuclear Waste & Its Disposal:
Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System.

- 3L

Safety Rules:
Personal Monitoring, Radiation Protection (Radiation Workers, Non-Radiation Workers, Public at large), Radiation Dose (Early effect, Late effect hereditary effect)

- 3L

Advanced Power Generation Technology

Combined Cycle (CC) Power Plants:
Thermodynamics of multifluid coupled cycles ; Combined Brayton and Rankine Cycle and GT-ST plants; Advantages of Combined Cycle - 3L

Futuristic Technologies :
Fuel Cells ; MHD-steam plant ; Thermoelectric – steam plant : Thermionic steam plant.

- 3L

Energy Storage :
Objective and scope- energy management ; Methods of energy storage – pumped hydro, Compressed air energy storage, flywheels, electrochemical , magnetic,Thermal and chemical energy storage ; Hydrogen energy – production, storage and utilization.

-8L

Suggested Text Books:

- P.K.Nag " Power Plant Engineering ", Tata McGraw Hill
- Arora & Domkundwar " Power Plant Engineering ", Dhanpat Rai & Co.
- Combined Power Plants by J.H.Horlock Pergamon Press.
- Power Plant Technology – M. M. EI – Wakil
- V.Ganesan: Gas Turbines; Tata McGraw Hill Publishing Co. Ltd. New Delhi,2003.

References:
Black / Veatch, " Power Plant Engineering " , CBS Published & Distributors.
Gas Turbine Theory –by Sh. H.Cohen, G.F.C. Rogers. H.I.H.Saravanamuttoo.
Longman Scientific & Technical.

Economics for Engineers HU-501
Contracts: 3L
Credits- 3

Sl. No.	Module	Topic	Contact hrs
	Economic Decisions Making	Overview, Problems, Role, Decision making process	
	Engineering Costs & Estimation	Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	
	Cash Flow, Interest and Equivalence	Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest	
	Present Worth Analysis	End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.	
	Cash Flow & Rate Of Return Analysis	Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.	
	Uncertainty In Future Events	Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options.	
	Depreciation	Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance	

		Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.	
	Replacement Analysis	Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems.	
	Inflation And Price Change	Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates	
	Accounting	Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	

Readings

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
2. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

Heat Transfer - ME-502

Contacts: 4L
Credits- 4

Sl. No.	Module	Topic	Contact hrs
	Module- 1	Introduction to modes of Heat Transfer, Basic equations.	[2]
	Module- 2	: Conduction: Fourier's law for isotropic materials. Thermal conductivity: 1-D and 3- D heat conduction equations, Boundary conditions. Solution of steady 1-D conduction problem with & without heat generation. Analogy with electrical circuits. Critical thickness of insulation.	[4]
	Module- 3	Fins- rectangular and pin fins, fin effectiveness and fin efficiency.	[3]
	Module- 4	Introduction to transient heat conduction, Lumped parameter approach, Time constant, Biot number: 1-D transient heat conduction solution without heat generation.	[4]
	Module- 5	Radiation: Physical mechanism of thermal radiation, laws of radiation, Definition of black body, emissive power, intensity of radiation, emissivity, reflectivity, transmittivity, irradiation, radiosity.	[3]
	Module- 6	Radiation exchange between black bodies, concept of Gray-Diffuse Isotropic (GDI) surface. Radiation exchange between GDI surfaces by radiation network and radiosity matrix method. Radiation shielding.	[4]
	Module- 7	Convective heat transfer, Newton's law of cooling and significance of heat transfer coefficients. Momentum and energy equation in 2-D.	[3]
	Module- 8:	Non – dimensional quantities in heat transfer, importance and physical significant order of magnitudes, Analysis for a flow over a flat plate, order of magnitude analysis.	[3]
	Module- 9	Boundary layer concepts, Velocity and thermal boundary layer by integral method.	[3]
	Module- 10	1-D solution for Coutte flow and Poiseullie flow. Concept of developing and developed flow. Introduction to the concept of similarity.	[4]
	Module- 11	Natural convection over a vertical plate. Concept and correlation.	[3]
	Module- 12	Heat exchangers: types of heat exchangers, parallel and counter flow types, Introduction to LMTD. Correction factors, fouling factor. E- NTU method for heat exchangers.	[4]

Total : 40L

Recommended Books:

1. S.K. Som, Introduction to Heat Transfer, PHI.
2. Yunus A. Cengel, Heat and Mass Transfer, The McGraw-Hill Companies.
3. Sarif K. Das, Fundamentals of Heat & Mass Transfer, Narosa.

4. Incropera, DeWitt, Bergmam, & Lavine, Fundamentals of Heat and Mass Transfer, Wiley India Edn.
5. N.V. Suryanarayana, Engineering Heat Transfer, Penram International.
6. Kreith, Principles of Heat Transfer, Cengage learning.
7. P.K. Nag, Heat & Mass Transfer, TMH.
8. P.S. Ghoshdastidar, Heat Transfer, Oxford University Press.
9. M. Thirumaleshwar, Fundamentals of Heat & Mass Transfer, Pearson.
10. O.P. Single, Heat & Mass Transfer, Macmillan India.
11. J P Holman & Souvik Bhattacharyya, Heat Transfer, TMH. Syllabus for B.Tech(Mechanical Engineering) up to Th

PWE 505B: Microprocessor and Digital Electronics
Contacts:3
Credits:3

Module 1. Digital Electronics

1. Data and number system, Binary representation, Codes and their conversions: BCD, Octal, Hexadecimal, ASCII representation, Binary arithmetic.
2. Combinational Circuits: Adder, Subtractor, Encoder, Decoder, Comparator, Multiplexor, De-multiplexor, Parity generator.
3. Sequential Circuits: Flip-flops, Various types of Registers and Counters.
4. Different types of A/D and D/A conversion techniques.
5. Different Logic family: TTL, ECL, MOS and CMOS, their operations and specifications in brief.
6. Memory Systems: RAM, ROM, EPROM, and EEPROM.

Module 2. Microprocessor & Microcontroller:

7. Introduction to 8085 CPU arithmetic-register organization, addressing modes and their feature. Software instruction set and Assembly Language Programming. Pin description and features.
8. Hardware Interfacing: Interfacing memory, peripheral chips (I/O mapped I/O & Memory mapped I/O) with few examples.
9. Peripherals: 8255, 8253, 8237, 8259, A/D and D/A converters and interfacing of the same.
10. Pin description of Intel / PIC 8-bit microcontroller, Software instruction set and Assembly Language Programming, Control words.
11. Typical applications of Microprocessor and Microcontroller.

Textbooks for Digital Electronics:

1. Jain-Modern Digital Electronics, 2/e, TMH
2. Leach & Malvino – Digital Principles & Application, 5/e, TMH
3. Digital Logic Design – Morries Mano, PHI.

References for Digital Electronics:

1. Digital Integrated Electronics- H.Taub & D.Shilling, Mc Graw Hill.
2. Givone-Digital Principle & design, TMH.
3. Digital Technology-Virendra Kumar, New Age.
4. Digital Circuit & Design-S.Aligahanan, S.Aribazhagan, Bikas Publishing House.
5. Fundamentals of Digital Electronics & Microprocessor- Anokh Singh, A.K. Chhabra, S. Chand.
6. Introduction to Digital Computer Design 4th Ed.- V.Rajaraman & T. Radhakrishnan, P.H.I.

References for Microprocessor, Microcontroller:

1. Microprocessor arithmetic, programming and applications with 8085/8085A, Wiley eastern Ltd, 1989 by Ramesh S. Gaonkar.
2. Intel Corp: The 8085/8085A. Microprocessor Book-Intel marketing communication, Wiley inter science publication,1980.
3. An introduction to micro computers Vol. 2 –some real Microprocessor-Galgotia Book Source, New Delhi by Adam Osborne and J. Kane.
4. Advanced Microprocessors by Ray and Bhurchandi-TMH.
5. Intel Corp. Micro Controller Handbook- Intel Publications, 1994.

PWE 504 : Hydro and Renewable Power Generation
Contacts : 4L
Credits : 3

1. Introduction:

Potential of hydropower in India- its development and future prospect. General hydrology-hydrological cycle, precipitation, run-off and its measurement, - 3 L

2. Hydro Electricity Power Plant:

Classification of hydroelectric power plants. Pondage and storage. Operating principles of different types of hydel plants like run-off-the-river type. Storage reservoir plant-pumped storage plant. Design, construction and operation of different components: Dams, spillways, Canals, penstocks, surge tanks, draft tubes etc; - 6 L

3. Selection of Hydraulic turbines, Design of components of Deriaz Turbine , Kaplan Turbines, Tubular Turbines, Torque, Power and efficiency. Characteristics of Water Turbines. -10 L

4. Selection of prime mover, speed and pressure regulation, methods of governing, starting and stopping of water turbines, Generator and its Construction. - 4 L

RENEWABLE ENERGY SYSTEMS

5. Introduction:

Energy demand growth and supply: Climate Change, Sustainable Development and Role of Renewable Energy Sources for steady and quality power supply. - 2 L

6. SOLAR ENERGY Systems:

The Sun as energy source and its movement in the sky ; Solar Energy received on the Earth ; - 1 L

SOLAR THERMAL ELECTRICITY GENERATION: Solar concentrators and tracking Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants ; Solar Ponds, Solar Chimney. – 3 L

SOLAR PHOTOVOLTAIC SYSTEMS: Basic principle of power generation in a PV cell; Band gap and efficiency of PV cells; Manufacturing methods of mono- and poly-crystalline cells; amorphous silicon thin film cells;

Single and multi junction cells; Application of PV; Brief outline of solar PV stand-alone system design; Storage and Balance of system.
Solar PV in convergence with Energy Efficiency - 4L

Air Conditioning & Refrigeration ME-505A
Contacts: 3L
Credits- 3

Module No.	Topics	Contact hrs
1.	Introduction: Concepts of Refrigeration and Air-conditioning. Unit of refrigeration, Refrigerants– Desirable Properties, Nomenclature	2L
2.	Simple Vapour Compression Refrigeration System (Simple VCRS): Vapour compression cycle on ph and T-s diagrams. Cycles with subcooling and superheating, their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS; dry compression and wet compression of refrigerant; actual Vapour Compression Cycle.	6L
3.	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual airrefrigeration cycle.	3L
4.	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithiumbromide-water System; Aqua-ammonia systems.	4L
5.	Equipment and Control: Major Refrigeration Equipment - Compressors: Types; reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	6L
6.	Ventilation – Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation	3L
7.	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.	6L
8.	Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification.	4L
9	Duct Sizing & Design.	2L
10	Air-conditioning equipment: Airhandling units, Cooling Towers.	4L

Total 40

Texts & References:
1. Stocker & Jones, Refrigeration and Air Conditioning, McGraw Hill.
2. C.P. Arora, Refrigeration and Air Conditioning.
3. P.L. Ballaney, Refrigeration and Air Conditioning.
4. R.C.Arora, Refrigeration and Air Conditioning, TMH.
5. Arora and Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication.

Principles of Management

HU-601
Contracts: 2L
Credits- 2

Sl. No.		L
	Basic concepts of management: Definition – Essence, Functions, Roles, Level	**5 L**
	Functions of Management : Planning – Concept, Nature, Types, Analysis, Management by objectives; Organisation Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.	
	Management and Society – Concept, External Environment, CSR, Corporate Governance, Ethical Standards	**5 L**
	People Management – Overview, Job design, Recruitment & Selection, Training & Development, Stress Management	
	Managerial Competencies – Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship	
	Leadership: Concept, Nature, Styles	**5 L**
	Decision making: Concept, Nature, Process, Tools & techniques.	
	Economic, Financial & Quantitative Analysis – Production, Markets, National Income Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.	
	Customer Management – Market Planning & Research, Marketing Mix, Advertising & Brand Management	**5 L**
	Operations & Technology Management – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.	

Readings:

1. Management : Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

Steam Generators and its Auxiliaries

Paper Code : PWE - 601
Contact : 3 L Credit : 3

		L
Module-1	Load duration curves, load factor, capacity factor, reserve factor, diversity factor, Site Selection and Location of Steam Power Plant, Power Plant Economics, cost of electricity, Layout of Thermal Power Plant.	4
Module -2	Coal and its analysis and properties, Fuel Oil and Natural Gas, stoichometrics and actual air fuel ratio, dew point and heating value, energy balance of steam generator, Draught system, natural and mechanical draught, FD and ID fans.	8
Module-3	Mechanism of solid fuel combustion, stokers, pulverized coal fired systems, coal burners, burner arrangements, fluidization regimes and combustion.	8
Module-4	Fire tube and water tube boilers Boiler circulation, natural and forced circulation, drum and its accessories, modern utility boilers, supercritical boilers	8
Module 5	Superheaters and temperature ,control, economizer, airpreheater, fluidized bed boilers, electrostatic precipitator, feedwater treatment,	8
Module-6	Fuel and Ash Handling systems Audio visual systems	4

Suggested Text Books & References: **Total Lectures 40**

1. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publication
2. Arora & S. Domkundwar, "A Course in Power Plant Engineering", Dhanpat Rai & Sons.
3. 'Modern Power Station Practice", Volume B, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991.
4. "Steam Generator and its Auxiliaries", Manufacturer's Power Plant Manual.
5. Power Plant Familiarisation – Vol. II, NPTI Publication.

Steam Turbine and its Auxiliaries.

Paper Code : PWE - 602
Contact : 3 L

Credit : 3

	Topics	L
Module-1	Properties of steam Mollier diagram.	2
Module-2	Flow through nozzles, critical pressure ratio and choked flow, flow area in nozzles, supersaturated flow and Wilson line	4
Module-3	Impulse turbine, velocity diagrams, optimum velocity ratio, compounding of steam turbines, Rateau stages, velocity compounding, two row Curtis stage.	8
Module-4	Reaction turbines, maximum blading efficiency, enthalpy drops in various stages, nozzle and blade heights, last stage, parallel exhausts, losses in steam turbines, reheat factor and condition line, design of multi stage turbines.	8
Module-5	Turbine governing, nozzle and throttle governor, emergency governor, dummy piston, blade stresses, critical speeds.	6
Module-6	Feed cycle, reheat and regeneration, feedwater heaters, de-aerator, drain cooler, boiler feed pump.	6
Module-7	Condenser-design considerations, air removal, SJAE, cooling towers,natural draught, forced and induced draught towers	6

Module-8	Generator cooling- HP – LP Bypass circuits	2

Total: 42L

Suggested Text Books & References:

1. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
2. Zoeb Hussain-Steam turbines, Tata Mc Graw Hill
3. "Modern Power Station Practice" Volume C, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991.
4. "Steam Turbine and its Auxiliaries", Manufacturer's Power Plant Manual.
5. Power Plant Familiarisation – Vol. III, NPTI Publication.
6. M. M. Vakil, " Power Plant Technology, Mc Graw Hill

IC Engines & Gas Turbine

PWE-603
Contacts: 3L
Credits 3

	Topic	**L**
Module- 1:	Classification and working principles of IC engine : SI & CI, 2 stroke, 4 stroke engines	3
Module- 2:	Air standard cycles and their analysis: fuel- air and actual cycles.	3
Module- 3:	Alternate fuels: methanol, ethanol, biogas propane and dual fuels	3
Module- 4:	Carboration, essential parts and different types. Mechanical and electronic injection systems.	4
Module- 5:	Ignition systems(battery, magneto and electronic), ignition timing and spark advance.	2

Module- 6:	Combustion-Mixing and flame front, abnormal combustion, engine variables, combustion chambers and fuel injection systems.	4
Module- 7:	Engine friction and lubrication, wet sump and dry sump, crank's lubrication	2
Module- 8:	Heat rejection and cooling-air and liquid cooling	2
Module- 9	Engine emissions and their control, catalytic converter for sulphur, exhaust gas recirculation.	2
Module- 10	Measurements and testing-friction, power, willam's line, morse test, motoring test, indicated power, brake power, speed, smoke, fuel consumption, noise, and flame temperature.	3
Module- 11	Performance parameters and engine characteristics, energy balance	2
Module- 12	Supercharging, types and methods	2
Module- 13	Gas Turbine (GT) Power plants: Closed cycle and open cycle plants , optimum pressure ratio, regeneration , reheating and intercooling, Performance, Components of Gas Turbine plant- compressor, combustion chamber , Turbine blade cooling ; Gas turbine materials.	6
Module 14	Combined Cycle (CC) Power Plants: Limitations of steam turbine (ST) and gas turbine (GT) power plants; combined GT-ST plants, merits and choices, STIG and repowering, coal based combined cycle plants, PFBC and IGCC plants, environmental impacts	6

Total : 44L

Recommended Books:

1. V. Ganesan, Internal Combustion Engines, The McGraw-Hill Companies.
2. M.L. Mathur and R.P. Sharma, A course in Internal Combustion Engines, Dhanpat Rai & Sons.
3. H.N. Gupta, Fundamentals of Internal C

Electrical Equipment in Power Generation, Transmission and Distribution Station-
Sub code: PWE 604
Contacts: 4L
Credits 4

Module-I Electrical Equipment in Power Station.

Sl. No.			L

	Hydrogen Cooling System and Stator Water Cooling System	: Different types of cooling arrangements for rotor and stator, Selection and properties of coolant, Air cooling, Hydrogen Cooling, Stator water cooling, H_2 Charging / Purging Cycle.	3
	Hydrogen Seal Oil System	: Details of the system, Function and purpose of differential pressure regulator and pressure oil regulators. Types of hydrogen seals and their constructional details.	3
	Generator Excitation System and AVR	: Principles, Simple arrangement of exciter and its field winding, Classification of excitation system and exciter development, High Frequency Excitations System, Static Excitation System, Brushless excitation System – their merits and demerits, Automatic Voltage Regulator and its control.	3
	HT-LT Supply System / DC Supply System	A typical layout of 6.6 KV, 3.3 KV and 415 KV supply system in a TPS, DC supply system in a TPS	3
	Switchyard:	A typical layout of Switchyard of a Thermal Power Station and its auxiliaries.	2
	Electrostatic Precipitator:	➢ Basic working principle and constructional details of Electrostatic Precipitator. Corona effect, Rapping Mechanism.	2
	Module-II Power Transmission System		
	Mechanical Design of Overhead transmission lines	Main components of overhead lines, Different types of Insulators, String efficiency, methods to improve SE, Corona and factors affecting corona, methods of reducing corona effect, sag calculation.	5
	Electrical Design of Overhead transmission lines	Constants of transmission line, skin effect, inductance of 1-ph and 3-ph overhead lines, concept of self GMD and mutual GMD. Capacitance of 1-ph and 3-ph overhead lines.	4
	Substations, Principals of Operation	Types of Substations & Substation Design	1
	Performance of Transmission Lines	Classification of overhead transmission lines, performance of short transmission lines, medium transmission lines- nominal pi & T methods, end condenser method. Long Transmission lines- generalized constants of a transmission line.	5
	Module-III Power Distribution System		
	Classification of Distribution system	Types of DC distributors, DC distribution calculation- ring distributor, 2 wire & 3 wire DC system, boosters and ground detectors. AC Distribution calculation, 3 ph 3 wire and 4-wire balanced and unbalanced load. Distribution system voltage regulation.	6
	Voltage Control	Importance, causes of Voltage drop and power loss calculation and methods of voltage control	3

Some of the sessions are supplemented by Audio Visual Session: CBT Total: 40 L

Suggested Text Books and Reference

1. "Power System Engineering" by A. Chakraborti, M.L. Soni, P.V.Gupta, U.S. Bhatnagar, Published by Gagan Kapur for Dhanpat Rai & Co., (P) Ltd. Edn.2003
2. "Electric Power Generation Transmission and Distribution" by S.M. Singh, by Prentice Hall of India, Regd.Office: D 13/12, Model Town Delhi.
3. T. Gonen, "Electric Power Transmission Engineering" McGraw Hill
4. T. Gonen, "Electric Power Distribution System Engineering" McGraw Hill, 1986
5. C.L.Wadhwa, "Electrical Power Systems" Willey Eastern Ltd., 1983
6. S.S. Rao, "EHV AC, HVDC Transmission and Distribution Engineering", Khanna Publishers
7. . Rakesh Das Begamudre, "Extra High Voltage AC Transmission Engineering", Willey Eastern Ltd.
   1986
7. Chakraborty & Halder Power System Analysis, Operation and Control-, PHI
8. "Modern Power Station Practice", Volume C&D, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991.
9. Deshpande, M.V. "Elements of Electric Power Station Design", A.H. Wheeler and Company, Allahabad, 1979.
10. Power Plant Familiarisation – Vol. IV, NPTI Publication

Additional References:

1. Pabla, "Electrical Power Distribution System", Tata McGraw Hill
2. Deshpande, "Electrical Power System Design" Tata McGraw Hill
3. Ramachandran, "Transmission Lines (IETE Vol.7)
4. Power System Analysis, Greinger and Stevenson, McGraw Hill

POWER ELECTRONICS
PWE605B
Contact: 3L
Credit: 3

Sl.No.	Module	Topics	Lectures
2	PNPN devices:	Thyristor, brief description of members of Thyristor family with symbol, V-I characteristics. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits. Different commutation techniques of SCR, DIACs, TRIACs, GTO, UJT.	(7)
3.	Phase controlled converters:	Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effect of freewheeling diodes and source inductance on the performance of converters. Techniques of power factor improvement,	(7)
4.	DC-DC converters	Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters.	(4)
5.	Inverters:	Definition, classification of inverters based on nature of input source.VSI, CSI. Principle of operation with R and R-L loads, three phase full bridge inverters, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. PWM and SPWP inverters.	(8)
6.	AC voltage controllers & Frequency controllers.	Principle of phase control, single phase controllers with R and R-L loads. Principle of operation of Cycloconverters, circulating and non circulating mode of operation, single phase to single phase step up and step down Cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconverters.	(6)
7.	Applications:	HVDC transmission, static circuit breaker, UPS, static VAR controller. SMPS, solid state relays.	(4)

Total: 36 L

Text Books:
1. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Grawhill, 2007.
2. Power Electronics, V.R. Moorthi, Oxford, 2005
3. Power Electronics, M.H. Rashid, Pearson Education, 3rd edition.
4. Power Electronics, P.S. Bhimra, Khanna Publishers, Third edition
Reference books:
1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Element of Power Electronics, Phillip T Krein, Oxford, 2007
3. Power Electronic systems, J.P. Agarwal, Pearson Education, 2006
4. Power Electronics, M.S. Jamal Asgha, PHI, 2007

5. Analysis of Thyristor power conditioned motor, S.K. Pillai, University press.

6. ”

THEORY OF MACHINES
Code: PWE-605A
Contacts: 3L
Credits : 3

Sl. No.			L
	Introduction	Mechanisms and Machines, Links, Kinematic Pair (sliding/rolling), classification, four bar mechanisms, inversion - slider crank, scotch yoke and oscillating cylinder mechanisms.	[2L]
	Velocity and Acceleration Analysis	**Analytical:** for Slider Crank Mechanism **Graphical :** for mechanisms with Turning and Sliding pairs, Instantaneous centres, Centrodes, Kennedy's theorem, Velocity and Acceleration diagrams, Coliolis' accelerations, Quick Return Mechanism, Klein's construction.	[8L]
	Balancing	Static & Dynamic Balancing, Balancing of Rotating Masses, Balancing of Reciprocating Masses, Balancing of in-line and V- engines : Primary and Secondary forces. Moments**.**	[9L]
	Critical Speeds and Vibrations	Shaft with a Single Disc with Viscous Friction, Synchronous Whirl. Features of Vibratory System, Degrees of Freedom (DOF), Single D F Systems - damped free and forced, Transmissibility of Vibrations and Isolation of Vibrations, Two Degrees of Freedom Systems : Undamped free Vibrations including Lumped Mass and Elasticity and Mass-less simply supported beams with Concentrated Inertias., Torsional Systems (Two Rotor), Rayleigh's Energy Method.	[9L]
	Belt Drive	Angular velocity ratio, effect of slip, length of open and cross belts,ratio of belt tension,centrifugal and initial tension,cone pulley and V belt drives, belt creep, rope drive, power transmission.	[2L]
	Cams	Classification of Followers and cams, Follower Displacement Diagrams and Graphical Synthesis of Cam Profile, Pressure Angle, Specified Cam Contours - Parabolic and Harmonic, Force and Torque in Rigid Systems.	[6L]
	Gears	Involute Profile, Pressure Angle , Law of Gearing, Interference and Minimum number of teeth on Pinion, Spur, Helical, Bevel and Worm Gears . Gear Trains , Epicyclic gearing.	[6L]
	Governors	Types (Centrifugal and intertia) - Watt, Porter &Hartnell Hunting of Centrifugal Governors, Isochronism sensitiveness and Stability, Governor Effort and Power .	[5L]

Text **Books:**

1) Theory of Mechanisms and Machines, A.Ghosh & A.K.Mallik, EWP.

2) Theory of Machines, S.S.Rattan, TMH
3) Mechanism and Machine Theory , J.S.Rao & R.V.Dukkipati, New Age International.
References :
1) An Introduction to the Mechanics of Machines, J.L.M Morrison and B. Crossland, Longmans (ELBS).
2) Theory of Machines and Mechanisms, I.E. Shigley and **J.J** Uicker, MeGraw Hill.
3) Introductory Course on Theory and Practice of Mechanical Vibrations, J.S.Rao and K. Gupta, New Age International.

Thermal Power Plant Operation & Maintenance
Code : PWE 701
Contacts : 4L
Credits : 4

Sl. No.	Topic	Lectures
1.	Availability of electrical supply to the equipment (source feeder of each equipment, points of isolation of the equipment, locking during isolation, other safety procedures. Permit to work)	**2 L**
2.	Characterization of coal for power generation, Pretreatment & demineralization, chemical dozing & Water conditioning, Combating corrosion, preservation.	**4 L**
3.	Fundamental of commissioning – Alkali boil out, thermal flow test & air tightness test. Acid cleaning, Safety valve setting, Hydraulic Test. Steam blowing.	**4 L**
4.	Balance of Plant Operation: Operation of CHP & OHP, CW System and Cooling Tower, AHP and Bearing Cooling Water, Compressor and Fire Fighting System.	**4 L**
5.	Boiler & its Auxiliaries Operation: Boiler pre light up checks including PA, FD, ID, Seal Air Fans, APH, Milling systems etc. Milling Systems Operation, Draft Systems Operation, Drum level control, Soot blowing, Boiler pressure raising and loading, shutdown, Interlock and Protection, FSSS, Emergency Operation.	**6 L**
6.	Turbine & its Auxiliaries Operation: Turbine rolling, Turbine cold start, work start and hot start. ATRS, TSE, Governing system operation, Boiler Feed Pump, Condensate Extraction Pump, Vacuum pulling in condenser, Regenerative Feed Heater including Deaerator Operation, Protection and Emergency Operations. Turbine gland sealing and Lub. Oil system operation.	**6 L**
7.	Synchronization, Power Evacuation, Generator Operation including cooling & sealing system. Excitation systems, AVR Transformer and Switchgear Operation.	**4 L**
8.	Power Plant Performance: Boiler, Turbine, Coal Mill, Feed Heaters, Condenser, ESP.	**3 L**
9.	Cost of Generation and Tariff.	**2 L**

10.	Maintenance procedure (Breakdown maintenance, corrective maintenance, preventive maintenance, condition based maintenance etc.)	**5 L**

40 L

Suggested Text Books and References:

1. Power Plant operation – NPTI Publication
2. BHEL manual
3. CEGB Manual on power plant operation
4. Power Plant Engineering by P. K. Nag, TMH
5. Power Plant Engineering by Morse.

Code : PWE 705 A (Manufacturing and Industrial Engineering) (Elective)
Contacts : 3 L
Credits : 3

Sl. No.	Topic	Credit Point
1.	**Metal Casting**: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.	**4 L**
2.	**Forming**: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes.	**4 L**
3.	**Joining**: Physics of welding, brazing and soldering; design considerations in welding. Arc welding, Gas Welding, TIG, MIG, Submerged Arc Welding.	**4 L**
4.	**Machining and Machine Tool Operations**: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.	**5 L**
5.	**Metrology and Inspection**: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.	**3 L**
6.	**Computer Integrated Manufacturing**: Basic concepts of CAD/CAM and their integration tools.	**5 L**
7.	**Production Planning and Control**: Forecasting models, aggregate production planning, scheduling, materials requirement planning. Work method design: Method study work measurement, time study, work sampling job evaluation, merit rating Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems. Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.	**8L**

33 L

Suggested Text Books and References:

6. Power Plant operation – NPTI Publication
7. BHEL manual
8. CEGB Manual on power plant operation

9. Power Plant Engineering by P. K. Nag, TMH
10. Power Plant Engineering by Morse.

Instrumentation & Process Control

Paper Code: PWE 702
Contacts : 3 L
Credit : 3

Sl. No.	Module	Detail of topics	No. of lecture
1	Importance of Instrumentation & Control system.	Discuss the reasons for impossibility of running TPP without adequate I&C.	01
2	Functions of I&C system	Measurement, data presentation, interlocking, annunciation, control, MIS related functions with examples.	02
3	Measurement of fluid pressure	Concept of absolute & gauge pressures & vacuum & their relations. Important units of pressure and their relations. Boudon tube type, pressure gauge? Basic construction, ranges of measurement & materials of wetted parts (no discussions on errors & calibration) basic concepts of installations for different applications – specially for steam pressure. Draught gauges, diaphragm & capsule type. Only construction & applications concept of direct differential pressure measurement. DPI concepts of pressure & differential pressure transmitter – ranges of transmission signals concepts of capacitance type & induction type pressure & differential pressure type transmitter.	05
4	Measurement of liquid level	Sight glass level gauge, bi-colour level gauge for boiler drum, dis-placer type level gauge, liquid head pressure type level gauge for open tank, boiler drum level measurement by differential head measuring instrument with thermo compensated condensing pot – theoretical treatment advantages and disadvantages. Differential conductivity type (Hydrastep type) boiler drum level gauge – its advantages ultrasonic type level gauge.	04
5	Measurement of liquid flow	Orifice type : basic idea, practical formula, Reynold's number and its significance, different pressure tappings, need for square root extraction, general installations for steam flow, water flow and gas flow measurements. Requirement of straight pipes both upstream & downstream. Venturi type & flow nozzle type – general constructional ideas, comparison between orifice type, flow nozzle type & venturi types. Rotameter,basic idea of operation & installation electromagnetic flow meter, ultrasonic flow meter and direct mass flow meter, principles, applications with advantages & disvantages, suggested flow measurements for different fluid flows in TPP.	05

6	Temperature measurement	Thermocouple type; Seebeck effect, construction, laws of thermoelectricity, different important thermocouples used in TPP, cold junction compensation ; necessity of extension wires, basic principles of operation of digital type indicator. RTD type : Principle with formula, Wheatstone bridge measurement, problem with lead wire resistances & lead wire compensation technique (triad cable), basic principle of operation of digital type indicator. Comparison between thermocouples & RTDs in respect of accuracy & temperature ranges. Some important application of both in TPP. Liquid filled dial thermometers; basic construction, thermistor type: Basic principle. Total radiation & optical pyrometer.	05
		Measurement of noise, and vibration	2
7	Instruments for important-analytical measurement	Zirconium type oxygen analyzer in flue gas – basic principle Carbon dioxide measurement in flue gas – basic principle Carbon monoxide measurement – basic principle Smoke density measurement in flue gas – basic principle Conductivity and pH measurement – basic principle Silica measurement – basic principle	7
8	Concept of interlocks	Functions of interlocks, starting interlocks and running interlocks with some examples. Implementation of interlocks with PLCs. Basic operation of a PLC with scheme and ladder logic diagram, scan cycle.	8
9	Control system	Necessity of control system; different types of lags, concepts of development of negative feed back, closed loop control system, examples of closed loop control system. Open loop control system with examples. Difference between closed loop & open loop control system – how to choose them. The reason for the closed loop control system becoming unstable how mathematical analysis can help to determine instability (only concepts) Explanations of proportional, integral and derivative control action – how does a PID controller react to an occurrence of error; control valves & positioner where to use PI, PD or PID actions, some examples - Tunning of controller.	05
10		Discussions of some important control system in a TPP with special references to & element & 3 element boiler drum level control; combustion control (discuss about the basic scheme)	
11	Turbo supervisory instrumentation	Main parameter measurements & their importance.	02
12	Computer applications in TPP	Data acquisition & HMI concepts leading to SCADA system. DDC with mainframe & SCADA – dis-advantages. Distributed control system with SCADA – advantages Multilevel DCS.	

		Total	46L

Recommended Text Books:

Control & Instrumentation- NPTI Publication Vol-I, II & III

Nagrath I J & Gopal M : Control System Engineering --- --- --- New Age International

Recommended Reference Books:

01. Gopal M : Control Systems – Principles & Design --- --- --- TMH

02. Bolton : Industrial Control & Instrumentation --- --- --- Orient Longman

03. Jain N K : A course in Automatic Control System Engineering --- --- Dhanpat Rai & Sons

- P.W. : "Golding Electrical Measurements and Instrumentation"
- Sawhney A. K:"A course in Electrical Measurement & Instrumentation"Dhanpat Rai & Sons
- Murty D.V.S. : "Transducers & Instrumentation" ; Prentice Hall

Patranabis- Sensors & Transducers

ELECTRIC DRIVES
Code : PWE 705B
Contacts : 3L
Credits : 3

Sl.No.	Module	Topic	Lectures
1.	Concept of electrical drives	Definition, elements of an electric drive, classification -group, individual and multi-motor drives), dynamics of electric drives, speed torque characteristics of different electric drives and various types of loads.	**6L**
2	Speed control of D.C. motors	Ward Leonard, Buck-boost, series-parallel control, rectifier and chopper fed drives, up based controllers for D.C. drives.	**5L**
3	Induction motor drives	Review of conventional methods(Pole changing, frequency variation, stator voltage variation, rotor resistance variation, slip power recovery) AC Regulators and cycloconverter fed IM drives, PWM fed IM drive: VSI & CSI drives, vector controlled IM drive	**5L**
4	Synchronous Motor Drives	Wound field brushless excitation, voltage source inverter drive. Constant v/f, E/f and field weakening control. Cyclo-converter control, self controlled synchronous motor drive.	**4L**
5	Starting and Braking	Conventional methods of starting,Soft starts, regenerative and dynamic braking. Transients and dynamics of electric motors under starting and braking conditions.	**3L**
6	Heating and Power Ratings	Service conditions of electric drives and selection of motor capacities. Operation of electric drives incorporating flywheel under shock loading conditions. (Loading conditions and classes of duty, motor heating & cooling characteristics. Determination of power rating for different applications, load equalization)	**3L**
7	Motor Controllers	Introduction to controller design techniques for electric drives: Block diagram representation, transfer functions, transient response, frequency response and stability, compensating techniques. Stepper Motor, Tachogenerator, Industrial application.	**3L**
8	Drives for specific applications:	Drives for specific applications: texctile mill, paper mill, cement mill, rolling mill, coal mines, centrifugal pumps, turbo compressors, traction etc.	

36 Lectures

Books:

Pillai S K: A First course in Electrical Drives, New Age International Pub.
De N K and Sen P K : Elective Drives; PHI
Subramaniyan V: Elective Drives - Concepts and Applications; TMH Pub.
Krishnan, Electrical Motor Drives, Pearson Education
De. G : Electrical Drives and their Control; Academic Books Ltd.
Dubey G K et. Al. Electrical Drives, New Age Pub.

H. Partab, Art & Science of Utilization of Electrical Energy, Dhanpat Rai & Sons
H. Partab, Modern Electrical Traction, Dhanpat Rai & Sons
Dubey G.K Fundamentals of Electric Drives, Narosa Publishing House.

Power Electronics & Drives, M.H.Rashid, PHI
Modern Power Electronics and AC Drives, B.K.Bose, Pearson

Electrical Protection Systems.
Code : PWE 703
Contacts : 3L
Credits : 3

Sl.No.	Topic	Lectures
1.	**Symmetrical three phase fault** - Short circuit transient on a transmission line, Short circuit of synchronous machines (unloaded and loaded), fault calculations, selection of circuit breakers. **Symmetrical Component** – Reservation of unbalance phases into their symmetrical components, phase shift of symmetrical components in Y- Δ transformer bank, power in terms of symmetrical components. Positive, negative and zero sequence networks of power system elements. **Unsymmetrical fault analysis** – Single L-G faults, L-L faults, L-L-G faults, open conductor faults, Unsymmetrical faults on an unloaded alternator, Unsymmetrical faults on an power system. Faults through impedance, Fault current calculation	9L
2.	Review of power system protection and various protective relays	1L
3.	Internal connection Diagrams and operating principles of induction type over current relays, instantaneous, inverse time – current and IDMT and their time current characteristics, PSM, TMS.	2L
4.	Different internal connection diagrams of Directional over current relay, Maximum torque angle.	2 L
5.	Feeder protection by time graded / current graded system / time current graded system , parallel feeder protection .	2L
6.	Transmission line protection – Impedance , Reactance and Mho relays, power swings , carrier current protection .	3L
7.	Over voltage relays , Under frequency relays. Static relays	1L
8.	Generator Protection– Differential relays, Unbalanced loading by negative sequence relays , overheating protection , loss of excitation , protection against interturn faults. Examples.	4L
9	Transformer Protection – Biased Differential relays for Y-Y , Y-Δ , Δ - Y and Δ - Δ connected transformers, Harmonic restraint relay , Buchholtz relays, and main protections Types of cooling, Mulsifire and other fire protection systems.	4L
11	Bus-bar Protection– Bus bar differential relay .	2L
12	Motor Protection– Different schemes .	2L
13	Substation equipment-Oil Circuit Breakers, Air Blast Circuit Breakers, SF_6 Circuit Breakers, Vacuum Circuit Breakers.	2L

14	Regulators, Reactors Loading Power Transformers Instrument Transformers (Current and Voltage Transformers) Transformer Connections and Phase Shift LTC Control and Transformer Paralleling Load Tap Changers No Load Taps, Seasonal Adjustment Transformer Modeling	4L

38 L

References:

- Power System Relaying : Horowitz and Phadke, Institute of Physics Publishing
- C. R. Mason : The Art and Science of Protective Relaying, General Electric, 1956
- T. S. Madhava Rao : Power System Protection Static Relay, Tata McGraw Hill, 1980
- B. Ravindranath, M Chander : Power System Protection and Switch Gear, Willey Eastern Ltd., 1977
- Westinghouse Electric Corporation : Applied Protective Relaying, Relay – Instrument Division, 1982.

Electrical Protection Systems.
Code : PWE 703
Contacts : 3L
Credits : 3

Sl. No.	Topic	Lectures
1.	**Short Circuit Calculations** : Symmetrical/three phase fault, steps of fault calculations, selection of base values, per unit impedance of three winding transformers, examples of symmetrical fault calculations in Power systems. Unsymmetrical fault , symmetrical components, sequence impedances, sequence networks of unloaded alternator, LG, LLG and LL faults on an unloaded alternator, zero sequence networks for different 3 phase transformer connections, connection of sequence networks for faults in Power Systems, examples of unsymmetrical fault calculations in Power Systems. Current limiting reactors, design features, types, locations and examples of fault calculations in presence of current limiting reactors.	9L
	Busbar arrangements and electrical layouts : Busbar arrangements, Generator Connections – classical and unit type of connections. Components of substation, comparison of substation and switching station, layout of substation equipment, busbar ratings.	2L
3.	**Protective relays :** Basic requirements, trip circuit, primary and back-up relaying over current relays & directional relays, characteristics and connections, TMS and PSM. Distance relays, impedance, reactance and mho relays. Differential relays & biased differential relays. Over voltage relays, under frequency relays, negative sequence relays and various static relays.	7L
4.	**Circuit interruption devices** : Current in the arc, definitions of sub-transient, transient, steady states definitions of making current, breaking current, recovery voltage, prospective current, reignition and restrike. Low and high resistance interruption, resistance switching. Air break circuit breaker, air blast CB, Oil CBs, SF_6 CB and vacuum CB.	3L
5.	**Protection of feeders and transmission lines :** Time graded and current graded over current protection. Protection of parallel feeders. Three zone distance protection, Carrier current protection	3L
6.	**Generator Protection :** Stator and rotor faults, abnormal running conditions. Biased differential protection, turn to turn fault protection, different types of stator earth fault protection, rotor earth fault protection, loss of field excitation and negative sequence protection.	3L

7.	**Transformer Protection** : Nature of transformer faults, faults in auxiliaries, overloads and external short circuits, Gas actuated devices – Buchholz relay.Biased differential protection of Y-Y, Y-Δ , Δ-Y , Δ-Δ and connected transformer differential protection of auto-transformer. Restricted earth fault protection. Differential protection of three winding transformers. Over current protection of Power transformers. Harmonic current restraint and harmonic blocking. Fire protection systems.	3L
8.	**Bus-bar Protection**– Bus bar differential relay .	2L
9.	**Motor Protection**– Different schemes .	2L
10.	Regulators, Reactors,Loading Power Transformers Instrument Transformers (Current and Voltage Transformers) Transformer Connections and Phase Shift LTC Control and Transformer Paralleling Load Tap Changers,No Load Taps, Seasonal Adjustment Transformer Modeling	4L

Total : 38 L

References:

- Power System Relaying : Horowitz and Phadke, Institute of Physics Publishing
- C. R. Mason : The Art and Science of Protective Relaying, General Electric, 1956
- T. S. Madhava Rao : Power System Protection Static Relay, Tata McGraw Hill, 1980
- B. Ravindranath, M Chander : Power System Protection and Switch Gear, Willey Eastern Ltd., 1977
- Westinghouse Electric Corporation : Applied Protective Relaying, Relay – Instrument Division, 1982.
- Electrical Power Systems, C.L.Wadhwa
- Power System Protection- S. Rao

POWER SYSTEM OPERATION
Paper Code : PWE 704
Contacts : 3
Credit : 3

Sl.No.	Module	Topic	Lectures
1.	Representation of Power System	Single line diagram, per unit quantities and its advantages, Impedance and Reactance diagram, bus admittance(Y bus) and Impedance (Z bus) matrices and their formation.	3L
2	Load Flow Studies	Power flow in a transmission system, bus classification, data for load flow studies, power system equation , solution techniques-Gauss iterative method, Gauss-Seidel method, Newton-Raphson method, Fast decoupled load flow (FDLF) method, comparison of load flow solution techniques.	5L
3	Economic Operation of Power System	Station performance and operating characteristics, Incremental rate theory, optimal Load distribution within generating station and between various generating station in a region. Transmission loss equation. Calculation of losses. Generation scheduling. Unit commitment.	6L
4	Modelling of a synchronous machine	Modelling of a synchronous machine, modeling of excitation system and AVR, Performance of AVR, Transient behavior of synchronous machine. Capability curve of alternators and different limits of AVR	3L
5	Fundamental theory of load compensation	Fundamentals of load compensation, power factor correction, voltage regulation, phase balancing and p-f correction for unbalanced load, representation of 3-ph delta connected unbalanced load. Some practical aspect of compensators used as voltage regulators.	3L
6	Modern Controllers in Power Network	Control complexities in integrated power network, Application of FACTS, FACTS devices- Static VAR system(SVS), Controllable series compensator(CSC) and Unified power flow controller(UPFC).	3L
7	Grid faults and Restoration	Cascade tripping of generating stations, general restoration methodology, Survival/startup of thermal power plant, , load restoration , transmission network and grid building.	2L
8	Power System Control	MW-frequency control, models of single area & multi area MW frequency control, Reactive Power-Voltage control.	4L

9	Power System Stability	Steady state stability and transient stability- stability problem, rotor dynamics and swing equation, power angle equation and diagram, equal area criterion and its application, critical clearing angle, fault clearing time, step-by-step solution of swing curve, factors influencing transient stability, methods of improving stability.	5L
10	Indian Electricity Grid Code (IEGC)	Structure of the IEGC, procedure for connection, reactive power compensation, international connection to ISTS, Operating policy ,system security aspects, outage planning, recovery procedures, demarcation of responsibilities, scheduling and dispatch procedure.	1L

35 L

Suggested Text Books/Reference:

1. Elgerd,O.I., "Electric Energy Systems Theory: An Introduction",Tata McGraw Hill, 2nd Edn,. 1982,
2. Stagg, G.W.and EI-Abaid , A.H.,"Computer Methods in Power System Analysis". McGraw Hill International Edition
3 Kundur, P., " Power System Stability and Control", McGraw Hill Inc., 1994.
3. Kimbark , E.W., " Power System Stability, Vol.I. Elements of Stability Calculations" John Wiley & Sons, 1948.
5. Westinghouse Electric Corporation, " Electrical Transmission and Distribution reference book East Pittsburgh , Pa., 1964.
6. I.J.Nagrath and D.P.Kothari,"Power System Engineering", Tata McGraw Hill 1994.
7. Wadhwa, C.L. "Electric Power Systems". Second Edition, Wiley Eastern Ltd., 1985.
8. Hadi Saadat, "Power System Analysis". McGraw Hill,1999.
9. Stevenson – Power System Analysis.

Protection Lab.
Paper Code : PWE 797
Contacts : 3
Credit : 2

- Demonstration of Inverse Characteristics of CDG11 RELAY.
- Demonstration of Characteristics of Definite Time Over current relay.
- Demonstration of Characteristics of Neutral Displacement relay.
- Demonstration of operation of Directional property of Directional over Current relay.
- Operation of Differential relay and determination of % biasing.
- Demonstration of instantaneous Operation of Short Circuit protection.
- Determination of Thermal Overload Operation time for a given setting .
- Determination of CT Ratio.
- Testing of Bimetal relays .
- Demonstration of Principle of CT connection for Differential Protection.

Instrumentation & Process Control Lab

Paper Code : PWE 798
Contacts : 3
Credits : 2

- Pressure Measurement / Calibration
- Temp. Measurement / Calibration
- Level Measurement / Calibration
- Auto Control Loop (P.I.D.)
  a) Temp.
  b) Pressure
  c) Flow
  d) Level

Control valve / Actuator – Calibration
Calibration of Transducers.

Code: PWE 705 A Manufacturing and Industrial Engineering
Contacts: 3 L
Credits: 3

Sl. No.	Topics	Lectures
1.	**Metal Casting:** Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.	4L
2.	**Forming:** Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.	4 L
3.	**Joining:** Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding	4L
4.	**Machining and Machine Tool Operations:** Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures	5L
5.	**Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.	3L
6.	**Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools. Work Method Design: Method study work measurement, time study,work sampling, job evaluation, merit rating	2 L 3 L
7.	**Production Planning and Control:** Forecasting models, aggregate production planning, scheduling, materials requirement planning.	2 L
8.	**Inventory Control:** Deterministic and probabilistic models; safety stock inventory control systems.	2 L
9.	**Operations Research:** Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.	4 L

33 L

References :

Manufacturing Engineering Technology, K. Jain, Pearson Education
Manufacturing Technology: Foundry, Forming and Welding by P.N.Rao, TMH.
Principles of Manufacturing Materials and Processes, James S.Campbell, TMH.
Welding Metallurgy by G.E.Linnert, AWS.
Production Engineering Sciences by P.C.Pandey and C.K.Singh, Standard Publishers Ltd.
Manufacturing Science by A.Ghosh and A.K.Mallick, Wiley Eastern.
Manufacturing Technology,Radhakrishnan,Scitech
Industrial Engineering and Management by C. Nadha Muni Reddy
Mechanical and Industrial Management by R. K. Jain, Khanna Publication
Industrial Organization of Engineering Economics by Banga / Sharma

11. Industrial Engineering and Management by Khanna P. P.

Energy Management

Code : PWE (HU) 801

Contacts: 2L Credits: 2

Sl. No.	Topic	Lectures
1.	Introduction to Energy Transformation - Classification of Energy Resources & Conservation Techniques	**2 L**
2.	Energy Economics, International / National Electrical System, Global Energy scenario, Energy Price Linkage, Energy pricing procedure and load curves.	**4 L**
3.	Energy wastes – Station performance linked losses like Working Voltage, Power Factor, Fixed Costs, Transportation of Resources, Insulation loss, optimum plant load selection criteria	**4 L**
4.	Energy-Environment Linkage , present emission norms and ambient air quality standards, emission control equipments, climate change control initiatives – National and global status, Kyoto protocol	**4 L**
5.	Energy Audit need in coal/Gas/Oil fired T.P Stations. Energy intensity of Indian Industries, Preliminary and Detail Audit procedure for TPP; Equipment required for flow, level, temperature, pressure , current, voltage, p.f.; harmonics measurements.	**6 L**
6.	Energy audit of mechanical / Electrical equipments and Auxiliaries	**5 L**
7.	Energy Conservation techniques, energy conservation opportunities, and programs in power generation Transmission and distribution, concept of ABT and safe grid operations	**5 L**

Total : 30 L

Suggested Text Books and References:

11. Energy Management Audit & Conservation – B.K.De; Vrinda Publications Ltd
12. CEGB Manual on power plant operation & Performance
13. Power Station Engineering and Economy – Bernhartd G.A. Skrotzki & W.A.Vopat, TMH Publn.

14. BEE Energy Auditor Course manual.

Industrial Engineering & Operations Research

Code : PWE 802A

Contacts : 2L Credits : 2

Sl. No.	Topic	Lectures
1.	Process / Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity – concepts & measurements; method study, principles of motion economy; work measurement – stop watch time study, work sampling, standard data, ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.	**4 L**
2.	Utility Facility Design: Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; materials handling systems for resource input and disposal of wastes including treatment.	**2 L**
3.	Principles of Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, budgets.	**4 L**
4.	Generation Planning and Inventory Control: Forecasting techniques; push and pull in on-grid generation systems; Inventory – perpetual and periodic inventory control systems.	**7 L**
5.	Operation Research: Linear programming – problem formulation, simplex method, duality; transportation and assignment models; simple queuing models; PERT and CPM.	**9L**
6.	Quality Management concept and statistical quality control.	**4 L**
7.	Plant life cycle analysis; value engineering and analysis.	**2 L**

Total :32 L

Suggested Text Books and References:

1. CEGB Manual on power station Layout
2. ISO Publcation.
3. Maintenance planning & Cost Control – NPTI Publication.
4. Fundamentals of Industrial Engineering
5. Operations Research –

High Voltage Engg.

Code : PWE 802B

Contacts: 2L +1 Tutorial Credits: 3

Sl. No.	Topic	Lectures
1.	Introduction to high voltage, application of high voltage engineering	2 **L**
2	Type of insulation, breakdown prevention of gaseous; liquid and solid insulation and vacuum	4L
3	GENERATION OF DIRECT VOLTAGES Generation and transmission of electric energy – voltage stress – testing voltages-AC to DC conversion – single phase rectifier circuits – cascaded circuits – voltage multiplier circuits – Cockroft-Walton circuits – voltage regulation – ripple factor – Design of HVDC generator – Vande-Graff generator.	3L
4.	GENERATION OF ALTERNATING VOLTAGES Testing transformer – single unit testing transformer, cascaded transformer – equivalent circuit of cascaded transformer – series resonance circuit – resonant transformer –voltage regulation, Tesla Coil.	4 **L**
5.	GENERATION OF IMPULSE VOLTAGES & CURRENT Characteristics of Impulse Voltage Marx generator – Impulse voltage generator circuit – analysis of various impulse voltage generator circuits – multistage impulse generator circuits – Switching impulse generator circuits – generation of non-standard impulse voltages and nanosecond pulses.	4 **L**
6.	MEASURMENT OF HIGH VOLTAGES & CURRENTS Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers and impulse voltage measurements. Measurement of impulse currents – Resistive shunts, measurement using magnetic coupling - Fast digital transient recorders for impulse measurements.	7 **L**
7	Testing of High Voltage Power Apparatus – AC high voltage test and impulse tests of the high voltage power apparatus such as Insulators, isolators, circuit breakers, cables and transformers.	6L
8.	Overvoltage phenomenon and insulation coordination, lightening phenomena, switching phenomena, Principle of Insulation coordination on high voltage	4L

Total : 34 L

Suggested Text Books and References:

1. Kuffel, E., Zaengl, W.S. and Kuffel J., “High V. Engg Fundamentals”, Elsvier (I) P. Ltd, 2005
2. Dieter Kind, Kurt Feser, “H Voltage Test Techniques”, SBA Elect.Engg Series, N Delhi, 1999.

3. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-hill Publishing Company Ltd., New Delhi, 2004.
4. Gallagher, T.J., and Permain, A., "H Measnt, Testing & Design", J. Wiley Sons, N.York, 1983.
5. R.Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, Roshdy Radwan, "H.V. Engg Theory & Practice" 2nd Ed., Revised and Expanded,Marcel Dekker, Inc., N. York, 2000.
6. N.H.Malik, A.A.Al_Arainy, M.I.Qureshi, "Elect. Insul. in Pwr Sys."Marcel Dekker,Inc., 1988.
7. Adolf J. Schwab, "High Voltage Measurement Techniques", M.I.T Press, 1972.

Design of Mechanical Equipments

Code : PWE 803A

Contacts: 2L +1 Tutorial Credits: 3

Sl. No.	Topic	Lectures
1.	Basic Concepts of Mechanical design; Theory of static and fatigue failure	**3 L**
2.	Design of torque transmitting elements such as shafts, couplings, key	**6 L**
3.	Design and selection of various equipments such as flat belt conveyor, pulley	**5 L**
4.	Design of various joints and selection of welding /riveting / fasteners procedure	**8 L**
5.	Preliminary design aspects of pressure vessels and selection of boiler tubes	**4 L**
6.	Selection of hydrodynamic bearings and selection of lubricants	**6 L**

Total :32 L

Suggested Text Books and References:

1. Hydrodynamic Lubrication, Yukio Hori; Springer, 2006
2. Design Concepts for Engineers; Mark N. Horenstein ; Prentice Hall, 2010
3. Indian Boiler Regulation – 1950
4. Design of Machine Elements,V. B. Bhandari; Tata McGraw-Hill Education, 2007
5. Mech Engg Design (SI) , Shigley; Tata McGraw-Hill Education
6. Textbook of Machine Design ; R S Khurmi & J K Gupta, Khanna Publishers
7. A Textbook of Machine Design; Dr. Rajendra Karwa; Laxmi Publications (P) Ltd.
8. Machine Design; S.G. Kulkarni, Tata McGraw-Hill Education, 2008


WEST BENGAL
UNIVERSITY OF TECHNOLOGY
Utech

Design of Electrical Equipments

Code : PWE 803B

Contacts : 2L +1 Tutorial Credits: 3

Sl. No.	Topic	Lectures
1.	Basic design principles and approaches, Magnetic and electrical loading, output equations and output coefficients, Main dimensions, ratings, heating cooling and temperature rise.	**4 L**
2.	Design of Transformers :Determination of main dimensions :- Magnetic circuit, care construction and design;Winding design : Winding types (Helical Crossover and disc); Loss estimation and cooling : Loss allocation and estimation, reactance, temperature rise, dry and oil cooled types cooling.	**8 L**
3.	Design of D.C Machine :No. of poles and main dimensions, armature windings, Magnetic circuit and magnetization cure commutator and brushes.	**6 L**
4.	Design of induction motors :Determination of main dimensions, specific loading; Design of stator windings; Rotor design : Single cage standard, deep bar/double cage;Calculations of equivalent circuit parameters; Slip-torque characteristics.	**6 L**
5.	Design of synchronous machine	**5 L**
6.	Main dimensions, Magnetisation characteristic, Field winding design. Excitation system.	**5 L**

Total :34 L

Suggested Text Books and References:

1. A course in Electrical Machine Design: A.K.Sawhney, Dhanpat Rai & Sons, New Delhi
2. The performance & Design of Alternating Current Machines, M.G. Say.