Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE
CITY CENTRE; DURGAPUR-16

COURSE STRUCTURE IN B.TECH POWER ENGINEERING

THIRD SEMESTER

A. THEORY:

A. THEORY							
	Code	Subjects	Contacts (periods/week)				Credit points
			L	T	P	Total	
1.	ME 301	Fluid Mechanics	3	1	0	4	4
2.	ME 302	Thermodynamics	4	0	0	4	4
3.	M 302	Mathematics	3	1	0	4	4
4.	ME 304	Mechanics of Deformable Bodies	3	0	0	3	3
5.	EE 301	Circuit Theory & Network	3	1	0	4	4
6.	EE 302	Electrical Electronic Measurement	3	1	0	4	4
Total of Theory						**23**	**23**

B. PRACTICAL:

B. PRACTICAL							
	Code	Subjects	Contacts (periods/week)				Credit points
			L	T	P	Total	
1.	ME 383	Mechanics of Deformable Bodies Lab.	0	0	3	3	2
2.	ME 391	Fluid Mechanics Lab.	0	0	3	3	2
3.	EE 391	Circuit Theory & Network Lab.	0	0	3	3	2
4.	EE 392	Electrical Electronic Measurement Lab.	0	0	3	3	2
Total of Practical						**12**	**8**
Total of 3rd Semester						**35**	**31**

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FOURTH SEMESTER

A. THEORY:

A. THEORY							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit points**
			L	T	P	Total	
1.	ME 401	Fluid Machinery	3	1	0	4	4
2.	ME 402	Engineering Thermodynamics	3	1	0	4	4
3.	ME 405	Materials Science and Technology	3	0	0	3	3
4.	ME 412	Theory of Machines	3	1	0	4	4
5.	EE 401	Electrical Machines	3	1	0	4	4
6.	EC 402	Digital Electronics & Integrated Circuits	3	1	0	4	4
Total of Theory						**23**	**23**

B. PRACTICAL:

B. PRACTICAL							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	
1.	ME 495	Materials Science Lab.	0	0	3	3	2
2.	EE 491	Electrical Machines Lab.	0	0	3	3	2
3.	EC 492	Digital Electronics & Integrated Circuits Lab.	0	0	3	3	2
Total of Practical						**09**	**06**

C. SESSIONAL:

C. SESSIONAL							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	

1.	HU 481	Technical Report Writing & / Language Practice Laboratory	0	0	3	3	2
Total of Sessional						**3**	**2**
Total of 4th Semester						**35**	**31**

- Non-credit industrial visits to local establishments.
- 4 week practical training at an Institute approved organization during vacation, to be credited in Semester-V.

FIFTH SEMESTER

A. THEORY:

A. THEORY							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit points**
			L	T	P	Total	
1.	PWE 501	Renewable Energy Systems	3	0	0	3	3
2.	PWE 502	Hydro Power Generation	3	0	0	3	3
3.	PWE 503	Nuclear Power Generation	3	0	0	3	3
4.	PWE 504	Electrical Machines-II	3	1	0	4	4
5.	ME 502	Heat Transfer	3	1	0	4	4
6.	EI 502	Microprocessor and Microcontrollers	3	1	0	4	4
Total of Theory						**21**	**21**

B. PRACTICAL:

B. PRACTICAL							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	
1.	PWE 594	Electrical Machines Lab.-II	0	0	3	3	2
2.	EI 592	Microprocessor and Microcontrollers Lab.	0	0	3	3	2
3.	ME 582	Heat Transfer Lab.	0	0	3	3	2
4.	ME 583	Fluid Machinery Lab.	0	0	3	3	2
Total of Practical						**12**	**8**

C. SESSIONAL:

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C. SESSIONAL							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	
1.	PWE 584	Vocational Training					2
Total of Sessional							**2**
Total of 5th Semester						**33**	**31**

SIXTH SEMESTER

A. THEORY:

A. THEORY							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit Points**
			L	T	P	Total	
1.	PWE 601	Steam Generators and its Auxiliaries	4	0	0	4	4
2.	PWE 602	Steam Turbines and its Auxiliaries	3	0	0	3	3
3.	PWE 603	Electrical Equipment in Power Station.	3	0	0	3	3
4.	PWE 604	Power Transmission and Distribution	3	0	0	3	3
5.	PWE 605	Control Systems	4	0	0	4	4
6.	PWE 606A OR PWE 606B	**Elective Paper:** Refrigeration and Air Conditioning High Voltage Engg.	3	0	0	3	3
Total of Theory						**20**	**20**

B. PRACTICAL:

B. PRACTICAL							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit Points**
			L	T	P	Total	
1.	PWE 697	Combustion Lab.	0	0	3	3	2
Total of Practical						**3**	**2**

C. SESSIONAL:

C. SESSIONAL							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit Points**
			L	T	P	Total	
1.	PWE 686	Seminar	0	0	3	3	2

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2.	PWE 687	Study of Power Plant Schemes (Mech.)	0	0	3	3	2
3.	PWE 688	Study of Power Plant and T & D Schemes (Elect.)	0	0	3	3	2
Total of Sessional						**9**	**6**
Total of 6TH Semester						**32**	**28**

*** Industrial training for 4 weeks as arranged by the Institute during vacation at the end of**
sixth semester , to be credited in the seventh semester.

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SEVENTH SEMESTER

A. THEORY:

A. THEORY							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit Points**
			L	**T**	**P**	**Total**	
1.	*PWE 701*	Advance Power Generation Technology	3	0	0	3	3
2.	**PWE 702**	Protections & Instrumentations	3	0	0	3	3
3.	**PWE 703**	Internal Combustion Engines	3	0	0	3	3
4.	**PWE 704**	Power System Operation	3	0	0	3	3
5.	**PWE 705A OR PWE 705B**	Elective Paper: Design of Mech. Equipments Design of Elect. Equipments	3	0	0	3	3
6.	**PWE 706A OR PWE 706B**	Elective Paper: Power Electronics Tribology & CBM	3	0	0	3	3
Total of Theory						**18**	**18**

B. PRACTICAL:

B. PRACTICAL							
	Code	**Subjects**	**Contacts (Periods/week)**				**Credit Points**
			L	**T**	**P**	*Total*	
1.	**PWE 797**	Protection Lab.	0	0	3	3	2
2.	**PWE 798**	Control & Instrumentation Lab.	0	0	3	3	2
3.	**PWE 799**	Heat Power Lab.	0	0	3	3	2
Total of Practical						**9**	**6**

C. SESSIONAL:

C. SESSIONAL							
	Code	*Subjects*	**Contacts (Periods/week)**				**Credit Points**
			L	**T**	**P**	**Total**	
1.	**PWE 7810**	Project - I (Mech./ Elect.)	0	0	6	6	4
2.	**PWE 7811**	Practical Training					2
Total of Sessional						6	6
Total of 7th Semester						**33**	**30**

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Eighth SEMESTER

A. THEORY:

A. THEORY							
	Code	Subjects	Contacts (Periods/week)				Credit points
			L	T	P	Total	
1.	PWE 801	Thermal Power Plant Operation & Maintenance .	4	0	0	4	4
2.	PWE 802	Operations Research and Industrial Engg.	3	1	0	4	4
3.	PWE 803A OR PWE 803B	**Elective**: Manufacturing Science OR Electric Drives	3	0	0	3	3
4.	PWE 804 A OR PWE 804 B	**Elective:** Technology of Machining and metal cutting OR HVDC Transmission	3	0	0	3	3
Total of Theory						**14**	**14**

B. SESSIONAL:

B. SESSIONAL							
	Code	Subjects	Contacts (periods/week)				Credit points
			L	T	P	Total	
1.	PWE 885	Project-II (Elect. / Mech.)	0	0		-	8
2.	PWE 886	Grand Viva-Voce	-	-	-	-	5
3.	PWE-886	Seminar on Power Engg.	-	-	-	3	2
Total of Sessional							**15**
Total of Practical							**29**

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DETAILS OF CURRICULUM

NATIONAL POWER TRAINING INSTITUTE
CITY CENTRE; DURGAPUR-16

COURSE STRUCTURE IN B.TECH POWER ENGINEERING

THIRD SEMESTER

DETAILED SYLLABI OF B.TECH PROGRAMME
IN MECHANICAL ENGINEERING

SEMESTER - III

ME 301 : Fluid Mechanics
Contacts : 3L + 1T
Credits : 4

Introduction : Definition of fluid, concept of continuum;
Fluid Properties : Density, Viscosity, Surface tension, Vapour pressure
Fluid statics : Body and surface forces, Stress at a point, State of stress in fluid at rest and in motion, Pressure distribution in hydrostatics, manometers, forces on plane and curved surfaces, Buoyancy and the concept of stability of floating and submerged bodies.
Fluid kinematics : Scalar and vector fields, Eulerian and Lagrangian approaches, Material derivative, Velocity and acceleration, Streamline, Streak line and path line, Deformation, rotation and vorticity, Deformation rate and strain rate tensor, Circulation.
Fluid flow : System and control volume approaches, Transport theorems, Continuity equation, Euler's equation, Bernoulli's equation, Momentum equations for stationary, moving and rotating control volumes, Application of Bernoulli's equation, static and dynamic pressure.
Fluid measurements : Pitot tube, Siphon, Venturimeter, Orificemeter, Mouthpiece, Sudden expansion in a pipe, Weirs and notches.

Viscous incompressible flow : Introduction to Navier Stokes equation, Boundary layer flow, Drag and lift, Laminar and turbulent flow, Couette flow, Plane Poisuille and Hagen Poisuille flow.
Internal viscous flow : Reynolds experiment, Critical Reynolds number, Darcy - Weisbach and Fanning friction factor, Moody's diagram, Minor losses and flow through simple network of pipes.
Principal of similarity : physical similarity, Dimensional Analysis, Buckingham pi theorem, Model studies and dimensionless parameters, Froude number, Euler number, Mach number, Weber number.

References :

1. Introduction to Fluid Mechanics and Fluid Machines by S.K.Som and G.Biswas.
2. Mechanics of Fluids by Irving H.Shames.
3. Fluid Mechanics by Victor L.Streeter.
4. Fluid Mechanics by Frank M. White.
5. Introduction to Fluid Mechanics by James A.Fay.
6. Fluid Mechanics and Hydraulics by J. Lal.
7. Fluid Mechanics by A.K.Jain
8. Engineering fluid mechanics,Garde,SCITECH

ME 302 : Thermodynamics
Contacts : 4L
Credits : 4

Introduction; Microscopic and macroscopic viewpoints in thermodynamics; Fundamental concepts of system, control volume, state properties, equilibrium, processes etc,Zeroth law;
Survey of units and dimensions; forms of energy and energy interaction; heat and work; State postulate; thermodynamic properties of pure substance in solid, liquid and vapour phases; P-V-T behaviour of simple compressible substances; phase rule; thermodynamic property tables and charts; ideal and real gases; equations of state; compressibility factor; generalised compressibility chart; First law of thermodynamics for closed loop system, internal energy and enthalpy; First law for control volumes, Steady flow and unsteady flow applications. Process calculations for ideal and real gases using equations, tables and charts.
Definitions of Heat Engine, Heat Pump, Thermal efficiency, COP; Carnot cycle.
Second Law of thermodynamics; Statements and corollaries; entropy; concept of reversibility and irreversibility.
Second law analysis of Control volumes; concept of entropy generation, reversible work, Availability and Irreversibility.
Tds relations; Maxwell equations; Clapeyron equation; Clausius Clapeyron equation, Joule Thompson coefficient; compressibility and expansion coefficient, development of property data in graphical and tabular form.

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References :

1. Engineering Thermodynamics by P.K.Nag.
2. Thermodynamics by Kenneth Wark.
3. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew.
4. Fundamentals of Classical Thermodynamics by Van Wylen and Sonntag.

MATHEMATICS

Code: **M 302**
Contacts: **3L + 1T**
Credits: **4**

Fourier Series:

Introduction: Euler's formula; Problems on general Fourier Series; Conditions for Fourier Expansion; Fourier Expansions of Discontinuous Functions; Even and Odd functions; Change of interval; Half range series; Typical Waveforms (Square, Saw-toothed, Triangular, Half Wave rectifier, Full Wave rectifier); Parseval's Identity (statement only); Fourier Transform (FT) and its properties; Inverse Fourier Transform (statement only); Fourier transform of derivative (statement only); Convolution (statement only); Application of Fourier Transform in solving partial differential equations — Laplace's Equation (2D only), Heat Conduction Equation (1D only) and Wave Equation (1D only). *12L*

Calculus of Complex Variable:

Functions; Limits and Continuity; Analytic Functions; Cauchy Riemann Conditions; Analytic Continuation; Complex Integration and Cauchy's Theorem; Cauchy's Integral Formula; Taylor's and Laurent Series; Zeros of an Analytic Function; Poles; Essential Singularities; Residue Theorem (statement only) and *14L*

it's application to evaluation of integral; Introduction to Conformal Mapping; Simple problems.

Probability and Statistics:

Mean, Median, Mode and Standard Deviation; Samples Space; Definition of Probability; Conditional Probability; General Multiplication Theorem; Independent Events; Bayes' Theorem; Random Variable; Discrete and Continuous Probability Distributions - Probability mass function; Probability density function; Distribution Function; Expectation; Variance; Probability Distribution— Binomial, Poisson and Normal. Correlation and Regression; Method of Least Squares; Linear Curve Fitting. *10L*

Graph Theory:

Graphs; Digraphs; Isomorphism; Walk; Path; Circuit; Shortest Path: Dijkstra's Algorithm; Tree; Properties of Tree; Binary Tree; Fundamental Circuit; Minimal Spanning Tree: Kruskal's Algorithm; Prim's Algorithm. Cut Set; Fundamental Cut Set and Cut Vertices; Matrix Representation of Graphs (Adjacency and Incidence Matrices); Network; Flow Augmenting Path; Ford-Fulkerson Algorithm for Maximum Flow; Max Flow – Min Cut Theorem (statement only). *12L*

Total ***48L***

Text Books:

1. Rathor, Choudhari,: Descrete Structure And Graph Theory.
2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics - Sultan Chand & Sons.
3. Lipschutz S: Theory and Problems of Probability (Schaum's Outline Series) - McGraw Hill Book. Co.
4. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series) - McGraw Hill Book Co.
5. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics - The World Press Pvt. Ltd.
6. Spiegel M R: Theory and Problems of Complex Variables (Schaum's Outline Series) - McGraw Hill Book Co.
7. Bronson R: Differential Equations (Schaum's Outline Series) - McGraw Hill Book Co.
8. Ross S L: Differential Equations - John Willey & Sons.
9. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
10. West D.B.: Introduction to Graph Theory - Prentice Hall
11. Deo N: Graph Theory with Applications to Engineering and Computer Science - Prentice Hall.
12. Grewal B S: Higher Engineering Mathematics (thirtyfifth edn) - Khanna Pub.

13. Kreyzig E: Advanced Engineering Mathematics - John Wiley and Sons.
14. Jana- Undergradute Mathematics
15. Lakshminarayan- Engineering Math 1.2.3
16. Gupta- Mathematical Physics (Vikas)
17. Singh- Modern Algebra
18. Rao B: Differential Equations with Applications & Programs, Universities Press
19. Murray: Introductory Courses in Differential Equations, Universities Press
20. Delampady, M: Probability & Statistics, Universities Press
21. Prasad: Partial Differential Equations, New Age International
22. Chowdhury: Elements of Complex Analysis, New Age International
23. Bhat: Modern Probability Theory, New Age International
24. Dutta: A Textbook of Engineering Mathematics Vol.1 & 2, New Age International
25. Sarveswarao: Engineering Mathematics, Universities Press
26. Dhami: Differential Calculus, New Age International

ME 304 : Mechanics of Deformable Bodies

Contacts : 3L

Credits : 3

Concept of stress, normal and shearing stresses in axially loaded members, factor of safety and introduction to design for strength - concept of strain, normal and shearing strains - stress-strain relationship - generalised Hook's Law - strain compatibility in two dimensions and application to isotropic materials - plane stress and plane strain - Poisson's ratio - stress strain diagrams for uniaxial loading - strain measurements - strain energy - relationship between elastic constants - deformation of axially loaded members and statically indeterminate problems - thermal stresses; Torsion of circular shafts - stress and deflections in close coiled helical springs subjected to axial forces; Members subjected to flexural loads - reactions for statically determinate beams - relationships between load, shear force and bending moment - shear force and bending moment diagrams - singularity functions - application of Dirac Delta functions in beam bending problems; Elastic curve - theory of simple bending - bending stresses in beams - members subjected to combined loads - stresses in short struts with eccentric loading - kern of rectangular and circular sections - composite beams - built up beams, shear flow and shear centre; Transformation of plane stresses and strains - principal stresses and principal planes - principal strains - Mohr's

Circle of stresses and strains - principal stresses in 3 D - strain rosettes, principal stresses for strain measurements; compounding of stresses - combined bending and torsion - investigation of stress at a point - thin walled pressure vessels - Hoop's stress - biaxial stresses - yield theories - principles of design for strength; deflection of beams - direct integration method, moment area method - buckling of columns - Euler's theory - critical loads and critical stresses for different types of constants - statically indeterminate structures - theorem of three moments - strain energy due to pure bending and shearing stresses - deflection by energy method.

References:

1. Engineering Mechanics of Solids by E.P.Popov, Prentice Hall.
2. Introduction to Solid Mechanics by I.H.Shames, 2nd ed., Prentice Hall.
3. Strength of Materials Vols - I & II by S.P.Timoshenko, CBS Publishers
4. Introduction to the Mechanics of Solids by S.H.Crandall, N.C.Dahl and T.J.Lardner, 2nd ed., McGraw Hill International.

CIRCUIT THEORY & NETWORKS
Code: EE 301
Contact: 3L + IT
Credit: 4

Different types of systems & networks: continuous & Discrete, Fixed and Time varying, Linear and Non-linear, Lumped and distributed, Passive & Active Networks & Systems
Laplace transform of impulse and sinusoidal steps waveforms for RL, RC, LC and RLC Circuits. Transient analysis of different electrical circuits with and without initial conditions, Fourier Series and Fourier Transform
Network theorems and their applications in circuit analysis, Formulation of network equations, Source transformations, Loop variable analysis and node variable analysis
Graph of network, concept of tree branch, tree link. Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials
Two port networks, Open circuit Impedance and Short circuit Admittance parameters, Transmission parameters, hybrid parameters, and their inter-relations
Indefinite admittance matrix- their applications to the analysis of active network

Active filter analysis and synthesis using operational amplifier

SPICE: How SPICE works. Model statement, models for passive and active device, D.C. circuits analysis, small signal analysis, capacitors and inductors in D.C. Circuits, steady state and transient, plotting and printing, input and output Impedance, D.C. sensitivity analysis, harmonic decomposition (Fourier Series), Harmonic re-composition, voltage controlled components

Text books **:**

Sudhakar:Circuits & Networks:Analysis & Synthesis 2/e TMH
Engineering circuit analysis with PSPICE and probe-Roger,MH
Engg Circuit Analysis: Hayt 6/e Tata Mcgraw-Hill
Valkenburg M. E. Van, “Network Analysis”, Prentice Hall
A. Chakravarty: Networks, Filters & Transmission Lines
D.Chattopadhyay and P.C.Rakshit: Electrical Circuits
A.V. Oppenheimer and A.S.Wilsky: Signals & Systems, PHI

8 R.V.Jalgaonkar.: Network Analysis & Synthasis.
9 Sivanandam: Electric Circuits Analysis
10 Gupta: Circuit Analysis with Computer Application, New Age International
11 Mann: Introductory A.C.Circuit Theory, Universities Press
12 Aatre: Network Theory & Filter Design, New Age International
13 Adby: Applied Circuit Theory, New Age International
14 Wadhwa: Network Analysis & Synthesis, New Age International
15 Roychowdhury: Linear Integrated Circuits, New Age International
16 Roy Choudhury D., “Networks and Systems”, New Age International Publishers.
17 V.K. Chandna, A Text Book of Network Theory & Circuit Analysis, Cyber Tech

References **:**

Reza F. M. and Seely S., “Modern Network Analysis”, Mc.Graw Hill Book Company
Kuo F. F., “Network Analysis & Synthesis”, John Wiley & Sons.

ELECTRICAL AND ELECTRONIC MEASUREMENT
Code : EE 302
Contacts : 3L + 1T
Credits : 4

General features – Construction and principle of operation of moving coil, moving iron, Dynamometer, Thermal and Rectifier type deflecting instruments. Deflecting, controlling and damping torques, extension of instrument ranges using shunts, multipliers and instrument transformers. Measurement of low, medium and high resistances, Kelvins double bridge, multimeters, megger, localization of cable faults.

D.C. and A.C. potentiometers, Measurement of high voltage, Electrostatic instruments, measurement of inductances, capacitance and frequency by A.C. Bridges.

Measurement of power in polyphase circuits, various wattmeter connections. A.C. and D.C. energy meters.

C.R.O. construction & principle measurement of voltage, current, frequency and phase by oscilloscope.

Electronic voltmeters – analog and digital. Digital multimeters, Audio oscillators, signal generators and frequency counter.

Text Books:

1. Golding E.W. & Wides F.C. : Electrical Measuring Instruments & Measurements ; Wheeler
2. Electronic Instrumentation – H.S. Kalsi, ISTE/EXCEL BOOKS
3 Singh:Industrial Instrumentation &control 2/e Tata Mcgraw-Hill,NewDel
4 Sawhney A K : A course in Electrical & Electronic Measurements & Instruments, Dhanpat rai
5 Kalsi:Electronic Instrumentation TMH
6 Heltrick A.D. & Cooper W.D. : Modern Electronic Instrumentation & Measuring Instruments; Wheeler
7 Patranabis D: Sensors & Transducers, Wheeler 96
8 R.V.Jalgaonkar.: Electronics Instrumentation.
9 Sutko: Industrial Instrumentations
10 Bolton W: Instrumentation & Process Measurement, Universities Press
11 Reissland: Electrical Measurement, New Age International

MECHANICS OF DEFORMABLE BODIES LAB.

ME : 383
Contacts : 3P
Credits : 2

Tension Test: Stress-strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in areas; Compression Test, Torsion Test; Hardness Tests: Brinnel and Rockwell tests; Impact tests: Charpy and Izod tests; Bending test: determination of bending stresses: Fatigue Test.

FLUID MECHANICS LAB.

ME 391
Contacts: 3P

Credits : 2

Fluid flow measurements:

Coefficient of discharge for venturimeter, orifice meter, nozzlemeter and weirs.

Flow through pipes:

Pipe friction in laminar and turbulent flow regimes. Pitot tube experiments on viscous flow and boundary layer theory.

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CIRCUITS & NETWORK LAB

Code: EE 391

Contact: 3P

Credit: 2

List of Experiments:

1. Transient response in R-L and R-C Network: Simulation/hardware
2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware
3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
4. Frequency response of LP and HP filters
5. Frequency response of BP and BR filters
6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form
7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB
8. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB
9. Determination of Lap lace transform and inverse Lap lace transformation using MATLAB
10. Spectrum analysis of different signals

Note: An Institution/College may opt for some other software or hardware simulation wherever possible in place of MATLAB

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ELECTRICAL AND ELECTRONIC MEASUREMENT LAB

Code: EE 392
Contact: 3P
Credit: 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/volmeter 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 Power in Polyphase circuits
8. Measurement of Frequency by Wien Bridge using Oscilloscope
9. Measurement of Inductance by Anderson Bridge
10. Measurement of Capacitance by De Sauty Bridge

Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE
CITY CENTRE ; DURGAPUR-16
COURSE STRUCTURE IN B.TECH POWER ENGINEERING

FOURTH SEMESTER

ME 401 : Fluid Machinery
Contacts : 3L + 1T
Credits : 4

Impact of Jet

Introduction : Classification of fluid machines.
Rotodynamic machines: Basic equation of energy transfer, definition of impulse and reaction machines, principle of similarity and dimensional analysis in rotodynamic machines, concept of specific speed.
Pelton wheel, analysis of force and power generation in a Pelton wheel, governing of Pelton wheel. Francis turbine, velocity triangles and analysis of force, power and efficiency, net head across Francis turbine, draft tubes. Kaplan turbines. Characteristics of reaction turbines. Comparison of specific speeds of hydraulic turbines.
Pumps : Classification of pumps. Centrifugal pump, pumping system and net head developed by a pump, manometric efficiency, losses in centrifugal pumps, head-discharge and power-discharge characteristics of a centrifugal pump. Axial flow pump. Matching of pump and system characteristics, pumps in series and parallel. Cavitation , NPSH .
Reciprocating Machines : Reciprocating pump, head-discharge characteristics, rate of delivery. Multi-cylinder pumps. Air vessels. Gear pump.
Air compressors : Centrifugal compressor, principle of operation, velocity triangles, stagnation pressure and temperature rise. Axial flow compressor, cascade flow and nomenclature, velocity triangles, degree of reaction, stalling and surging of compressor. Fans and Blowers. Testing and characteristics of Fluid Machinery.

Tidal & Pump storage unit.

References :
1. Hydraulic Machines by J. Lal.
2. Hydraulic and Compressible Flow Turbomachines by A.T.Sayers.

3. Turbine, Compressors and Fans by S.M.Yahya.
4. Turbomachines,Radhakrishnan,Scitech

ME 402 : Engineering Thermodynamics

Contacts : 3L + 1T

Credits : 4

Compression of air and gases : Reciprocating compressors and their cycles, work required, volumetric efficiency, FAD, compression efficiency and compressor efficiency; multistage compression.

Air standard engine cycles : Otto, Diesel, Dual combustion, Brayton and Stirling cycles; Gas turbine cycles with intercooling, reheating and regeneration; use of air tables.

Vapour cycles : Carnot cycle, Rankine cycle, work ratio, reheat and regenerative cycles used in steam power plants.

Reversed Carnot cycle: Vapour and air refrigeration cycles, absorption refrigeration cycles.

Binary vapour cycles. Cogeneration cycles.

Psychrometrics, calculation of properties of air-water vapour mixtures. Processes in pyshcrometric chart.

Combustion Analysis : Fuels, HIV and LTV, Air requirements, excess air, analysis of products of combustion. Enthalpy of formation, adiabatic flame temperature, enthalpy of combustion, heat of reaction.

Second Law analysis of reacting systems.

Third law of thermodynamics.

References :

1. Engineering Thermodynamics by P.K.Nag.
2. Thermodynamics by Kenneth Wark.
3. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew.
4. Fundamentals of Classical Thermodynamics by Van Wylee and Sonntag.

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ME 405 : Materials Science and Technology

Contacts : 3L

Credits : 3

Nature and properties of materials : Crystal structures and lattices, crystal imperfections, slip and dislocations, plastic deformation, phase diagrams, solidification and structure of metals and alloys, Iron-carbon diagram, various types of bonds, mechanical, magnetic and electronic properties, binary phase equilibrium characteristics of alloy, ternary phase diagram.

Metallography : Study of microstructure

Powder Metallurgy.

Heat treatment processes - general classifications, various heat treatment of steels, properties and applications of alloy steels, tool steels, stainless steels and cast iron, different heat treatment furnaces.

Hot and cold working of metals, recovery, recrystallisation and grain growth.

Fracture, fatigue and creep phenomenon in metallic materials.

Non-ferrous materials - Copper and Aluminium based alloys.

Mechanical, Magnetic, Electrical and Electronic properties of metals, alloys, ceramics, semiconductors and composites.

References :

1. Material Science and Engineering by V.Raghavan, Prentice Hall.
2. Introduction to Engineering Materials by B.K.Agarwal, TMH.
3. Mechanical Metallurgy by G.E.Dieter, McGrawhill.
4. Physical Metallurgy Principles by R.E.Reedhill, East-West Publishers.
5. Principles of Materials Science by W.F.Smith, 3rd ed., McGrawhill.
6. Steel and its Heat Treatment by K.E.Theling, Butterworth.
7. Material Science by J. C. Anderson, K. D. Leaver, R. D. Rawlings and J. M. Alexander, Chapman Hall, 4th Ed., 1992.

8.Material Science,Palanisamy,Scitech

Power Engineering Syllabus

THEORY OF MACHINES

Code: **ME 412**
Contacts: **3L + 1 T**
Credits : 4
Allotted Hours : 47 L

Introduction:

Mechanisms and Machines, Link, 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 cenres, 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 ReciprocatingMasses, 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]

Gyroscopes .

Motion of a Rigid Rotor, Spin and Precession, Gyroscopic Torque , Gyroscopic Effects in Machines.
[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]

Goyrnors:

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.

Refernees :

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.

Power Engineering Syllabus

ELECTRICAL MACHINES

Code: EE 401
Contracts : 3L + 1T
Credits : 4

General Principles of Dynamo-electric machinery
D.C.Machines:
Construction magnetic circuit, armature winding, Types of excitation Generated e.m.t. – Performance equations for generators and motors operation and characteristics. Interlopes and commutation parallel operation of generation.

Starting and speed control of d.c. Motors (including electronic control)

Losses & efficiency – testing of D.C. machines.

3-phase transformers – types – phasor groups, Effects of unbalanced loading, generation of harmonics by transformers and their suppression, 3-phase to 2-phase and 3-phase to multiphase transformation.

3-winding transformers – parameters estimation, voltage regulation – applications. Parallel operation of transformers. Autotransformers and phase-shifters.

3-phase induction machines – types, construction, rotating magnetic field and principle of operation – slip. Equivalent circuit, performance equations – torque slip curve, Common tests – parameter. Starting and speed control of induction motors. Braking – trouble and troubleshooting.

Text:

1. Nagrath I.J &Kotharu D.P.: Electric Machines. TMH
2. Bhattacharya – Electrical Machines, 2/e, TMH
3. Mukherjee P K & Chakraborty S : Electrical Machines : Dhanpat Rai Pub.
4. Sen S K : Electrical Machines : Khanna Pub.

5. Clayton A.E.& Hancock N N : Performance & Design of Director Current Machines. CBS Pub. & Distributors.
6. Parker Smith – Problems in Electrical Engg. – CBS Pub. & Distributors.
7. Say M G : Performances & Design of A.C. Mechnies ; CBS Publishers & Distributors.

Reference:

1. Fitzgerald – Electric Machinery, 6/e, TMH
2. Kothari & Nagrath – Theory & Problems in Electric Machines, 2/e.TMH

Power Engineering Syllabus

DIGITAL ELECTRONICS & INTEGRATED CIRCUITS

Code : EC 402
Contacts : 3L + 1T
Credits :4

Data and number systems, Binary representation, Codes and their conversions: BCD, Octal, Hexadecimal, ASCII, EBDIC, Gray, Signed binary number representation with 1's and 2's complement methods, Binary arithmetic.

Boolean algebra, Venn diagram, logic gates and circuits, Minimization of logic expressions by algebraic method, K-map method and Quine Mc Clauskey method
Combinational circuits- adder, subtractor, encoder, decoder, comparator, multiplexer, de-multiplexer, parity generator, etc

Design of combinational circuits-Programming logic devices and gate arrays.

Sequential Circuits- Flip Flops, various types of Registers and counters and their design, Irregular counter, State table and state transition diagram, sequential circuits design methodology.
Different types of A/D and D/A conversion techniques.
Different Logic families- TTL, ECL, MOS and CMOS, their operation and specifications.
Memory Systems: RAM, ROM, EPROM,EEROM

Textbooks:

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

Reference:

1. Digital Integrated Electronics- H.Taub & D.Shilling, Mc Graw Hill.
2. Givone—Digital Principles & 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 4^{th} Ed.- V.Rajaraman & T. Radhakrishnan, P.H.I.

Power Engineering Syllabus

MATERIAL SCIENCE LAB.

Code: ME – 495
Contracts: 3P
Credits: 2

1. Sample preparation for optical microscopy.
2. Study of an optical microscopy.
3. Study of macrostructure of a cast sample.
4. Determination of liquid-solid transformation points and phase diagram by thermal analysis.
5. Study of single-phase cast and eutectic microstructure.
6. Study of macro and microstructure of ceramic, polymeric and composite materials.
7. Photomicrography and printing of micrographs.
8. Heat treatment of plain carbon steel – annealing, normalizing , hardening and tempering.
9. Pack curburising and surface heat treatment of steel.
10. Effect of cold working and annealing on microstructure and mechanical properties of metals and alloys.
11. Jominy harden ability test.
12. Spectroscopic analysis of Metals.
13. Model study-Lattice structure of various types of unit cells, Miller in dices at various planes of a unit cell.
14. Measurement of di-electric behaviour of normal insulating materials.
15. Study of Photo-voltaic effect in a test bench .

Power Engineering Syllabus

ELECTRICAL MACHINES LAB

Code: EE 491
Contacts: 3 P
Credit2: 2

1. Study of the characteristics of a separately excited D.C generator.
2. Studies of the characteristics of a D.C shunt motor.
3. Speed control of a D.C motor.
4. Study of the characteristics of a compound D.C generator (short shunt)
5. Measurement of the speed of a D.C series motor as a function of load torque.
6. Study of the equivalent circuit of a single-phase transformer.
7. Polarity test on single phase transforms and study of the different connections of three-phase transformer.
8. Study of the equivalent circuit of three-phase induction motor by No-Load & Blocked-Rotor tests.
9. Study of the performance of wound Rotor induction motor under load.

Study of the performance of three-phase Squirrel-Cage induction Motor-Determination of Iron-Loss, Friction & Windage Losses.

DIGITAL ELECTRONICS &INTEGRATED CIRCUITS LAB.

Code : EC 492
Contacts : 3P
Credits : 2

1. Realization of basic gates using Universal logic gates.
2. Code conversion circuits-BCD to Excess-3 & Vice-versa.
3. 4-bit parity generator & comparator circuits.
4. Construction of simple Decoder & Multiplexed circuits using logic gates.
5. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexed.
6. Construction of simple arithmetic circuits-Adder, Subtractor.
7. Realization of RS-JK & D flip-flops using Universal logic gates.
8. Realization of Universal Register using JK flip-flops & logic gates.
9. Realization of Universal Register using multiplexed & flip-flops.
10. Construction of Adder circuit using Shift Register & full Adder.
11. Realization of Asynchronous Up/Down counter.
12. Realization of Synchronous Up/Down counter.
13. Design of Sequential Counter with irregular sequences.
14. Realization of Ring counter & Johnson's counter.
15. Construction of adder circuit using shifts Register & full Adder.

HU 481: Technical Report writing & / Language Practice Laboratory

Power Engineering Syllabus

Contacts: 3S
Credits: 2

Topics to be covered and number of hours required for it:

Introductory lecture is to be given to the students so that they get a clear idea of the syllabus and understand the need for having such a practice lab in the first place(3 hours).
Conversation practice is done on given situation topics. The students are also made to listen to pre-recorded cassettes produced by British Council and also by the Universities of Oxford and Cambridge (6 hours)
Group Discussions:- The students are made to understand the difference between the language of conversation and group discussion. Strategies of such discussions are to be taught to them. It is also helpful to use videocassettes produced by the U.G.C. on topics like group-discussion. Afterwards the class is divided into groups and the students have to discuss on given topics on current socio-economic-political-educational importance(12 hours)
Interview sessions : students are taught the do's and don'ts of facing a successful interview. They then have to face rigorous practices of mock-interviews. There would be simulations of real life interview sessions where students have to face an interview panel(12 hours)
Presentations: The secrets of an effective presentation are taught to the students. Then each and every student has to make lab presentations with the help of the overhead projector/ using power point presentation and other audio-visual aids in the laboratory. They also have to face the question answer sessions at the end of their presentation (12 hours)
Classes are also allotted to prepare the students for competitive examinations like the TOEFL by making the students listen to specially produced CD/ cassettes of such examinations (3 hours)

The overall aim of this course is to inculcate a sense of confidence in the students and help them to become good communicators in their social as well as professional lives.

References:

1. Business Correspondence & Report Writing by R.C. Sharma and K.Mohan, TMH
2. How to prepare for Group Discussion & Interview (With Audio Cassette) by Prasad, TMH
3. Spoken English – A self-learning guide to conversation practice (with Cassette) by Sasikumar, TMH

Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE(ER)
CITY CENTRE; DURGAPUR-16

COURSE STRUCTURE IN POWER ENGINEERING

FIFTH SEMESTER

PWE 501 : Renewable Energy Systems
Contacts : 3L
Credits : 3

1. INTRODUCTION (3)

Energy demand growth and supply : Historical Perspectives ; Fossil fuels: Consumption and Reserve ; Environmental Impacts of Burning of Fossil fuels ; Sustainable Development and Role of Renewable Energy Sources.

2. SOLAR ENERGY (2)

The Sun as energy source and its movement in the sky ; Solar Energy received on the Earth ; Primary and Secondary Solar energy and Utilization of Solar Energy. Characteristic advantages and disadvantages.

3. SOLAR THERMAL ELECTRICITY GENERATION (4)

Solar concentrators and tracking ; Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants ; Solar Ponds.

4. SOLAR PHOTOVOLTAIC SYSTEMS (6)

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 ouline of solar PV stand-alone system design ; Storage and Balance of system.

5. WIND ELECTRICITY GENERATION (6)

Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Windfarms for bulk power supply to grid; Potential of wind electricity generation in India and its current growth rate.

6. BIOMASS ENERGY (5)

Biomass: Sources and Characteristics; Wet biogas plants ; Biomass gasifiers: Classification and Operating characteristics ; Updraft and Downdraft gasifiers ; Gasifier based electricity generating systems ; Maintenance of gasifiers.

7. OCEAN ENERGY (4)

Tidal power plants : single basin and two basis plants, Variation in generation level ; Ocean Thermal Electricity Conversion (OTEC) ; Electricity generation from Waves : Shoreline and Floating wave systems.

8. GEOTHERMAL ENERGY (2)

Geothermal sites in India ; High temperature and Low temperature sites ; Conversion technologies- Steam and Binary systems ; Geothermal power plants.

9. GRID INTERCONNECTION (3)

General nature of renewable energy sources and variation in availability; Impact on grid ;
Allowable grid penetration in preserving reliability of supply ; Stand-alone systems ; Storage of electricity for autonomous supply ; Examples of design of remote supply systems.

REFERENCES (in additon to the list printed)

1. 'Our Common Future', Report of the World Commission on Environment & Development.Oxford University Press, NY, 1987.

2. John W. Twidell & Anthony D.Weir, 'Renewable Energy Resources'

3. Geofrey Boyle, ' Renewable Energy: Power for a Sustainable Future', OUP in assn with Open University, 1996.

Power Engineering Syllabus

Power Engineering Syllabus

PWE 502 : Hydro – Power Generation

Contacts : 3L
Credits : 3

Introduction, Potential of hydropower in India- its development and future prospect. General hydrology-hydrological cycle, precipitation, run-off and its measurement, hydrography, unit hydrograph, flow duration and mass curve. Site investigations. 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; Power – house structure.

Selection of prime mover, speed and pressure regulation, methods of governing, starting and stopping of water turbines, operation of hydro turbines. Machine loading and frequency control, Maintenance of hydropower plants

Suggested Text Books & References:

- Jagdish Lal, " Hydraulic Machines", Metropolitan book company(P) ltd.
- Modi , P.N., & Seth, S.M.,"Hydraulic & Fluid mechanics including Hydraulic
  Machines", Standard Book House .
- Guthrie Brown,"Hydroelectric Engg. Practice",2nd ed.(in 3 vols.)
  Vol. I : Civil Engineering
  Vol.II : Mechanical & Electrical Engg.
  Vol III : Economics, Operation , Maintenance
- Hydro Power an Indian Perspective
  Author-Cum-Editor Dr. B.S.K. Naidu , Director General , NPTI.
- Hydro –Electric and Pump storage Plants – MG Jog , Wiley Eastern Limited.
- Micro Hydroelectric Power Stations – By L.Monition, Power Ststions- By L.Monition , Mle Nir, J.Roux translated by Joan Mc Mullan, John Wiley & Sons.
- Hydro Power by Professor Dr. Ing. Joachim Raable VDI- Verlag Gmbtt.
- Hydro Power Plant Familarisation, NPTI Publication.

Power Engineering Syllabus

PWE 503 : Nuclear Power Generation

Contacts : 3L
Credits : 3

Introduction to Nuclear Engineering:
Introduction, Why Nuclear Power for Developing Countries, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction, types of Nuclear Reactions, Initiation of Nuclear Reaction, Nuclear Cross – section, Nuclear Fission, The Fission Chain Reaction, moderation, Fertile Materials and Breeding.

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) Type 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 Nuclear Plants with Thermal Plants.

Nuclear Materials:
Introduction, Fuels, Cladding and Structural Materials Coolants, Moderating and Reflecting Materials, Control Rod Materials, Shielding Materials.

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

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

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 .

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.

Power Engineering Syllabus

ELECTRICAL MACHINES-II

CODE : PWE 504
CONTACTS : 3L + 1T
CREDITS : 4

SYNCHRONOUS MACHINES - CONSTRUCTION, PRINCIPLE OF WORKING, EXCITATION , PHASOR DIAGRAMS, SYNCHRONOUS REACTANCE , VOLTAGE REGULATION, DETERMINATION OF REGULATION BY DIFFERENT METHODS, TWO REACTION THEORY, PHASOR DIAGRAM OF SALIENT POLE MACHINES, POWER ANGLE CHARACTERISTICES, TRANSIENT ANALYSIS, SUDDEN SHORT CIRCUIT, LOADING & LOAD REJECTION, PARAMETER ESTIMATION, TRANSIENT REACTANCES , SYNCHRONIZING , SYNCHRONIZING POWER AND TORQUE, PARALLEL OPERATION, V-CURVES, STARTING OF SYNCHRONOUS MOTORS , HUNTING,DAMPER WINDING , APPLICATIONS.

SINGLE PHASE INDUCTION MOTOR: CONSTRUCTION, DOUBLE REVOLVING FIELD THEORY & CROSS FIELD THEORY, STARTING METHODS, SPEED- TORQUE CHARACTERISTICS, PHASOR DIAGRAM & CONDITION FOR MAXIMUM TORQUE, DETERMINATION OF EQUIVALENT CIRCUIT PARAMETERS, APPLICATIONS.

PARALLEL OPERATION OF ALTERNATORS, SYNCHRONOUS MACHINES CONNECTED TO INFINITE BUS – BAR, STARTING OF SYNCHRONOUS MOTORS, V- CURVES, TORQUE ANGLE CHARACTERISTICS, HUNTING.

SPECIAL ELECTRICAL MACHINE:
SWITCHED RELUCTANCE MOTOR, PERMANENT MAGNET MACHINES. STEPPER MOTOR, HYSTERESIS MOTOR, SUB FRACTIONAL ELECTRICAL MACHINES.

BOOKS :

- Bimbhra P.S.: Electrical Machinery; Khanna Pub
- Nagrath I.J. & Kothari D.P. : Electric Machines, TMH
- Mukherjee P K & Chakraborty S : Electrical Machines ; Dhanpat Rai Pub.
- Sen S K : Electrical Machines ; Khanna Pub.
- Clayton A.E. & Hancock N N : Performance & Design of Direct Current Machines, CBS Pub. & Distributors;
- Parker Smith- Problems in Electrical Engg; - CBS Pub & Distributors.
- Say M G : Performances & Design of A.C. Mechines; CBS Publishers & Distributors.
- Gupta: Fundamentals of Electrical Machines, New Age International
- Bhattacharya: Control of Electrical Machines, New Age International
- Bhattacharya: Experiments in Basic Elect Engg, New Age International

- Athani: Stepper Motors

Heat Transfer

ME 502 :
Contacts : 3L + 1T
Credits : 4

Introduction: modes of heat transfer.
Conduction: Fourier law of heat conduction for isotropic material. Thermal conductivity. Derivation of the energy equation in three dimensions including transient effect. Nondimensional - thermal diffusivity and Fourier number. Types of boundary conditions (Dirchlet, Neumann, mixed type). One-dimensional solution with and without heat generation. Analogy with electrical circuits.
Fins, rectangular and pin fins. Fin effectiveness and efficiency.
Critical thickness of insulation.
Lumped parameter approach and physical significance of time constant, Biot number, Validity of lumped parameter approach. Introduction to Heissler Chart.
Numerical methods for heat conduction.
Radiation: Physical mechanism of thermal radiation, laws of radiation, definition of black body, emissive power, intensity of radiation, emissivity, reflectivity, transmittivity, irradiation, radiosity.
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.
Convection: Introduction, Newton's law of cooling and significance of the heat transfer coefficient.
Momentum and energy equations in two dimensions, nondimensionalisation, importance of nondimensional quantities and their physical significance. Order of magnitude analysis for flow over a flat plate. Velocity and thermal boundary layer thickness by integral method. Analogies between momentum, heat and mass transfer. Natural convection, effect of coupling on the conservation equations, vertical flat plate (concept and correlations)
One-dimensional solution for Couette flow and Poisullie flow.
Concept of developing and developed flow.
Introduction to the concept of similarity.
Heat exchangers: Types of heat exchangers, parallel and counter flow types, Introduction to LMTD. Correction factors, fouling factor. E-NTU method for heat exchangers.

References:

1. Fundamentals of Heat and Mass Transfer by F.P.Incropera and D.P.Dewitt, 4th ed., John Wiley & Sons

2. Principles of Heat Transfer, Kreith, ASIAN BOOKS/THOMPSON
3. Heat Transfer by J.P.Holman, 8th ed., and McGraw hill.
4. Elements of Heat & Mass Transfer by Vijay Gupta, 2nd ed., New Age International Publishers.
5. Heat Transfer - A Basic Approach by M.N.Ozisik, McGraw hill.

Microprocessor and Microcontrollers
Code: EI 502
Contacts: 3L + 1T
Credits:4

Introduction to 8085A CPU architecture-register organization, addressing modes and their features. Software instruction set and Assembly Language Programming. Pin description and features.

Instruction cycle, machine cycle, Timing diagram.

Hardware Interfacing: Interfacing memory, peripheral chips (IO mapped IO & Memory mapped IO).

Interrupts and DMA.

Peripherals: 8279, 8255, 8251, 8253, 8237, 8259, A/D and D/A converters and interfacing of the same.

Typical applications of a microprocessor.

16 bit processors: 8086 and architecture, segmented memory has cycles, read/write cycle in min/max mode. Reset operation, wait state, Halt state, Hold state, Lock operation, interrupt processing. Addressing modes and their features. Software instruction set (including specific instructions like string instructions, repeat, segment override, lock prefizers and their use) and Assembly Language programming with the same.

Brief overview of some other microprocessors (eg. 6800 Microprocessor).

References:

1. Microprocessor architecture, 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 publications, 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.

6. Microprocessors and Interfacing by Douglas V. Hall, McGraw Hill International Ed. 1992
7. Assembly Language Programming the IBM PC by Alan R. Miller, Subex Inc, 1987
8. The Intel Microprocessors: 8086/8088, 80186, 80286, 80386 & 80486, Bary B. Brey, Prentice Hall, India 1996.

ELECTRICAL MACHINES LAB-II

Code :PWE 594
Contacts : 3 P
Credit : 2

LIST OF EXPERIMENTS :

1) DIFFERENT METHOD OF STARTING OF 3 PHI SQ.CAGE INDUCTION MOTOR & THEIR COMPARISON [D.O.L,AUTO TRANFORMER & STAR-DELTA].
2) SPEED CONTROL OF 3 PHI SQUIRREL – CAGE INDUCTION MOTOR BY DIFFERENT METHODS & THEIR COMPARISON[VOLTAGE CONTROL & FREQUENCY CONTROL].
3) DETERMINATION OF REGULATION OF AN ALTERNATOR BY SYNCHRONOUS IMPEDENCE METHOD.
4) DETERMINATION OF MAGNETISATION CHARACTERISTICS OF AN ALTERNATOR . a) at no – load rated speed b) at no- load half rated speed c) at full load (non inductive load) rated speed.
5) Load test on 1 phi induction motor & deriving its performance characteristics.
6) Study of various connections of 6- coil alternator & its operation at no – load.
7) To determine the direct axis reactance [X_d] & quadrature axis reactance [X_q]
8) Load test on a wound rotor induction motor & deriving its performance characteristics.
9) Determination of equivalent circuit parameters of a 1 phi induction motor.
10) To make connection diagram of full pitch & fractional slot winding of a 18 slot sq. cage induction motor for 6 pole & 4 pole operation.

Power Engineering Syllabus

Microprocessor and Micro-controller Lab
Code: EI 592
Contacts: 3P
Credits: 2

Sl. No.	Name of the Experiments	*No. Of hours*
1.	Familiarization with 8085 register level architecture and trainer kit components, including the memory map. Familiarization with the process of storing and viewing the contents of memory as well as registers.	**3**
2.	a) Study of prewritten programs on trainer kit using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical) Assignments based on above.	**3**
3.	a) Familiarization with 8085 simulator on PC. b) Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the simulator. Assignments based on above	**3**
4.	**Programming using kit/simulator for** i) table look up ii) Copying a block of memory iii) Shifting a block of memory iv) Packing and unpacking of BCD numbers v) Addition of BCD numbers vi) Binary to ASCII conversion vii) String Matching Multiplication using Booth's Algorithm	**9**
5.	Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit eg, subroutine for delay, reading switch state & glowing LEDs accordingly, finding out the frequency of a pulse train etc	**3**
6.	Interfacing any 8-bit Latch (eg, 74LS373) with trainer kit as a peripheral mapped output port with absolute address decoding	**3**
7.	**Interfacing with I/O modules:** a) ADC b) Speed control of mini DC motor using DAC c) Keyboard d) Multi-digit Display with multiplexing Stepper motor	**12**
8.	Writing programs for 'Wait Loop (busy waiting)' and ISR for vectored interrupts (eg, counting number of pulses within specified time period)	**3**
9.	**Study of 8051 Micro controller kit and writing programs for the following tasks using the kit** a) Table look up b) Basic arithmetic and logical operations c) Interfacing of Keyboard and stepper motor	**6**

10. Familiarization with EPROM programming and Erasing 3

Heat Transfer Lab.

ME 582 :

Contacts : 3
Credits : 2

1. Thermal Conductivity of Metal Bar.
2. Heat Transfer in Forced Convection.
3. Heat Transfer in Natural Convection.
4. Hear Transfer from Pin Fin.
5. Emmissivity Measurement Apparatus.
6. Critical Heat Flux Apparatus.
7. Parallel Flow / Counter Flow Heat Exchanger.

ME 583 : Fluid Machinery Laboratory

Contacts : 3P
Credits : 2

Experiments on Fluid Machinery:
Pumps, Reciprocating pumps, Blowers, Compressors.

Experiments on Turbines:
Francis and Pelton turbines, governing of turbines.

Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE (ER)
CITY CENTRE;DURGAPUR-16
COURSE STRUCTURE IN POWER ENGG.

6TH SEMESTER

Steam Generators and its Auxiliaries
Paper Code : PWE - 601
Contact : 4 L
Credit : 4

Introduction:
- Site Selection and Location of Steam Power Plant.
- Layout of Thermal Power Plant.
- Load duration curves
- Power Plant Economics
- Rankine Cycle with Re-heating and Re-generative Feed Heating.

Fuel:
- Types of Coal and their Characteristics, Coal Analysis.
- Fuel Oil and Natural Petrol Gas
- Industrial Waste and Bi-Product
- Bio-mass

Fuel Handling Systems
- **Coal and Oil Handling Plant Layout in T.P.S. and description, functions of the equipments used, Handling, Storage, Fuel Preparation.**
  Combustion Mechanism, Combustion Equipment and Firing Methods.
- Kinetics of Combustion Reactions
- Mechanism of Solid Fuel Combustion
- Kinetic and Diffusion Control
- Combustion Equipment for Burning Coal with a special emphasis to coal feeders & Coal Mills.
- Fuel Bed Combustion
- Mechanical Stokers
- Pulverized Coal Firing System
- Cyclone Furnace

Steam Generators
- Description of Main Boiler: Classification and Types of Steam Generators, Fundamentals of Boilers design.

Power Engineering Syllabus

- Constructional details including steam water circuit of high pressure and high capacity water tube boilers, Economizers, Super-heaters, De-Superheater, Re-heaters
- Boiler Circulation Theory: Boiler Drum & its Internals, Boiler Mountings.
  Feed water treatment.
- Air Pre-heater: Types and functions, Constructional details, SCAPH, Soot Blower.
- Draft System: Theory of Natural, Induced, Forced and Balance Draft, Constructional details /
  Lubricating Oil System for PA Fan, FD Fan, ID Fan etc. Layout.
- Electrostatic Precipitator: Basic working principle and constructional details of Electrostatic
  Precipitator. Corona effect, Rapping Mechanism.
- Ash handling system: Bottom ash, Fly ash, System Layout, equipment description, Ash disposal
  and utilization.
- Audio Visual Session: CBT
  Furnace Safeguard Supervisory System (FSSS) (Non E & I)

Suggested Text Books & References:

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.

Power Engineering Syllabus

Steam Turbine and its Auxiliaries.
Paper Code : PWE - 602
Contact : 3
Credit : 3

- Flow through nozzles: Flow in Steam Nozzles, Nozzle types, Flow area of nozzle, Nozzles operating in the off design condition, super saturated flow.
- Steam Turbine: Classification of Turbines, Metallurgical Consideration, Working Principles, Description of main components i.e. Turbine Casing, Rotor, Blades, Steam admission Valves, Couplings, Bearing, Barring Gear, Turbine Velocity Diagrams, Diagram work and diagram efficiency.
- Turbine Lubrication Oil System: Construction and working principles of main oil pumps, starting oil pumps, AC, DC Oil pumps, Oil coolers, Centrifuge.
- Turbine Gland Sealing System: Layout and description.
- Steam Condensation and Condensers: Film wise / drop wise condensation, vacuum creation, condenser types and working principles, constructional details, design calculation.
- C.W. System & Cooling Towers: CW Open and Closed System, CW pumps, Cooling Towers, CT Fans, Calculation.
- Regenerative Feed Heating System: Description and Layout system, Working Principles and constructional details of L P Heaters, HP Heaters, Deaerator, GSC, Ejector. Drip drain system, Regenerative Rankine Cyle with calculations.
- Turbine House Pumps & Compressor: Constructional details and working principles of condensate extraction pump, Boiler feed pump, clarified water pump, HP & LP Dozing pump, PA & IA Compressors with drier.
- Turbine Governing System: Types of Governing System, various components, systems and their functions, oil circuit for Governing System, overall working of Governing System with reference to load throw off and load raising.

HP / LP Bypass System and PRDS: HP / LP bypass circuit and its utility, working principles and layout of PRDS

- Audio Visual Session: CBT

Suggested Text Books & References:

1. Rajmohan Gupta, “Steam Turbine”, Oxford & IBH Publishing Co. Pvt. Ltd.
2. P. K. Nag, “Power Plant Engineering”, Tata McGraw Hill Publications.
3. R. Yadav, “Steam Turbine”, Khanna Publishers.
4. “Modern Power Station Practice” Volume C, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991.

5. “Steam Turbine and its Auxiliaries”, Manufacturer’s Power Plant Manual.
6. Power Plant Familiarisation – Vol. III, NPTI Publication.
7. M. M. Vakil, “ Power Plant Technology”

Power Engineering Syllabus

Electrical Equipment in Power Station.

Paper Code : PWE - 603
Contact : 3 L
Credit : 3

Generator Constructional Details: Basic principle of electricity generation, Development of generator design, Constructional details of rotor, stator etc.

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.

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.

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.

Transformers: Various types of transformers used in a power station, Constructional features of main transformer and accessories, Bucholtz relay and main protections, Types of cooling, Mulsifire and other fire protection systems.

Audio/Visual/Discussion Session:

Motors: Constructional details of HT/LT motors, Various motors used in Power Stations.

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.

Switchyard: A typical layout of Switchyard of a Thermal Power Station, Bus system, Isolators, CTs, PTs, Earthing, Oil Circuit Breakers, Air Blast Circuit Breakers, SF_6 Circuit Breakers, Vacuum Circuit Breakers.

Audio / Visual Session: – Computer based Training

Suggested Text Books & References:

1. 'Modern Power Station Practice", Volume C&D, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991.
2. Deshpande, M.V. "Elements of Electric Power Station Design", A.H. Wheeler and Company, Allahabad, 1979.
3. Power Plant Familiarisation – Vol. IV, NPTI Publication.

Power Plant Electrical Machines & Systems, Manufacturer's Power Plant Manual.

Power Engineering Syllabus

Power Transmission and Distribution
Paper Code : PWE - 604
Contact : 3 L
Credit : 3

Power System Operation Overview and Supporting Standards:

Introduction to electrical Power System
Transmission Lines
Transformers
Substations
Loads (the Reason all the preceding exists)
Ancillaries (Reactors, Capacitors etc.)
Related Standards that Apply to the above

Transmission and distribution system :

Standard voltages for transmission
Substations and Feeders
Distributors & Service mains

Overhead transmission lines:

Basic Design considerations of Lines & towers
Tower design
Substation Design
Sag calculation in conductors

a) Suspended on level supports
b) Supports at different levels
c) Effect of wind and ice tension and sag at erection, Stringing chart

Line parameters:

Calculation of inductance of single phase, three phase lines with equilateral and unsymmetrical spacing.
Inductance of composite – conductor lines
Capacitance – Calculation for two wires and three phase lines, capacitance calculation for two wires 3 phase lines with equilateral and unsymmetrical spacing.

Characteristics and performance of power transmission lines:

Short transmission lines
Medium transmission lines
Nominal T and Π representation of long lines, equivalent T and Π network representation of long transmission line, Power flow through a transmission line,
P-F and Q-V coupling

Insulators:

Types, potential distribution over a string of suspension insulators
String efficiency and methods of increasing string efficiency and methods of increasing string efficiency, testing of insulators

Underground Cables:

Types, material used, Insulation resistance
Thermal rating of cables, charging current
Grading of cables, capacitance grading and inter sheath grading, testing of cables.

Substation Equipment:

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

Substations, Principals of Operation

Types of Substations & Substation Design
Switching Configurations
High Voltage Switching Equipment
Grounding and Lightning Protection

Analysis Tools

An Introduction to Symmetrical Components for Power System Analysis
The Per-Unit System
Power flow analysis
Fault Analysis in Power Systems

Distribution

Design of sub transmission lines and distribution substation
Voltages drop and power loss calculation
Distribution system voltage regulation
Demand side management, metering, Customer relations
Distribution system automation

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.Wadhera, "Electrical Power Systems" Willey Eastern Ltd., 1983
6. K.R. Padiyar, "HVDC Power System Transmission Systems", New Age International (P) Ltd. 1990
7. S. Rao, "EHV AC, HVDC Transmission and Distribution Engineering", Khanna Publishers
8. "Power System" by Strevenson by Prentice Hall
9. "Naidu and Kamaraju, "High Voltage Engineering" Tata McGraw Hill

10. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", Willey Eastern Ltd. 1986

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 Engineering Syllabus

Control Systems

Paper Code : PWE 605
Contacts : 3L
Credit : 3

- **Introduction to control systems**
  3

Introduction ; Examples of control systems ; Elements of automatic (feedback) control system ; Application of control engineering; Feedback Characteristics of Control Systems.

- **Mathematical modeling of physical systems**
  3

Modeling of electrical, mechanical and thermal systems ; Transfer functions ; Block diagram algebra ; Signal flow graph ; Mason's Gain formula.

- **Control systems and components**

Electrical, mechanical and electromechanical components.

- **Time-Response Analysis**
  6

Introduction ; standard test signals ; types of systems ; transient response of first, second and higher order systems ; different specifications ; steady state error constants ; MATLAB based examples.

- **Basic Control Actions and Concept of different controllers**

3
Introduction ; Basic control actions ; P, PI, PD and PID controllers.

- **Concepts of Stability and Algebraic Criteria**

2

Concept of stability ; Characteristic equation ; Necessary controls for stability ; Routh-Hurwitz stability criterion.

- **Root-Locus Analysis**

5

Introduction ; Concept of root-locus ; general rules for constructing rot-loci ; Important properties ; Parameter design by root-locus method ; MATLAB based design examples.

- **Frequency-Response Analysis and Stability Studies in Frequency Domain**

10

Introduction ; Correlation between time and frequency response ; Polar Plots ; Nyquist Stability Criterion ; Stability analysis in frequency domain ; Relative stability ; Closed-lop frequency response ; MATLAB examples ; Bode Plots

- **Design and Compensation Technique**

5

Introduction to control system design by classical method using Lead, Lag, Lead-lag compensation in frequency domain and s-domain ; MATLAB examples.

- **State variable Analysis and Design**

6

Concept of state ; state variables and state model ; state models of linear continuous-time systems (electrical, mechanical, electromechanical, thermal system) ; State transition matrix ; Controllability and observability ; MATLAB examples.

Recommended Text Books:

01. Nagrath I J & Gopal M : Control System Engineering --- --- --- New Age International
02. Ogata K : Modern Control Engineering --- --- --- PHI / Pearson Education
03. Kuo B C : Automatic Control System --- --- --- Oxford University Press
04. Dasgupta S : Control System Theory --- --- --- Khanna Publishers

Recommended Reference Books:

01. Sinha : Control Systems --- --- --- New Age International
02. Gopal M : Control Systems – Principles & Design --- --- --- TMH
03. Bolton : Industrial Control & Instrumentation --- --- --- Orient Longman
04. Jain N K : A course in Automatic Control System Engineering --- --- Dhanpat Rai & Sons

Power Engineering Syllabus

REFRIGERATION & AIR CONDITIONING
Paper Code : PWE – 606A
Contact : 3L
Credit : 3

Introduction: Necessity: Methods of refrigeration: Unit of refrigeration: Coefficient of performance (COP): Fundamentals of air conditioning system: Refrigerants Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants. Introduction to eco-friendly refrigerants: Introduction to Cryogenics.

Air Refrigeration Systems: Carnot refrigeration cycle. Temp. Limitations: Brayton refrigeration of the Bell Coleman air refrigeration cycle: Necessity of cooling the aero plane. Air craft refrigeration system – Simple cooling evaporative types, Boot strap evaporative types. Regenerative type and Reduced Ambient type systems, Comparison of different systems, Problems.

Vapour Compression (VC) Refrigeration System: Simple VC Refrigeration Systems – Limitations of Reversed Car not cycle with vapour as the refrigerant, Analysis of V.C. Cycle considering degrees of sub cooling and super heating, VC cycle on p-v., T-s. and p-h. Diagrams, Comparison of VC cycle with Air Refrigeration cycle, Concepts of Multi-Stage Refrigeration Systems.

Vapour Absorption Refrigeration System: Basic Systems, Actual Systems, COP of the System Performance, Relative merits and demerits: Properties of aqua ammonia: Electrolux Refrigerator, Problems; Concepts of Steam Jet Refrigeration System and Cascade Refrigeration Systems.

Psychrometry & Air Conditioning Process: Properties of moist Air Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp. Thermodynamic wet bulb temp., Psychometrics chart, Psychrometry of air conditioning processes, Mixing Process, Basic Processes in air conditioning of air, Psychrometric processes in air washer problems.

Suggested Text Books & References:

1. C.P. Arora, “Refrigeration & Air Conditioning”, Tata McGraw Hill Publication.
2. R.C. Jordand & G.B. Prister, “Refrigeration & Air Conditioning”, Prentice Hall of India Publication.
3. W.F. Stocker & J.W. Jones, “Refrigeration & Air Conditioning”, Tata McGraw Hill Publication.
4. Dr. Manohar Prasad, “Refrigeration & Air Conditioning”, Wiley Eastern.
5. S. Domkundwar, “A Course in Refrigeration & Air Conditioning”, Dhanpat Rai & Sons.

Power Engineering Syllabus

HIGH VOLTAGE ENGINEERING

Paper Code : PWE 606B
Contacts : 3L
Credits : 3

- **Breakdown in Gases**
  6L

  Insulation materials Classification, Gases as insulating media, ionization and decay process, Breakdown in gases, Townsend's law, Streamer mechanism of spark Paschen's Law , Corona discharge, Electronegative gases.

- **Breakdown in Liquid and Solid Dielectrics**
  6L

  Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, High voltage bushings, Guarding, Shielding, Field plotting.

- **System Overvoltages**
  8L

  Occurrence and characteristics ; electrostatic fields and voltage distribution across insulators. Traveling wave phenomena, Bewley lattice diagrams; wave tables , switching and lightning overvoltages . Attenuation and distortion of surges; overvoltage protection devices; rod and expulsion gaps; surge diverters. Power frequency overvoltage and harmonics; neutral earthing of power systems.
  Insulation coordination Insulation design of EHV lines, basic insulation level, surge diverters and arresters. Insulation co-ordination of HV and EHV power system and substation equipment.

- **Generation of High Voltage and Current**
  4L

  Generation of high d.c, a.c and impulse voltages, Standard impulse wave shapes, Switching surges, single and multi-stage impulse generators, tripping and control of impulse generators.
  High voltage DC: Rectifier circuits, voltage multipliers , Van-de-Graaf and electrostatic generators.
  High voltage AC: Cascaded transformers and Tesla coils.

- **High Voltage and Current Measurement**
  4L

Peak voltage, Impulse voltage and High direct current measurement methods, Non-destructive measurement and testing , High voltage dielectrics loss and capacitance measurement , Radio frequency and partial discharge measurement.

- **High Voltage Testing 4L**

  Basic terminology, Testing of Insulators, Bushings, Cables, Transformers, Surge diverters and isolators.

- **Circuit Breakers 8L**

  General principle of operation , fundamentals of fault clearing and C.B. ratings. Arc interruption theory and processes . Overview of various types of circuit breakers and their applications-Air circuit breakers, Air Blasé circuit breakers, Vacuum circuit breakers and SF_6 circuit breakers. Restricting recovery voltages. Recent developments in circuit breakers. Short circuit testing of circuit breakers, insulation requirements and high voltage testing of circuit breakers , insulation requirements and high voltage testing of circuit breakers.

Recommended Books :

- Gallagher T J and Pearmain A J , High Voltage Measurement Testing and Design, Wiley.
- E.Kuffel and M. Abdullah- High Voltage Engineering Pergamon Press
- M.S.Naidu and V.Kamraju – High Voltage Engineering , Tata McGraw Hill Publishing Company, New Delhi.
- Switchgear & Protection – S.S. Rao , Khanna Publishers
- M.S. Naidu and V.N.Maller – SF_6 and Vaccum Insulation for High Voltage Application , Khanna Publications ,Delhi

Combustion Lab
Code : PWE 697
Contacts : 3/2

Credits :2

- Determination of Hardgrove Grindability Index (HGI) of Coal.
- Determination of Calorific value by Bomb Calorimeter.
- Proximate Analysis of Coal – Determination of fixed Carbon, Volatile matter, Moisture and ash in a Coal sample.
- Determination of flash point of liquid fuel using Abel flash point apparatus.
- Determination of flash point of fuel using Pensky Marten Flash point apparatus.

Seminar
Code : PWE 686
Contacts : 3P
Credits : 2

Seminar – Related to Power Engineering .

Study of Power Plant Schemes (Mech.)
Code : PWE 687
Contacts : 3P
Credits :2

- Layout of coal to electricity.
- Fuel handling systems:

  Layout and equipments used in coal handling plant (unloading, conveying, stocking, crushing, transferring RCB etc.)

  Layout and equipments used in LDO & FO plant (unloading, storage, transferring, heating, pumping etc.)
- Steam and water circuit in 110MW / 210MW Boiler including boiler drum connections.(Feed water flow through economizer, water walls , saturated steam flow through superheater, reheater).
- Boiler Draft Systems:

  Layout and description of FD, ID, PA Fans including seal air, scanner air fans, flue gas path , Air pre-heated , ESP .
- Coal Milling System :

  Layout and description of raw coal feeder , Coal Mill with connections , sealing systems , hot and cold air arrangement, Bottom and Fly Ash disposal system .
- C.W. Systems :

Layout and description of intake pump , Clarifloculator, filtration , CW Pump , condenser and cooling tower arrangements .

- Regenerative feed heating systems :

  Layout and description of CEP, steam ejectors, gland steam coolers , HP & LP heaters , De-aerator, BFP & Feed Control Station.

- Steam Turbine :

  Layout and description of turbine. HP, IP and LP cylinders with connections.

  Turbine lubrication oil and gland sealing systems. HP,LP by-pass systems.

Study of Power Plant and T & D Schemes (Elect.)
Code : PWE 688
Contacts : 3
Credits :2

- Layout and description of Generator and excitation system, AVR, CT, PT etc.
- Layout and description of Generator seal oil and hydrogen gas systems.

  Generator stator cooling water systems.
- Layout and description of 20KV switch yard.

  Generator Transformer, station Transformer, Main and Transfer bus, bus coupler, circuit breaker, Isolator, Lightning arrestor etc.
- Layout and description of 6.6 KV – 415V supply systems.

  Unit Aux. Transformer, Circuit breaker bay, MCC Pannel, D.C. and UPS.

EHV 400 KV Substations-
Incoming lines, outgoing lines, Towers, Gantry, Bus reactor, Series Capacitors, Wave Trap, Bus Bar Scheme, LA, Lightning mast, ICT, CT, PT, Circuit Breakers, Isolators etc.

SCADA System-
RTUs (Remote Terminal Units), Communication Front End, Sub Load Despatch centre, Regional Load dispatch Centre, National Load Dispatch centre etc.

33/11 KV Sub-Station-
Incoming Feeder, Distribution Transformers, outgoing Feeders, Poles, Conductor, Insulators, Vibration Dampers etc.

Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE (ER)
CITY CENTRE; DURGAPUR-16
COURSE STRUCTURE IN POWER ENGG.

7TH SEMESTER

Power Engineering Syllabus

Advanced Power Generation Technology

Paper Code : PWE 701
Contacts : 3L
Credit : 3

- Gas Turbine (GT) Power plants: Closed cycle and open cycle plants ; Analysis of a Gas Turbine plant; optimum pressure ratio, regeneration , reheating , intercooling ; Performance; Components of Gas Turbine plant- compressor, combustion chamber , Turbine ; Gas turbine materials. (6)

- Combined Cycle (CC) Power Plants: Limitations of steam turbine (ST) and gas turbine (GT) power plants; Thermodynamics of multifluid coupled cycles ; Combined Brayton and Rankine Cycle and GT-ST plants; Advantages of CC plants; Effect of supplementary heating ; Gas-based CC plants- choices of GT and ST plants; Coal based CC plants-PFBC and IGCC plants ; STIG and Repowering ; Environmental impact ; Scope of CC plants. (10)

- Futuristic Technologies : Fuel Cells ; MHD-steam plant ; Thermoelectric – steam plant : Thermionic steam plant. (4)

- Fluidized Bed Technology : Theory of fluidization – regimes, packed bed, bubbling bed , turbulent bed and fast bed ; Terminal Velocity and elutriation ; Hydrodynamics and heat transfer ; Combustion in fluidized beds ; Pressurized fluidized beds ; Coal gasifiers ; IGCC plants ; Fluidized bed boilers – bubbling bed and circulating bed boilers ; Cyclone separators ; Pressurized fluid bed boilers ; Advantages and scope of CFB boilers. (12)
- 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. (8)

Recommended Books :

- V.Ganeshan: Gas Turbines; Tata McGraw Hill Publishing Co. Ltd. New Delhi,2003.
- P.K.Nag, Power Plant Engineering; TMH Publishing Co. Ltd., New Delhi,2001.
- Circulating Fluidized Bed Boilers – Dr. Prabir Basu & Scot Fraser, Butterworth, Canada / USA,1991

Power Engineering Syllabus

Protection & Instrumentation

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

Protections

- Review of power system protection and various protective relays (1)
- 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. (2)
- Different internal connection diagrams of Directional over current relay, Maximum torque angle . (2)
- Feeder protection by time graded / current graded system / time current graded system , parallel feeder protection . (2)
- Transmission line protection – Impedance , Reactance and Mho relays, power swings , carrier current protection . (3)
- Over voltage relays , Under frequency relays. Static relays (1)
- Generator Protection – Differential relays, Unbalanced loading by negative sequence relays , overheating protection , loss of excitation , protection against interturn faults. Examples . (4)
- Transformer protection – Biased Differential relays for Y-Y , Y-Δ , Δ - Y and Δ - Δ connected transformers, Harmonic restraint relay , Buchholtz relays, Examples. (4)
- Bus bar protection – Bus bar differential relay . (1)
- Motor Protection – Different schemes . (2)

Instrumentations

- Concept and layout of Control and Instrumentation in Thermal Power Plant
- Pressure Measurement and measuring instruments
- Temperature Measurement and measuring Instruments
- Flow measurement and measuring instruments
- Level measurement and measuring instruments

Power Engineering Syllabus

- Introduction to auto control
- Auto control loops used in thermal power stations
- Turbo supervisory instrumentation (Parameters limits, Basic concepts of measuring devices)
- Commissioning of control loops
- Sensors and Transducer used for power plant
- Automatic Turbine Run up System (ATRS)
- Analytical Instrumentation for Boiler (Water, Steam ,Flue Gas H_2 / O_2 / CO_2)
- Introduction to Distributed Digital Control (DDC), Data Acquisition System (DAS) and Programmable Logic Control (PLC)

Suggested Text Books and Reference

- "Power System Protection" : Warrington
- "Protective Relaying" : Mason
- P.W. : "Golding Electrical Measurements and Instrumentation"
- Sawhney A. K. : "A course in Electrical Measurement & Instrumentation", Dhanpat Rai & Sons
- Considine : "Instrumentation Handbook" ; McGraw Hill
- Murty D.V.S. : "Transducers & Instrumentation" ; Prentice Hall
- Melville B. Stout : "Basic Electrical Measurements" ; Prentice Hall

Additional References:

- Power System Relaying : Horowitz and Phadke, Institute of Physics Publishing
- P. M. Anderson : Elements of Power System Protection, ICWA State University Press, 1975
- J.L.Blackbum : Protective Relaying Principles and Applications, Marcel Decker, Inc, 1987.
- 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.
- A. G. Phadke, J.S. Thorp : Computer Relaying for Power System, Research Studies Press,

Suggested Text Books and References :

- A.K. Sawhney : " Electrical & Electronic Measurements and Instrumentation". Dhanpat Rai and Sons,2003.
- "Modern Power Station Practice" Volume F, British Electricity International Ltd., Central Electricity
  Generating Board, Pergamon Press, Oxford, 1991
- "Control & Instrumentation", NPTI Manuals Volumes I,II,III.

Power Engineering Syllabus

Internal Combustion Engines

Paper Code : PWE 703
Contacts : 3 L
Credits : 3

- **Introduction :** Basic engine nomenclature ; Internal Combustion Engine classification ; 4-stroke and 2-stroke engines; Comparison of 4-stroke and 2-stroke engines and between Spark Ignition Engines. and Compression Ignition Engines. (3)

- **Review of Air Standard cycles:** Otto , Diesel , Dual and Brayton cycles ; Fuel-air Cycles , variation of specific heats , dissociation effect. (3)

- **S.I.Engine fundamentals :** Ignition limits , detonation and knocking and their control, carburettors and mixture distribution. (3)

- **Combustion in C.I. Engines:** Air-fuel ratio: Ignition lag; Diesel knock and its control; C.I. combustion chambers ; Swirl chambers. (4)

- **Fuel Injection :** Heat release pattern ; C.I. fuel injection systems ; Fuel pump ; Injectors and nozzles ; Spray formation. (3)

- **Engine friction and lubrication :** Engine cooling and Radiators. (2)

- **Two – stroke engines:** Scavenging ; Valve timing diagrams . (2)

- **Supercharging** : Objective ; Methods in Spark Ignition Engines and Compression Ignition Engines; Turbocharging.

- **Performance parameters :** Volumetric efficiency; Measurements of speed , fuel and air consumption, brake power, indicated power; performance curves . (4)

- **I.C.Engine fuels :** Petroleum structure , Refining products ; S.I. engine fuels and Octane rating ; Diesel fuels and Cetane Rating ; Alternate fuels ; Biofuels. (3)

- Impact on environment and air pollution (1)

Power Engineering Syllabus

Recommended Books :

- M.L.Mathur and R.P.Sharma: A Course in Internal Combustion Engines , Dhanpat Rai & Sons, Delhi, 1990

- V.Ganesan , Internal Combustion Engines, Tata McGraw Hill, New Delhi, 1992

- P.K.Nag, Power Plant Engineering , TMH, New Delhi, 2001.

Power Engineering Syllabus

POWER SYSTEM OPERATION

Paper Code : PWE 704
Contacts : 3
Credit : 3

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.
(3)

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.
(5) **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 and dispatch code as per IEGC.
(6+2=8) **Faults and Network**
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 calculations.(9)
Modern Controllers in Power Network
Control complexities in integrated power network, Flexible AC transmission system (FACTS), technology, FACTS devices- Static var system(SVS), Controllable series compensator(CSC) and Unified power flow controller(UPFC). Design and coordination of power system controller.
(5)
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.
(2)
Power System Control

MW-frequency control, models of single area & multi area MW frequency control, Reactive Power-Voltage control and AVR.

(5)

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.

(7)

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.

(2)

Suggested Text Books/Reference:

1. Grainger John,J.and Stevenson Jr. , W.D.,"Power System Analysis". McGraw Hill.1994
2. Elgerd,O.I., "Electric Energy Systems Theory: An Introduction",Tata McGraw Hill,2nd Edn,. 1982,
3. Stagg, G.W.and EI-Abaid , A.H.,"Computer Methods in Power System Analysis". McGraw Hill International Edition
4. Kundur, P., " Power System Stability and Control", McGraw Hill Inc., 1994.
5. L.K.Kirchmeyer, " Economic Operation of Power Systems", John Wiley & Sons Inc.,1958 (Wiley Eastern Ltd., 1993)
6. Kimbark , E.W., " Power System Stability, Vol.I. Elements of Stability Calculations", John Wiley & Sons, 1948.
7. Westinghouse Electric Corporation, " Electrical Transmission and Distribution reference book ", East Pittsburgh , Pa., 1964.
8. I.J.Nagrath and D.P.Kothari,"Power System Engineering", Tata McGraw Hill ., 1994.
9. Wadhwa, C.L. "Electric Power Systems". Second Edition, Wiley Eastern Ltd., 1985.
10. C.A.Gross "Power System Analysis", John Wiley & Sons ,Inc.,1986.
11. Hadi Saadat, "Power System Analysis". McGraw Hill,1999.
12. Arillagga,"Computer Methods in Power System Analysis".
13. Stevenson – Yellow colour book.

Design of Mechanical Equipment

Paper Code :PWE 705A
Contact : 3 L
Credit :3

Power Engineering Syllabus

- Basic Ideas of Design
- Analysis and Design of various equipments such as design of welding joints, shaft belt conveyor, pulley.
- Design of torque, transmitting elements such as shaft coupling and Gear
- Design of Pressure vessel.
- Design of Hydro Dynamic Bearings.

Design of Electrical Equipment
Paper Code :PWE 705B
Contact : 3 L
Credit :3

1. **DESIGN OF TRANSFORMERS: SINGLE PHASE AND THREE PHASE**
   a. Determination of Main Dimensions
   b. Winding Design: Helical, Crossover, Disc
   c. Loss Estimation and Cooling – Dry & Oil Cooled Types
2. **DESIGN OF INDUCTION MOTORS: SQ & WR (Squriel Cage and wound rotor)**
   a. Determination of Main Dimensions
   b. Armature Design: Principal Types & Selection
   c. Rotor Winding: Single Cage Standard, Deep Bar / Double Cage
   d. Slip-Torque Characteristics
3. **DESIGN OF SYNCHRONOUS GENERATORS**
   a. Determination of Main Dimensions OF (i) Cylindrical Rotor & (ii) Salient Pole Machines
   b. Field Winding of Cylindrical Rotors
   c. Exciters: DG and AC – Standard and High Frequency
   d. Sliprings and Brushgear
   e. Brushless Excitation Systems

Power Engineering Syllabus

POWER ELECTRONICS

Paper Code : PWE 706A
Contacts : 3L + 1T
Credits : 4

- Power semiconductor devices: PNPN diodes, DIACS, Thyristors, TRIACS, GTO devices. L T
  Power transistors, Power MOSFET. Rating, Losses and Cooling. Triggering circuits for
  SCRs, UJT. Blocking Oscillators, Schmitt trigger circuits – Power MOS gate drive circuits. 8 1
- Uncontrolled and controlled Rectifiers: Single phase and polyphase Bridge rectifiers.
  Transformer ratings. Inductive load, free wheeling diodes.
  6 1
- Converter operation: Overlap, power factor, inversion, regulation, P-pulse converters,
  power factor control via PWM converters.
  6 1
- D.C. line commutation: Series and parallel capacitor turn off, resonant turn off, impulse
  commutation.
  3 -
- AC Voltage Controllers / Regulators.
  3 1
- D.C. Choppers: Principles, classification, use.
  6 1
- Frequency conversion: Cycloconverter- single and three phase circuits, blocked group
  operation, circulating current mode. Single phase and three phase inverters, constant
  voltage source and constant current source inverters, HF inverters for heating.
  8 1
- Application: D.C. and A.C. drives, SMPS, Resonant converters, AC Line Filters, ratio,
  interference suppression. HDVC transmission.
  6 -

Suggested Text Books/References :

- Rammurthy M – An Introduction to Thysistors and their applications

- Lauder C W - Power Electronics, 3rd Edn. MHI 1993
- Sen P C – Power Electronics, TMH
- Rashid M H – Power Electronics, PHI Pub.
- Dubey S K – Thysistorised Power Controller; John Wiley & Sons
- Singh M D & Khanchandni : Power Electronics ; TMH Pub.
- Dewan S B & Stranghen A – Power Semiconductors circuit
- Mohan N, Underland T M & Robbins W P : Power Electronics, John Wiley & Sons.
- Bose B K : Modern Power Electronic ; Jaico Pub. House
- Dubey G.K.: Thyristorised Power Controllers, New Age International
- Subramanyam: Power Electronics, New Age International
- Sugandhi: Thyristors: Theory & Applications, New Age International

Tribology and CBM

Paper Code : PWE 706B
Contacts : 3L
Credits : 4

Tribology

- Friction
- Mechanic of friction
- Causes of friction
- Loss of friction
- Solid and rolling friction
- Belts and ropes
- Static and dynamic co-efficient of friction
- Numerical example

Wear

- Nature of wear
- Basic types of wear
- Measurement and assessment of wear
- Numerical example

Lubrication

- Lubrication System
- Synthetic and solid lubricants
- Viscosity evaluation
- Addictives of lubricants
- Contamination and loss of viscosity in practice

Rotor Dynamic

- Stability of Rotor

- Hydro static and hydro dynamic bearings
- Vibration of rotor system
- Numerical example

CBM

- Basic maintenance aspects
- Types of maintenance action
- Comparative study of predictive and preventive maintenance
- Advantage of predictive or condition based maintenance
- Condition monitoring for mechanical fault
- On-line and of-line symptoms]
- System reliability
- Problems and solution

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.

Control & Instrumentation 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.

Power Engineering Syllabus

HEAT POWER LAB.

Paper Code : PWE 799
Contacts : 3
Credit : 2

Air Conditioning

- To study the Vapour Compressing Cycle
- To calculate co efficient of Performance (COP)
- To Evaluate tonnage capacity
- To study humidification and de-humidification

Vapour Absorption Refrigeration System

- To study Vapour Absorption Refrigeration Cycle
- Performance efficiency Ratio

Internal Combustion Engine

- Plot valve – timing diagram when operated manually
- Study the functional aspects continuously at very slow speed
- When operated with a fractional HP Motor
- BHP measurement
- Brake thermal efficiency
- Fuel consumption measurement
- Air intake measurement
- Measurement of heat rejected to water jacket
- Heat balance test

STUDY OF FBC BOILERS IN COLD WORKING MODELS

- CFB
- AFB

Power Engineering Syllabus

NATIONAL POWER TRAINING INSTITUTE (ER)
CITY CENTRE; DURGAPUR-16
COURSE STRUCTURE IN POWER ENGINEERING

8TH SEMESTER

Power Engineering Syllabus

Thermal Power Plant Operation & Maintenance
Code : PWE 801
Contacts : 4L
Credits : 4

- ✓ Availability of electrical supply to the equipment (source feeder of each equipment, points of isolation of the equipment, locking during isolation, other safety procedures. **- 2L**
- ✓ Operation of service auxiliaries (cooling water pump, compressors, auxiliary steam, fuel oil pump etc.) **- 2 L**
- ✓ Boiler pre light up checks. **- 1L**
- ✓ Operation of air-pre heater and ID, FD & PA fan (Rechecks, flow path line up, permissives, interlocks). **– 3L**
- ✓ Mill operation (pre checks, flow path line up, permissives, interlocks). **– 2L**
- ✓ Characterization of coal for power generation, Pre treatment & demineralization, chemical dozing & Water conditioning, Combating corrosion, preservation. **– 5L**
- ✓ Fundamental of commissioning – Alkali boil out, thermal flow test & air tightness test. Acid cleaning, Safety valve setting, Hydraulic Test. **– 5L**
- ✓ Operation of turbine lubricating system and barring gear **– 1L**
- ✓ Operation of condensate and feed water system (B.F.P., Heaters CEP). **– 2L**
- ✓ HP/LP Bypass operation and turbine heating. **– 2L**
- ✓ Turbine rolling and synchronization **–2L**
- ✓ Operation of generator cooling system (stator and hydrogen cooling).**– 2L**
- ✓ Operation of Generator Excitation System AVR. **– 2L**
- ✓ Operation of Turbine Governing System. **– 3L**
- ✓ Integrated operation of unit (Unit loading and shut down sequence) **– 2L**
- ✓ Operational difference between cold start up, warm start up and hot start up. Load dispatching and coordination with load dispatch centre. **– 3L**
- ✓ Power Plant emergencies (Boiler & Turbine) **– 3L**

- ✓ Performance monitoring of Boiler, Turbine, Condenser, Feed Heater, Coal Mills & ESP. **– 5L**

- ✓ Cost of Generation – 1L

Maintenance:

- ✓ Maintenance procedure (Breakdown maintenance, corrective maintenance, preventive maintenance, Condition based maintenance etc.) **– 2L + 1L**
- ✓ Replacement model **–1L**
- ✓ Alignment, vibration and balancing, NDT methods. **– 2L + 2L**
- ✓ Pump, Valve, Bearing Maintenance **– 3L + 2L**

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.

Operations Research & Industrial Engineering

Code : PWE 802
Contacts : 4L
Credits : 4

Introduction:

Operations Research: Origin & Development of O.R. Models in O.R., Models in O.R., General So/m. methods for O.R. Models, Methodology of O.R., Scientific method in O.R. Applications of O. R. uses & Limitations of O.R.

- 2L

Linear Programming Problem:

Introduction, Mathematical Formation, Graphical Solution method, General LPP, Canonical & Standard form of L.P.P. Basic solution, Degenerate solution, basic feasible solution, optional solution, simplex algorithm.

- 2L

Simplex Method: Slack & Surplus variables, solving LPP wring simplex method, Big-M method, Two-phase method, Degeneracy, Applications.

- 4L

Duplex Method: Concept of Duality, Primal & Dual problem, conversion between primal & Dual problem and its solution. Dual simplex method, Applications.

- 8 L

Assignment Problem:

Mathematical formulation of an assignment problem (AP), Method of solving AP, Application. Routing problem, traveling salesman problem. - 2L

Power Engineering Syllabus

Queuing Theory:

Queuing system & its characteristics, introduction to Poisson & Exponential Distribution. Poisson process, Exponential process, M/M/1 Queuing system & related problems. Waiting zinc distribution of M/M/1. Birth – Death process.

- 8 L

Network Scheduling:

Network & basic components, CPM & its applications PERT & its applications.

2L + 1L

Industrial Engineering.

Types of Production (Mass, Batch, Project), Functions of Production Management. Productivity Engineering: Concept, Different Inputs and Productivity Measures, Efficiency and Effectiveness, Measures to increase Productivity.

- 5 L

Work Method Design – Method study work measurement, time study, work sampling, job evaluation, merit rating.

- 3L

Inventory Control: Deterministic and probabilistic model, stock inventory control / systems, material requirement planning. Selective Inventory Control – ABC, VED, FSN analysis.

- 8L

Sales and Marketing Management.

- 3L

Cost Accounting and Control, Budget and Budgetary control.

- 4L

References:

1. Operations Research – An Introduction by H.A.Taha, Prentice Hall of India / Pearson Education.
2. *Operations Research by J. K. Sharma, Macmillan.*
3. *Operations Research by Vijayakumar, Scitech.*
4. *Operations Research by S. Kalabati, Bikash Publisher*
5. *Operations Research by Hira Gupta*
6. *Operations Research by Kanti Swarup*
7. *Operations Research by Hillier Liberman, Tata Magrohill*
8. *Industrial Engineering and Management by C. Nadha Muni Reddy*
9. *Mechanical and Industrial Management by R. K. Jain, Khanna Publication*
10. *Industrial Organization of Engineering Economics by Banga / Sharma*
11. Industrial Engineering and Management by Khanna P. P.

ELECTIVE

Power Engineering Syllabus

Manufacturing Science

Code : PWE 803A
Contacts : 3L
Credits : 3

Types of production and production processes, product configuration and manufacturing requirements. - **2L**
Fundamental of Pattern making, allowances and core making. – **1L**
Basic Principle of Casting processes of ferrous and non-ferrous metals including die casting, investment casting, centrifugal casting, loam molding, transfer molding. Solidification principles, design of molds, risering, sprues and gating system, casting defects. – **15L**
Fundamental of Metal joining processes : soldering, brazing, fusion and non-fusion welding processes, various modern welding processes like TIG, MIG, Submerged Arc Welding, Friction Welding. Welding defects. – **15L**
Fundamental of Non Conventional Machinery process EDM, ECE,WJM. – **2L**
Fundamentals of hot and cold working processes – forging, extrusion and rolling. – **2L**

References :

1. Manufacturing Engineering Technology, K. Jain, Pearson Education
2. Manufacturing Technology: Foundry, Forming and Welding by P.N.Rao, TMH.
3. Principles of Manufacturing Materials and Processes, James S.Campbell, TMH.
4. Welding Metallurgy by G.E.Linnert, AWS.
5. Production Engineering Sciences by P.C.Pandey and C.K.Singh, Standard Publishers Ltd.
6. Manufacturing Science by A.Ghosh and A.K.Mallick, Wiley Eastern.

7.Manufacturing Technology,Radhakrishnan,Scitech

Power Engineering Syllabus

ELECTIVE

ELECTRIC DRIVES

Code : PWE 803B
Contacts : 3L
Credits : 4

Concept of electrical drives: group, individual and multimotor drives, quadrantal diagram speed torque characteristics under four quadrant operation of d.c. and induction motors. **8L**

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. **6L**

Induction motor drives: Pole changing, frequency variation, stator voltage variation, rotor resistance variation, slip power recovery, variable voltage - variable frequency control, (VVVF). **6L**

P.W.M., inverter, cycloconverter control, non-sinusoidal voltage operation, A.C. regulators closed loop regulators. **6L**

Synchronous Motor Drives: Wound field brushless excitation, voltage source inverter drive. Constant v/f, E/f and field weakening control. Cycloconverter control, self controlled synchronous motor drive. **4L**

Starting and Braking: soft starts, regenerative and dynamic braking. Transients and dynamics of electric motors under starting and braking conditions. **4L**

Heating and Power Ratings: Service conditions of electric drives and selection of motor capacities. Operation of electric drives incorporating flywheel under shock loading conditions. **4L**

Motor Controllers: PL, Stepper Motor, Tachogenerator, Industrial application. **4L**

Principles of Electric Traction: Traction motor, Traction motor control, EMU, DMU **4L**

Books:

1. Pillai S K: A First course in Electrical Drives, New Age International Pub.
2. De N K and Sen P K : Elective Drives; PHI

3. Subramaniyan V: Elective Drives - Concepts and Applications; TMH Pub.
4. Krishnan, Electrical Motor Drives, Pearson Education
5. Elsharwaki, Electrical Drives, Vikas
6. De. G : Electrical Drives and their Control; Academic Books Ltd.
7. Dubey G K et. Al. Electrical Drives, New Age Pub.

Power Engineering Syllabus

ELECTIVE

Technology of Machining and Metal Cutting

Code : PWE 804A
Contacts : 3L
Credits : 3

Matel Cutting – 1L

Mechanics , Tool materials , Temperature Cutting forces – 2L + 1L =3L
Wear and Tool life considerations - 2L + 1L = 3L
Tool geometry and chip formation, surface finish and machinability - 3L
Optimisation of cutting parameter – 1L + 1L = 2L

Machine Tools - 12L + 2L = 14L

Generation and machining principle , setting and operations on machines viz. lathe, milling , shaping, , slotting , planing , drilling boring , broaching, grinding (cylindrical, surface, centreless) Thread rolling and gear cutting machines.

Tooling - 13L

Jigs and fixtures, principles of location and clamping - 2L + 1L = 3L
Batch production and mass production – 2L + 1L = 3L
Operations on capstan and turret lathes – 3L + 1L = 4L
Single spindle automats – 2L + 1L = 3L

Finishing - 3L + 1L = 4L

Microfinishing operations like honing , lapping and superfinishing.

References :

1. Principles of Metal Cutting/Principles of Machine Tools by G.C.Sen and A. Bhattacharya, New Central Book Agency, Kolkata.
2. Fundamentals of Metal Cutting Machine Tools by G.Boothroyd, TMH.
3. Production Technology, HMT Publication, TMH.
4. Production Engineering Sciences by P.C.Pandey and C.K.Singh, Standard Publishers Ltd.
5. Manufacturing Science by A.Ghosh and A.K.Mallik, Wiley Eastern.
6. Manufacturing Process by Danilovsky and Maslov et. Al, Mir Publication.
7 Metal working and Metrology,Narayana,Scitech

Power Engineering Syllabus
ELECTIVE

HVDC TRANSMISSION

Code : PWE 804B
Contacts : 3L
Credits : 3

AC/DC Conversion - Hg. Arc, SCR, Bridge rectifier and inverter circuits. Recent trends of HVDC valves. Principles of grid control, firing angle control, harmonic analysis, commutation failure, starting and stopping of DC Link. **22L**

Reactive Power requirement, types of forced commutation. Corona and Radio interference, protective devices. **7L**

Smoothing reactors - Functions, double commutation failure, consequent commutation failure - their prevention. **6L**

Simulation of HVDC systems, Parallel operation of HVDC and AC systems, multiterminal DC systems. **6L**

Stability of AC/DC interconnected systems. **4L**

Books:

1. Chakraborty A, Kothari D P, Mukhopadhyay A K - The Performance, Operation and Control of EHV Power Transmission Systems; Wheeler Pub.
2. Das Begamudre R - The E H V A C Transmission - New Age International.