Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

B. E. (Power Engineering) scheme - CBS pattern

VII & VIII Semester B. E. Power Engineering

SEVENTH SEMESTER

S.N.	Power Engg code	Subject Code	Subject	Board	Teaching Scheme				Credits	Examination Scheme			Min. Passing Marks	Paper Duration
					L	T	P	Total		College Assessment	Univ. Assessment	Total Marks		
1	BEPOE701T	BEPOE701T	Steam Turbine & its auxilliaries	POE	3	1	0	4	4	20	80	100	40	3 Hours
2	BEPOE702T	BEPOE702T	Turbo Generator & its auxilliaries	POE	3	1	0	4	4	20	80	100	40	3 Hours
3	BEPOE703T	BEPOE703T	Power Plant Operation & Performance	POE	4	1	0	5	5	20	80	100	40	3 Hours
4	BEPOE704T	BEME704T	Energy Conversion - II	ME	3	1	0	4	4	20	80	100	40	3 Hours
5	BEPOE704P	BEME704P	Energy Conversion - II	ME			2	2	1	25	25	50	25	
6	BEPOE705T	BEME705T	Design of Mechanical Drives	ME	3	1	0	4	4	20	80	100	40	3 Hours
7	BEPOE705P	BEME705P	Design of Mechanical Drives	ME	0	0	2	2	1	25	25	50	25	
8	BEPOE706P	BEPOE706P	Project Seminar	POE	0	0	3	3	3	50	0	50	25	
9	BEPOE707P	BEPOE707P	Power Plant Visits	POE	0	1	2	3	2	50	0	50	25	
			Total		16	6	9	31	28	250	450	700		

EIGHTH SEMESTER

S.N.	Power Engg code	Subject Code	Subject	Board	Teaching Scheme				Credits	Examination Scheme			Min. Passing Marks	Paper Duration
					L	T	P	Total		College Assessment	Univ. Assessment	Total Marks		
1	BEPOE801T	BEME801T	Industrial Management	ME	3	1	0	4	4	20	80	100	40	3 Hours
2	BEPOE802T		Elective-I	ME	3	1	0	4	4	20	80	100	40	3 Hours
3	BEPOE803T	BEELE803T	Switchgear & Protection	EE	4	1	0	5	5	20	80	100	40	3 Hours
4	BEPOE803P	BEELE803P	Switchgear & Protection	EE	0	0	2	2	1	25	25	50	25	
5	BEPOE804T	BEPOE804T	Power Plant Erection & commissioning	POE	4	0	0	4	4	20	80	100	40	3 Hours
6	BEPOE805T	BEPOE805T	Power Plant Maintenance Practices	POE	3	1	0	4	4	20	80	100	40	3 Hours
7	BEPOE806P	BEPOE806P	Power Plant Operation Practices	POE	0	1	4	5	3	50	50	100	50	
8	BEPOE807P	BEPOE807P	Project	POE	0	0	6	6	6	75	75	150	75	
			Total		17	5	12	34	31	250	550	800		

BEPOE802T		Elective- I	
BEPOE802T1	BEME803T3	Renewable Energy Systems	ME
BEPOE802T2	BEME603T	Operations Research	ME
BEPOE802T3	BEME702T6	Material Handling System	ME

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Absorption Scheme for the students of B. E. (Power Engineering)
from OLD semester pattern to NEW semester pattern
VII & VIII Semester B. E. Power Engineering

Subject Code	Name of subject in old semester pattern	Subject code	Name of subject in new semester pattern
7th semester			
7POE1	Steam Turbine & its Aux.	BEPOE701T	STEAM TURBINE & ITS AUXILIARIES
7POE2	Machine Design II	BEPOE705T	Design of Mechanical Drives
7POE2P	Machine Design II(Practical)	BEPOE705P	Design of Mechanical Drives
7POE3	Thermal Power Plant Commissioning	BEPOE804T	POWER PLANT ERECTION & COMMISSIONING
7POE4	Energy Conversion II	BEPOE704T	ENERGY CONVERSION II
7POE4P	Energy Conversion II(Practical)	BEPOE704P	ENERGY CONVERSION II
7POE5	Turbo Generator & its Aux.	BEPOE702T	TURBO GENERATOR & ITS AUXILIARIES
7POE6	Project Seminar	BEPOE706P	PROJECT SEMINAR
		*BEPOE707P	POWER PLANT VISITS
8th semester			
8POE1	Switchgear & Protection	BEPOE803T	SWITCHGEAR & PROTECTION
		*BEPOE803P	SWITCHGEAR & PROTECTION
8POE2	Thermal Power Plant Operation & Performance	BEPOE703T	POWER PLANT OPERATION & PERFORMANCE
8POE3	Power Plant Maint. Practices	BEPOE805T	POWER PLANT MAINT. PRACTICES
8POE4	Power Plant Operation Practices	BEPOE806P	POWER PLANT OPERATION PRACTICES
8POE5	Elective I	BEPOE802T	ELECTIVE- I
8POE6	Project Work	BEPOE807P	PROJECT WORK
		*BEPOE801T	Industrial Management

* The student who opts for absorption shall have to pass these subjects.

The students who fail to clear any subject(s) of the VII VIII semester (old pattern) by the last chance prescribed, shall be required to clear the respective equivalent subject of VII VIII semester (new pattern)

Rastrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
B.E. (POWER ENGINEERING): SEVENTH SEMESTER (CBS)
Syllabus

BEPOE701T-STEAM TURBINE AND ITS AUXILIARIES
Credits: 04

Teaching Scheme	**Examination Scheme**
Lectures: 3 hours/week	Duration of paper: 3 Hours
Tutorial: 1Hour/week	University Assessment: 80 Marks
	College Assessment: 20 Marks

Course Objective

The paper covers the principle of working of steam turbine, its types & the constructional features and the various auxiliary systems associated with a typical steam turbine used in a utility power plant. The student would understand in detail the constructional aspects of steam turbines and various turbine auxiliary systems like lub oil system, condensate and feed water system, governing system etc. and the significance of various components in these subsystems.

Unit I Steam Turbines : [8 Hrs.]

Steam cycle theory, Carnot cycle, rankine Cycle, Steam Turbines: Types and working principles, Classification of turbine, Metallurgical consideration, Description of Turbine main components. Casing, rotors, blades, Cylinders and exhaust arrangement. Control and Stop Valves.

Unit II Gland Sealing System and Turbine Support arrangement [8 Hrs.]

Turbine Glands arrangement and sealing for HP/IP and LP turbines, Gland Seal Steam system, Turbine support arrangement, Bearings, Pedestals and Fixing of Turbine casing and rotor with pedestal and their expansion.

Unit III Condensate System and Turbine lub oil system [8 Hrs.]

Condensers. Types of condensers, condensate pump. Air ejection system. Turbine lubrication system, Lub oil characteristics, Lub oil pumps, coolers, injectors, Jacking oil system, Barring/Turning Gear

Unit IV Power station Pumps [8 Hrs.]

Classification of pumps, Boiler Feed Pump: BFP Description. Pump drive, booster pump, hydraulic coupling, lub oil system, booster pump, turbo driven BFP.

CW system: Open/closed system, CW Pumps, Cooling towers, CT fans etc

Unit V Regenerative Feed Heating System [8 Hrs.]

Working principle and constructional details of High pressure and low pressure heaters, gland steam cooler, drain cooler, deaerator and its connections.

HP/ LP Bypass System - Advantage of HP/LP bypass system, bypass valves and system description.

Unit VI PRDS & Turbine governing system [8 Hrs.]

Significance, arrangement and scheme of PRDS, Principles and types of steam turbine governing, Governing characteristics, Mechanical, Hydraulic and Electro- hydraulic governing systems, overall working of governing system

Books Recommended

1. Steam Turbines and Gas Turbines by R. Yadav
2. BEI Publications on Steam Turbine
3. NPTI manuals PPF Volume 3
4. NPTI publication on Steam Turbine
5. NPTI publication on Steam Turbine Governing system

BEPOE702T - TURBO GENERATOR AND ITS AUXILIARIES.

Credits: 04

Teaching Scheme
Lectures: 3 hours/week
Tutorial: 1Hour/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Course Objective

The paper covers the principle of working of Turbo generator, & the constructional features and the various auxiliary systems associated with it in a power plant. The student would understand in detail the constructional aspects and the important role of turbo generator and various generator auxiliary systems like seal oil system, stator water system, excitation system and the various electrical equipments in the plant.

Unit I Turbo Generator [8 Hrs.]

Development - Theory- Working Principle- Characteristics - Different parts of a turbo - generator- Stator- Rotor and Supports.

Unit II Generator Cooling and Sealing System [8 Hrs.]

Need for cooling and sealing- Different coolants- properties- Schemes and components of cooling and sealing arrangements. Hydrogen cooling system, Stator water system, generator seal oil system

Unit III Excitation System [8 Hrs.]

Excitation- Characteristics - Development- Different types of excitation systems - Automatic Voltage Regulator (AVR)

Unit IV Auxiliary Power Supply system [8 Hrs.]

Electrical Power Supply arrangements in a Thermal Power Station, Components - UPS - Emergency Supply arrangement, Batteries

Unit V Switchyard Equipments [8 Hrs.]

Description and layout of a Switchyard of a Thermal Power Station-
Function of various Components – Their arrangements (Breakers, Isolators, CT, PT, CVT, Bus bars, Reactors etc.)

Unit VI Electrical Equipments [8 Hrs.]

Constructional details and Maintenance of various electrical equipments, Generators, Switchgears, Transformers and Motors etc.

Recommended Books
1) O & M Manuals of BHEL
2) BEL Publications.
3) NPTI manuals PPF Volume 4

BEPOE703T-THERMAL POWER PLANT OPERATION & PERFORMANCE

Credits: 04

Teaching Scheme	**Examination Scheme**
Lectures: 3 hours/week	Duration of paper: 3 Hours
Tutorial: 1Hour/week	University Assessment: 80 Marks
	College Assessment: 20 Marks

Course Objective

The paper covers the operation and performance aspects of a thermal power plant. The student would understand in detail the sequential procedure of operation of Boiler, Steam Turbine, Generator & their associated systems and balance of plant alongwith their prechecks, interlocks and protections including some emergency operations. The student also would understand the efficiency aspects of Boiler, Steam turbine and their auxiliaries.

Unit I Boiler Operation [8 Hrs.]

General Principles of Power Plant Operation, Operation of Boiler and its auxiliaries. Air Preheater, ID, FD, PA Fan, Mill and Feeder Operation, Start- up and shut down, Interlocks and protections, Boiler operation. Purging and light up, Burner Management system, Boiler loading, Boiler shutdown, Auxiliary Steam System, Routine checks, Emergency operation.

Unit II Turbine Operation [8 Hrs.]

Operation of turbine and auxiliaries, lubricating oil system, governing system, condensate and feed water system, HP/LP bypass operation, protections and interlocks, turbine rolling, cold, warm, hot start, planned shutdown, routine checks, emergency operation.

Unit III Generator Operation [8 Hrs.]

Generator and its auxiliaries operation, generator cooling and sealing system, generator synchronisation, routine operation and periodic checks, operational limits of generator and capability curve.

Unit IV Outdoor plant operation [8 Hrs.]

Oil handling plant, coal handling plant and ash handling plant.

Unit V Boiler performance [8 Hrs.]

Boiler performance, Calculation of Boiler efficiency, milling plant performance, Air heater Performance, Fan performance, ESP performance,

Unit VI Turbine performance [8 Hrs.]

Turbine performance, condenser performance, feed water heater performance, pump performance, generator performance

Books Recommended:

1. O & M Manuals of BHEL
2. O & M Manuals of NTPC
3. NPTI manual on Efficiency and Performance Monitoring
4. BEI Publication
5. Power Plant Engg. - P.K. Nag
6. Power Plant Engg. - Domkundwar

BEPOE704T (BEME704T) ENERGY CONVERSION II

Credits: 04

Teaching Scheme
Lectures: 3 hours/week
Tutorial: 1Hour/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Course Objectives and Expected Outcomes: This course is designed to study the energy conversion systems and power generation systems. It includes the construction, operation and analysis of air compressors, internal combustion engines. Introduction to conventional refrigeration and air conditioning is also included. At the end of this course, students will be able to analyze the performance of air compressors, internal combustion engines and refrigeration and air conditioning installations.

UNIT – I **[8 Hrs.]**

Air Compressors:- Introduction, classification, applications.Positive displacement Compressors:-

Reciprocating compressors: - Construction and working, isothermal, polytropic & adiabatic compression process, work done with and without clearance, P-V diagram, volumetric efficiency, effect of clearance, isothermal efficiency, methods for improving isothermal efficiency, volumetric efficiency, mechanical efficiency, multistage compression, intercooling, condition for minimum work input.

UNIT – II **[8 Hrs.]**

Rotary compressors:-

Positive displacement rotary compressors- Roots blower & vane blower: - Principle, operation, parts, indicator diagram, work done, roots efficiency, vanes efficiency. (No analytical treatment expected)

Centrifugal compressor:- Principle, operation, parts, velocity diagrams, static & total head quantities, work done by impeller, isentropic efficiency, width of impeller and diffuser blades, slip factor, pressure coefficient, power input factor.

Axial flow compressor:- Principle, operation, parts, velocity diagrams, work done, degree of reaction, stage efficiency compressor characteristics, surging, chocking, stalling, polytropic efficiency.

UNIT – III **[8 Hrs.]**

Internal Combustion Engines: Introduction, classification, components of I.C.Engines, working of two stroke and four stroke S.I. and C.I.Engines, valve and port timing diagram. Advantages and disadvantages, applications.

Combustion in I. C. Engines: Combustion in S. I. Engine, stages of combustion, ignition lag, detonation, Combustion in C. I. Engine, stages of combustion, delay period, diesel knock, abnormal combustion in S.I. and C.I. engines, detonation and knocking.

Fuel injection in I. C. Engines:

Fuel supply to S. I. Engine, carburetion, simple carburetor, components, operation, MPFI.

Fuel supply to C. I. Engine, air injection system, solid injection, fuel pump & fuel injector.

(Analytical treatment not expected)

UNIT – IV **[8 Hrs.]**

Testing of I. C. Engines:- Performance parameters, measurement of indicated, friction & brake power, measurement of speed, fuel & air consumption, calculation of indicated & brake thermal efficiency, volumetric efficiency, relative efficiency and mechanical efficiency, percentage of excess air, Heat balance sheet, exhaust gas calorimeter, exhaust analysis, performance characteristics, factors influencing the performance of I.C.engines, performance analysis of single and multicylinder I. C. engines.

UNIT – V **[8 Hrs.]**

Refrigeration: Introduction, definition & unit of refrigeration, single stage vapour compression refrigeration system, effect of subcooling and superheating on COP with P-h and T-S diagram, Vapor absorption refrigeration system (concept only) refrigerants, refrigerants nomenclature, air refrigeration systems.

UNIT – VI **[8 Hrs.**

Air conditioning: Introduction, psychrometric properties and processes, human comfort and factors affecting comfort, Bypass factor, application of Psychrometrics to simple air conditioning systems, typical summer and winter air conditioning system(concept only) evaporative cooling, working of air washer.

LIST OF TUTORIALS:

1) Analysis of single stage reciprocating compressors.
2) Analysis of multistage reciprocating compressors
3) Analysis of double acting reciprocating compressors
4) Performance analysis of centrifugal compressor.
5) Performance analysis of axial flow compressor.
6) Numericals on Morse test
7) Analysis of multicylinder engines.
8) Numericals on heat balance sheet.
9) Analysis of simple vapour compression Refrigeration system.
10) Analysis of VCRS with Superheating & Sub cooling system.
11) Analysis of Air Conditioning Systems.

TEXT BOOKS:

1. Thermal Engineering, P.L.Ballaney, Khanna publishers.
2. Thermal Engineering, R. K. Rajput, Laxmi publications.
3. IC Engine, V. Ganesan, McGraw Hill education.
4. Refrigeration and & Air conditioning, Domkundwar, Arora, Dhanpat Rai & Sons.
5. Thermal Engineering, M.M. Rathore, TMH
6. Refrigeration & Air conditioning, C. P. Arora, PHI Learning.

REFERENCE BOOKS:

1 Internal Combustion Engines, E. Obert, Intex educational publication

BEPOE704P (BEME704P) ENERGY CONVERSION II

Credits: 01

Teaching Scheme
Practical: 2 hours/week

Examination Scheme
University Assessment: 25 Marks
College Assessment: 25 Marks

LIST OF PRACTICALS:

Minimum Eight out of the following shall be performed (out of which six must be experimental):

1. Performance analysis of reciprocating compressor
2. Study of performance characteristics of rotary compressor.
3. Study and demonstration of internal combustion engine and its components.
4. Study and demonstration of fuel injection systems and ignition systems of I. C. Engines.
5. Performance testing of a single cylinder I.C. Engine.
6. Study and demonstration of engine cooling and lubrication systems.
7. Performance analysis of multicylinder engine with energy balance sheet.
8. Exhaust gas analysis of I. C. Engine
9. Conduction of Morse test on multicylinder I.C. engine
10. Performance on vapour compression refrigeration System
11. Study & demonstration on household refrigerator
12. Study of vapour absorption refrigeration system.
13. Study of Psychometric Processes on mini-air conditioning tutor.

BEPOE705T (BEME705T) Design of Mechanical Drives

Credits: 04

Teaching Scheme
Lectures: 3 hours/week
Tutorial: 1Hour/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Course Objectives and Expected Outcomes: This course is aimed to make the students conversant with design principles & design procedure of mechanical drives like coupling, flywheel, belt drive, chain drive, gear drive, wire rope etc. Design of journal bearing, IC engine components & selection of antifriction bearings is also included. At the end of this course, student will be able to select and design appropriate mechanical drive/s.

UNIT – I [12 Hrs.]

Design of Coupling: Types of shaft coupling, design of flange coupling, flexible bush coupling.

Design of Flywheel: Functions, Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy storage in flywheel, stresses in flywheel, design of flywheel.

Design of Bearings: Lubrication, Types of Lubrication, oil seals, design of hydrodynamic journal bearings for radial loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, bearing housing.

UNIT – II [12 Hrs.]

Design of Flat belt drive: Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley.

Design of V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt & pulley.

Design of Roller chain drive: Velocity ratio and length of chain, design of chain, dimensions of tooth profile, design of sprocket.

Design of wire rope drive: Introduction to wire rope, stresses in hoisting wire rope. Design of wire rope, sheave and drum.

UNIT – III [12Hrs.]

Design of Gears: Review of kinematics of gears & terminology, interference, tooth profiles, formative number of teeth etc. Design of Spur Gear drive, Helical Gear drive.

Design of Bevel Gear Drive: Types of bevel gear, proportions of bevel gear, force analysis of bevel gear drive, design of bevel gear drive.

UNIT – IV [12Hrs.]

Design of Worm Gear Drive: Worm Gearing—AGMA Equation; Worm-Gear force analysis

Designing a Worm-Gear Mesh; Buckingham Wear Load.

Design of I. C. Engine components, Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, design of piston and piston-pins, piston rings.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Machine Design, Maleev & Hartman, CBS publishers.
2. Machine Design, P.H. Black, TMH.
3. Mechanical Engg. Design, Shigley, TMH.
4. Design Data book, B.D. Shiwalkar, Central Techno publications.
5. Design data book for engine parts, Khandare, Kale, Akshaya publications, Nagpur.
6. Design of Machine Elements, V. B. Bhandari., McGraw Hill education.
7. Design of Machine Elements, B.D. Shiwalkar. Central Techno publications.
8. Elements of Machine Design, Pandya N. C. and Shah C. S., Charoter publishing.
9. Mechanical Design Analysis, M. F. Spotts, Prentice-Hall.
10. Design of Machine Elements, Sharma & Purohit, PHI.
11. Machine Component Design, Robert C. Juvinall, Kurt M. Marshele, Wiley.
12. Design Data Hand Book, Mahadevan, CBS publishers.
13. Design Data Book, PSG.

REFERENCE BOOKS:

1. Hand book of Machine Design, Shigley & Mischke, McGraw Hill.
2. Mechanical Engineering Hand book Vol 1 & 2, Kent, John Willey & Sons.
3. Machine Tool Design Data Book, CMTI.
4. Engineering Design, Dieter G E., McGraw Hill education.
5. Machine Design, Robert L.Norton, Pearson.

BEPOE705P (BEME705P) Design of Mechanical Drives

Teaching Scheme	Examination Scheme
Practical: 2 Hours/Week	University Assessment: 25 Marks
	College Assessment: 25 Marks

LIST OF PRACTICALS:

A) Design problems (at least 8 problems should be included in the Journal)

1. Design of fly wheel.
2. Design of coupling.
3. Design of Journal Bearing.
4. Design & Selection of Antifriction bearing.
5. Design of Belt drive.
6. Design of chain drive.
7. Design of Wire rope.
8. Design of I C engine Components.
9. Design of Spur Gear drive.
10. Design of Helical Gear drive.
11. Design of Bevel Gear drive.
12. Design of Worm Gear drive.

B) Student shall submit one assembly design report along with the drawing for assembly/sub assembly for any mechanical system consisting of not less than four members included in the syllabus. Submission mentioned in (A) & (B) are compulsory.

BEPOE706P PROJECT SEMINAR

Credits: 03

Teaching Scheme	**Examination Scheme**
Practical: 3 hours/week	College Assessment: 50 Marks

It is expected to select project topic as per the guidelines of the project to be undertaken in the 8th Semester. Also it is expected to carry out the Literature survey for their project work and finalize the methodology and schedule of the project. Each student of the concerned project batch shall present a seminar using audio- visual aids of about 15 minutes duration on their project methodology and schedule of completion. Seminar delivery will be followed by question- answer session. The students shall also be required to submit in advance a detailed type written report on his work.

BEPOE707P POWER PLANT VISITS

Credits: 02

Teaching Scheme	**Examination Scheme**
Practical: 2 hours/week	
Tutorial: 1Hour/week	College Assessment: 50 Marks

Course objectives: The students are expected to know the various schemes from the point of view of understanding the operational procedures in a coal based thermal power plant. The basic understanding of various schemes is a prerequisite for proper and effective operation of the thermal power plant.

Course work:

Scheme briefing

Detailing of various schemes on boiler, turbine, generator, balance of plant.

Power plant visits

It is expected that the students should trace the schemes by visiting the power plant and identify the various equipments including various valves, dampers, strainers, and note down various important parameters in the schemes as per the scheme tracing booklet and the same is to be submitted for evaluation.

Rastrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
B.E. (POWER ENGINEERING): EIGHTH SEMESTER (CBS)
Syllabus

BEPOE801T (BEME801T) Industrial Management

CREDITS: 04

Teaching Scheme	Examination Scheme
Lectures: 3 Hours/Week	Duration of Paper: 03 Hours
Tutorial: 1 Hour/Week	University Assessment: 80 Marks
	College Assessment: 20 Marks

Course Objectives and Expected Outcomes : This course is designed to understand the concept of administration & management; basic Management Functions, the recruitment, man power planning at industry as well as various aspect governing with industrial acts, to understand plant management, Lay-outs, Industrial safety programes, classification of production systems. This course shall also explore the core concept in marketing, Product Life cycle, Pricing, Channel of product distribution, concept of material management, Purchase function, Vender Selection, Ethics in purchasing and various codifications. It will also aware the students regarding concept of finance management, various sources of generating the finance and to understand the books of account & also about recent trends in management.

UNIT – I [8 Hrs.]

Principles of management, Concepts of management, development of scientific management, principles of Fredric W. Taylor, principles of Henry Fayol & functions such as planning, organizing, staffing, leading, motivating, communicating, controlling, decision making, span of control, delegation of authority.

UNIT – II [8 Hrs.]

Personal management, meaning, functions of personal management, manpower planning, selection, arbitration, collective bargaining, wages & salary administration, labor welfare, training, trade unions, Trade union act & Labor Legislation.

UNIT – III [8 Hrs.]

Marketing management, Definition, selling & modern concept of marketing, market research, marketing mix, new product development, product life cycle, new product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation.

UNIT – IV [8 Hrs.]

Financial management, Sources of finance, financing organizations, types of capital, elements of costs & allocation of indirect expenses, cost control, break even analysis, budgets & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.

UNIT – V [8 Hrs.]

Plant management, Plant location, plant layout, Material handling objectives, principles & selection of material handling equipments types. Industrial safety, causes & cost of accidents, accident biorhythms, safety programs, job, batch & process type of production.

UNIT – VI [8 Hrs.]

Recent treads in production and operation management like Lean Manufacturing, World Class Manufacturing, Retail Management, Supply Chain Management, Value Engineering, Re-engineering, Reverse Engineering, Business Process Re-engineering, Quality Circle, Just in Time (JIT), Kaizen, Poka Yoke.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

Industrial Organization & Engineering Economics, Banga T. R., Sharma S.C., Khanna publications.
Industrial Management, Dr. D. K. Bhattacharya, Vikas Publication.
Financial Management, Kuchal S.C, Chaitanya Publishing House.
Principles of Marketing Management, Kotler P., Stauton William, Prentice Hall.
Industrial Engineering Management, N.V.S Raju, Cengage Learning.

REFERENCE BOOKS:

Principles of management, Koontz, O Daniall, McGraw Hill.

BEPOE802T ELECTIVE- I

BEPOE802T1 (BEME803T3) Renewable Energy Systems

Credits: 04

Teaching Scheme	**Examination Scheme**
Lectures: 3 hours/week	Duration of paper: 3 Hours
Tutorial: 1Hour/week	University Assessment: 80 Marks
	College Assessment: 20 Marks

Course Objectives and Expected Outcomes : This course is designed to make the students conversant with the non conventional energy sources and their utilization to harness power.The students will be learning the solar utilization its applications. The generation of power with the use of wind. The students will understand the various methods by which energy can be generated by the tidal (ocean).The student can come to know how power can be generated from geothermal energy, Biogas and MHD. At the end of this course, students will appreciate the importance of renewable energy systems & will be able to build them.

UNIT – I **[8 Hrs.]**

Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, measurement of solar radiation and measuring instruments. Solar radiation geometry, solar angles, estimation of average solar radiation, radiation on tilted surface, tilt factors ,solar fuel cell..

UNIT – II **[8 Hrs.]**

Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, transmissivity of glass cover system, collector efficiency, analysis of flat plate collector, fin efficiency, collector efficiency factor and heat removal factor, selective surfaces, evacuated collectors, novel designs of collector.

UNIT – III **[8 Hrs.]**

Concentric collectors: line focusing, point focusing and non focusing type, central receiver concept of power generations, compound parabolic collector, comparison of flat & concentric collectors. Applications of solar energy to water heating, space heating, space cooling, drying refrigeration, distillation, pumping. Solar furnaces, solar cookers, solar thermal electric conversion, solar photo- voltaics. Solar energy storage, sensible, latent and thermo chemical storage, solar pond

UNIT – IV **[8 Hrs.]**

Biogas: - Introduction, bio gas generation, fixed dome & floating drum biogas plants their constructional details, raw material for biogas production, factors affecting generation of biogas and methods of maintaining biogas, production, digester design considerations, fuel properties of biogas and utilization of biogas. Bio Mass :- Introduction, methods of obtaining energy from biomass, Incineration, thermal gasification, classification of gasifiers & constructional details, chemistry of gasification, fuel properties, applications of gasifiers.

UNIT – V **[8 Hrs.]**

Wind and Ocean energy: -Power in wind, forces on blades. Wind energy: Basic principle of wind energy conversion, site selection consideration, wind data and energy estimation. Basic components of WECS classification of WEC systems, savonius and darrieus rotars applications of wind energy.

Ocean energy: Introduction, ocean thermal electric conversion, open and closed cycle of OTEC, hybrid cycle, energy from tides basic principles of tidal power & components of tidal power plants. single & double basin arrangement, estimation of tidal power and energy.

UNIT – VI **[8 Hrs.]**

Geothermal and MHD power generation:

Geothermal energy: Introduction, classification of geothermal systems vapour dominated, liquid dominated system, total flow concept, petrothermal systems, magma resources, applications of geothermal operational & environmental problems.

Magneto Hydro Dynamic power generation: Introduction, principles of MHD power generation, MHD open and closed systems, power output from MHD generators.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Renewable Energy Recourses: Basic principle and applications: G.N.Tiwari and M.K.Ghosal, Narosa publication.
2. Non-conventional energy resources: B.H..Khan, Tata McGraw Hill.
3. Solar Energy Utilization, G.D.Rai.
4. Industrial energy conservation, D. A. Ray, Pergaman Press.

REFERENCE BOOKS:

1. Non-conventional Energy Sources , G.D.Rai.
2. Solar Energy, S.P.Shukhatme.
3. Renewable energy sources and Energy Techniques, Kothari.

BEPOE802T ELECTIVE- I

BEPOE802T2 (BEME603T) Operations Research

Credits: 04

Teaching Scheme	**Examination Scheme**
Lectures: 3 hours/week	Duration of paper: 3 Hours
Tutorial: 1Hour/week	University Assessment: 80 Marks
	College Assessment: 20 Marks

Course Objectives and Expected Outcomes

The objectives of this course are to provide a formal quantitative approach to problem solving and perception about situations where such an approach is appropriate, to introduce some widely used mathematical models and to provide tools that the students can use to solve management problems. After going through this course, students will gain proficiency with tools for optimization, simulation, including fundamental applications of those tools in industry in context of uncertainty and scarce or expensive resources.

UNIT – I **[8 Hrs.]**

Introduction to O. R. & basic O.R. Models, Characteristics, phases & Methodology of O.R., Limitations & Applications.

Linear Programming:- Introduction, Linear programming problem formulation, LPP Solution by Graphical Method, Simplex Method, Principle of Duality & Formulation of Model only, Sensitivity Analysis Concept Only.

UNIT – II **[8 Hrs.]**

Transportation Model – Introduction, Formulation, Optimal Solution by MODI method, Unbalanced Transportation Problem, Degeneracy, Transshipment Problem.

Assignment Model – Introduction, Variants of Assignment Problems.

Traveling Salesman Problem – Branch & Bound Technique.

UNIT – III **[8 Hrs.]**

Game Theory- Introduction, Minimax and Maximin, Criteria and Optimal Strategy, Solution of games with Saddle Points, Games without Saddle Points, 2x2 games, Dominance Principle, mx2 & 2xn games. (No Graphical Method).

Sequencing Model – Introduction, Sequencing Model: n job two machines problem, n job 3 machines problem, 2 jobs m machine problem.

Inventory Model: Inventory control costs, analysis of inventory models with deterministic demand (Single Product), ABC analysis.

UNIT – IV **[8 Hrs.]**

Network Model – Project Management, Formation of Network, CPM & PERT analysis, Probability of Completion of Project, Cost Analysis of Project, and Concept of Crashing.

.

UNIT – V **[8 Hrs.]**

Replacement Model – Replacement Analysis – Replacement of items that deteriorated with time, Replacement of items that fails suddenly, Group Replacement

UNIT – VI **[8 Hrs.]**

Queuing Theory, M/M/1 model (without derivation).

Simulations – Concept, applications in waiting line situations, inventory and network.

TEXT BOOKS:

1. Operation Research, D.S. Hira & P. Gupta, S. Chand Publications.
2. Operation Research, J. K. Sharma, Macmilan Publishers.
3. Operation Research, H. Taha, Dorling Kindersley.
4. Operation Research, R. D. Askhedkar & R.V. Kulkarni, Dhanpat Rai & Sons

BEPOE802T ELECTIVE- I

BEPOE802T3 (BEME702T6) Material Handling System

CREDITS: 04

Teaching Scheme
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme
Duration of Paper: 03 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Course Objectives and Expected Outcomes: This course is designed to understand the basic concepts of materials handling, selection and design of materials handling systems, cost analysis for design of components of material handling systems, objectives of storage, bulk material handling, gravity flow of solids through slides and chutes, storage and warehouse planning and computerized warehouse planning. At the end of this course, student will be able to understand and design the various material handling systems as per requirements.

UNIT – I [8 Hrs.]

Elements of Material Handling System:-
Importance, terminology, objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and Plant layout, physical facilities and other organizational functions; Classification of Material Handling equipments.

UNIT – II [8 Hrs.]

Selection of Material Handling Equipments:-
Factors affecting for selection; Material Handling equation; choices of Material Handling equipment; general analysis procedures; basic analytical techniques; the unit load concept; selection of suitable types of systems for applications; activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.

UNIT – III [8 Hrs.]

Design of Mechanical Handling Equipments:-
[A] Design of Hoists:- Drives for hoisting, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms.

[B] Design of Cranes:- Hand-propelled and electrically driven EOT overhead traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary Cranes with fixed radius; fixed post and overhead traveling cranes; Stability of stationary Rotary and traveling rotary cranes.

UNIT – IV [8 Hrs.]

Design of load lifting attachments:-
Load chains and types of ropes used in Material Handling System; Forged, Standard and Ramshorn Hooks; Crane Grabs and Clamps; Grab Buckets; Electromagnet; Design consideration for conveyor belts; Application of attachments.

UNIT – V [8 Hrs.]

Study of systems and Equipments used for Material Storage:-
Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors;Vibratory Conveyors; Cabin conveyors; Mobile racks etc.

UNIT – VI [8 Hrs.]

Material Handling / Warehouse Automation and Safety considerations:-
[A] Storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; Levels and Means of Mechanizations.
[B] Safety and design; Safety regulations and discipline.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

Material Handling Equipments, N. Rudenko, Peace Publishers.
Material Handling System Design, James M. Apple, John-Willey and Sons Publication.
Material Handling, John R. Immer, McGraw Hill Co. Ltd.
Material Handling in Machine Shops, Colin Hardi, Machinery Publication Co. Ltd.
Material Handling Equipment, M .P. Nexandrn, MIR Publishers.
Conveying Machines - Volumes I and II, Spivakovsy A.O. and Dyachkov V.K., MIR Publishers.
Design Data Book, PSG.

REFERENCE BOOKS:

Bulk Solid Handling, C. R. Cock and J. Mason, Leonard Hill Publication Co. Ltd.
Material Handling Hand Book, Kulwiac R. A., John Wiley Publication.

BEPOE803T (BEELE803T)) SWITCHGEAR & PROTECTION

Credits: 05

Teaching Scheme
Lectures: 4 hours/week
Tutorial: 1Hour/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Learning Objectives	**Learning Outcomes**
Students will understand • The theory and applications of the main components used in power system protection. • The protection systems used for electric machines, transformers, bus bars, transmission lines. • The theory, construction, and applications of main types of circuit breakers. • to design the feasible protection systems needed for each main part of a power system	Students has understood • Theory & application of main components used in power system protection. • Protection systems used for electric machines, transformers, bus bars, transmission lines. • Theory, construction, and applications of main types of circuit breakers. • Design the protection systems needed for each main part of a power system.

Unit 1:- General philosophy of Protective Relaying: Protective zones, primary protection, Back up protection Remote and Local Back up selectivity.

Unit 2:- Medium voltage Line Protection: Over current relaying, directional- over current relay.

Unit 3: High Voltage Line Protection: Distance relays, carrier distance Schemes. Unit carrier schemes.

Unit 4: Equipment Protection: Principles of differential relaying, protection of generator, transformers and bus Bars by differential relaying and other relays. Protection of Induction Motors against overloads, short circuits. thermal relays, miniature circuit breakers.

Unit 5: - Introduction static relays *:* Comparison of static and electro mechanical relays, two input amplitude and phase comparator and their duality. Generation of various distance relay characteristics using above comparators.

Unit 6: Switchgear: Circuit breakers. Arc interruption theory, recovery and Restricting voltages, RRRV, breaking of inductive and capacitive currents, C.B, ratings, different media of arc interruption*,* overview of oll circuit breakers, construction and operation of Air blast, SF6

and vacuum breakers.

Books:

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Switchgear and Protection	Sunil S Rao	Khanna Publishers, 1992
Power System Protection and Switchgear	B. Ravindranath, M. Chander	New Age International
Power System Protection and switchgear	B.Ram	Tata McGraw Hill
Reference Books		
The art and science of protective relaying	C. Russell Mason	Wiley, 1956
Protective Relaying, Vol. I & II	Warrington	Springer

BEPOE803P (BEELE803P)) SWITCHGEAR & PROTECTION

Credits: 01

Teaching Scheme
Practical: 2 hours/week

Examination Scheme
University Assessment: 25 Marks
College Assessment: 25 Marks

Practicals based on above syllabus

BEPOE804T POWER PLANT ERECTION & COMMISSIONING

Credits: 04

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

Course objective

The area of thermal power plant erection and commissioning is quite complex. A properly erected and commissioned plant ensures its maximum availability with smooth and efficient operation. The objective of the course is to make the student aware about various activities involved in power plant, their sequence, interdependence and significance.

Unit I **Various schemes of Thermal Power Plant** **8 Hrs**

Schemes of Boiler, Turbine, generator and Balance of plant, Network techniques CPM/PERT for planning erection and commissioning activities

Unit II **Thermal power Plant Erection** **8 Hrs**

Methods and techniques of erection, Boiler, Turbine and generator erection, alignment of rotating machinery
.

Unit III **Boiler Commissioning** **8 Hrs**

Hydraulic Test, , Chemical cleaning of Boiler, Air and Flue gas tightness Test, Trial Run of auxiliaries, Alkali Boil out, Acid cleaning, Thermal flow test of water walls and economizers, steam blowing, safety valve setting, commissioning of Boiler auxiliaries, ESP etc.

Unit IV **Commissioning of Turbine & its Auxiliaries.** **8 Hrs**

Alkaline flushing and commissioning of Regenerative feed heating system. Acid cleaning of oil pipe lines, oil flushing procedures of lub oil, Governing Systems. Turbine lub oil flow testing, steam blowing, Reheater safety valve setting, vacuum tightness test.

Unit V **Commissioning of Generator & its Auxiliaries** **8 Hrs**

Generator testing, Rotor and Stator Cooling system, Excitation system

Unit VI **Commissioning of Electrical Systems and C & I Systems** **8 Hrs**

Transformers, Circuit Breakers, Isolators, CTs, PTs, Rectifiers and D.C. Systems, Commissioning of Control Valves and Actuators, Tuning of controllers.

Books Recommended

1. Commissioning Manual - BHEL Publication
2. NTPC Manuals on Erection and commissioning

BEPOE805T POWER PLANT MAINTENANCE PRACTICES

Credits: 04

Teaching Scheme
Lectures: 3 hours/week
Tutorial: 1Hour/week

Examination Scheme
Duration of paper: 3 Hours
University Assessment: 80 Marks
College Assessment: 20 Marks

OBJECTIVE: To develop student's ability to 1) know and understand established maintenance procedures and practices in power plants 2) analyze engineering maintenance problems in a simple and logical manner and to apply a few well understood basic principles to find its solution.

Unit I : **8 Hrs**

Different types of valves in thermal power plant, their construction and applications. Valve characteristics, replacement of worn out or damaged parts of valves, valve lapping, blue matching, use of correct lapping discs, overhaul and maintenance of valves. Setting of safety valves. Introduction to bearings, classification, application and selection of bearings, Plain bearing and antifriction bearing maintenance. Bearing clearances, gap adjustments of sleeve bearing/journal. Grooving on plain bearings, scrapping of journal bearings, mounting and dismounting of antifriction bearings, bearing designations.

8 Hrs

Unit II:

Power station pumps : Construction and functional features of power station pumps, Balancing arrangements in centrifugal pumps, Sealing of pump, Maintenance of stuffing box and mechanical seal, Maintenance and trouble shooting of BFP, CWP, CEP, GS and positive displacement pumps, gland packing fitting, bearing removal and inspection, clearances in pumps and renovation of wear rings and impellers. Troubleshooting of pumps using vibration analysis. Theory of alignment, prior checks and shim thickness calculation, shaft alignment using dial gauges, Construction, working and maintenance of Fluid coupling,

Unit III: **8 Hrs**

Condition monitoring, NDT/NDE and troubleshooting techniques: Human senses (look, listen, feel, smell etc.), Walk around analysis, Basic Inspections (Mechanical Inspection, Electrical Inspection, Leak Detection), Vibration analysis of rotating machines, Oil chemical analysis, Lubricant monitoring (Spectrographic oil analysis) or Wear Debris analysis, Orbit analysis, Infrared Thermograpy, Acoustic and Ultrasonic emission, NDT Inspections (Magnetic Particle Testing, Dye-Penetrant test, Endoscopy, Eddy Current testing, etc.), NDE Techniques (Microscopy, Optics, Electromagnetics and radiography) , Motor Current Signature Analysis (MCSA), Rated or Process parameters monitoring, Calibration / Instruments health Monitoring, Water chemistry and corrosion monitoring, Thermal and pressure loading monitoring, Trend analysis, alarm limits and correlation, Performance / Efficiency monitoring and equipment tests. Equipment condition assessment, Failure History and logbooks, Failure classification, Functional failures, Machine fault/failure matrix, Failure Mode and Effect Analysis, Introduction to fault/failure screening, Fault tree construction and analysis,

Unit IV: **8 Hrs**

Maintenance of turbine and its auxiliaries: Steam Turbine bearing pedestals and support system, Turbine expansions, Constructional and functional features of Lube oil system, Preventive and predictive maintenance of Lube oil system, Turbine vibrations and signature analysis. Maintenance activities during annual and capital overhaul of steam turbine. Offline and online cleaning and maintenance of condensers. Maintenance of HP, LP heaters and ejector.

Unit V **8 Hrs**

Maintenance of Main Boiler, fans and coal mills: Maintenance of Main Boiler including pressure parts, Maintenance activities during capital overhaul of Boiler, Boiler tube failures and tube thickness survey, Maintenance of PA, ID, FD fans and coal mills.

Unit VI: **8 Hrs**

Maintenance Planning and cost control – Availability, Maintainability and Reliability, Overview of maintenance planning strategies, Planning of routine and preventive maintenance, Predictive maintenance, proactive maintenance, Introduction to RCM, planning techniques (CPM/PERT), Planning of capital / Annual overhaul of major equipments like boiler and steam turbine, purchasing and stores control, cost control, Introduction to maintenance risk analysis, introduction to computerized inventory and maintenance planning.

Books Recommended:

1. O & M Manuals of BHEL
2. O & M Manuals of NTPC
3. Maintenance planning and cost control by Kelly (East West Publisher).

BEPOE806P POWER PLANT OPERATION PRACTICE

Credits: 03

Teaching Scheme **Examination Scheme**

Practical: 4 hours/week

Tutorial: 1Hour/week University Assessment:50 Marks

College Assessment: 50 Marks

Course Objective –

The objective of the course is to give the students practical training of the thermal power plant operation procedures with the help of power plant simulator. By performing various exercises the student shall learn about the sequential operation procedure for a typical thermal power plant enabling them to understand the integrated unit operation.

- Following practicals/exercises shall be performed by the students with Actual Hands on practice on Thermal Power plant Simulator to learn thermal power plant Operation procedures like cold start-up Planned shut down and hot re-start and starting and stopping of power plant auxiliaries etc. This will normally include following activities.

1. Checking of electrical supply system, line up of GSW system, DM make up system, Instrument and service air compressors and CW system
2. Boiler drum filling, Dearator filling, charging of PRDS, Deaerator pegging, SCAPH charging, Line up of LDO and HFO
3. Line up and Start up of Airheater, ID fan, FD fan, establishing minimum air flow, boiler purging, setting furnace to windbax Dp, boiler light up and pressure raising etc
4. Starting turbine lub oil system, Readyness of Gen seal oil system, Hydrogen pressure and purity, Putting turbine on turning gear
5. Line up and starting of Condensate extraction pump, Boiler feed pump, Condenser vacuum pulling
6. Boiler blowdown and relightup of boiler with HFO, Main steam line charging, Taking HP/LP bypass system into service
7. Building up steam parameters for rolling of tubine, Turbine rolling and raising speed to 3000 rpm
8. Generator synchronization and taking house load
9. Establishing PA fan, Coal mill and coal feeder, raise steam parameters, increasing load, taking LP heaters on service
10. Establishing coal cycles, 2nd ID, FD and BFP. Load raising to 210 MW.
11. Control of drum level, Main steam temperature, HRH steam temperature
12. Planned shut down of Unit for hot restart
13. Hot start up procedure, Boiler light up, Rolling the turbine through ATRS.

Books Recommended

1. NPTI power plant simulator manuals
2. NTPC Manuals
3. NPTI operation manual

BEPOE807P PROJECT WORK

Credits: 06

Teaching Scheme
Practical 6 hours/week

Examination Scheme
University Assessment:75 Marks

College Assessment: 75 Marks

The project work may be carried out on any of the following broad based work.

1. Detailed design of some mechanical system. This may comprise of machines, Thermal, Hydraulic/Pneumatic system related to Industry.

2. Detailed experimental/Practical verification of some thermal Engineering systems.

3. Detailed study of some manufacturing industry. This study may comprise of various aspects such as plant layout, mechanical handling system, assembly shop, quality control system, maintenance system, various service systems, design, development and planning functions, techno-economic studies etc.
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4. Study may also comprise of in-depth and exhaustive analysis of any one of the above mentioned systems.
5. Detailed study of the literature on a relevant topic alongwith the comparative study of various approaches studied under literature.