Annexure - B

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Bachelor of Engineering (Mechanical Engineering)

III Semester B.E. (Mechanical Engineering)

Subject Code	Subject	Teaching Scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T	P		Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks	Max. Marks University Assessment	Max. Marks College Assesment	Total Marks	Min. Passing Marks
BEME301T	Applied Mathematics- III[#]	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME302T	Kinematics of Machine	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME303T	Fluid Mechanics	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME304T	Manufacturing Processes	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME304P	Manufacturing Processes	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME305T	Engineering Metallurgy	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME305P	Engineering Metallurgy	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME306P	Machine Drawing	-	02	02	04	-	-	-	-	-	50	50	100	50
BEME307P	Technical Report and Seminar	-	-	02	02	-	-	-	-	-	-	50	50	25
Total		**15**	**07**	**08**	**-**	**-**	**400**	**100**	**500**	**-**	**100**	**150**	**250**	**-**
Semester Total		**30**			**28**	**Marks 750**								

[#] Applied Mathematics – III (BEME301T) subject pertains to Board of Studies in Applied Sciences & Humanities

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Bachelor of Engineering (Mechanical Engineering)

IV Semester B.E. (Mechanical Engineering)

Subject Code	Subject	Teaching Scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T	P		Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks	Max. Marks University Assessment	Max. Marks College Assesment	Total Marks	Min. Passing Marks
BEME401T	Applied Mathematics- IV #	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME402T	Engineering Thermodynamics	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME403T	Hydraulic Machines	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME403P	Hydraulic Machines	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME404T	Machining Processes	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME404P	Machining Processes	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME405T	Mechanics of Material	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME405P	Mechanics of Material	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME406T	Environmental Studies	03	-	-	College Assessment in Grades as O, A, B, C, (Evaluation Guidelines mentioned in the Syllabus of concerned Subject)									
BEME407P	Mini Project	-	-	02	02	-	-	-	-	-	-	50	50	25
Total		**18**	**05**	**08**	**-**	**-**	**400**	**100**	**500**	**-**	**75**	**125**	**200**	**-**
Semester Total		**31**			**25**	**Marks 700**								

Applied Mathematics – IV (BEME401T) subject pertains to Board of Studies in Applied Sciences & Humanities

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Engineering and Technology

B.E. (MECHANICAL ENGINEERING)

ABSORPTION / EQUIVALENCE SCHEME

For the Failures/Ex-Students of Third to Eighth Semester of B.E. (Mechanical Engineering)

THIRD SEMESTER B.E. (Mechanical Engineering)

As Per Credit Grade Semester Scheme				As per Semester Scheme		
Subject Code	**Subject**	**Theory/ Practical**		**Subject Code**	**Subject**	**Theory / Practical**
BEME301T	Applied Mathematics- III	Theory		3ME1	Applied Mathematics - III	Theory
BEME302T	Kinematics of Machine	Theory		3ME2	Theory of Machines - I	Theory
BEME303T	Fluid Mechanics	Theory		3ME3	Fluid Power – I	Theory
BEME404T	Machining Processes	Theory		3ME4	Manufacturing Process - I	Theory
BEME404P	Machining Processes	Practical		3ME4	Manufacturing Process - I	Practical
BEME305T	Engineering Metallurgy	Theory		3ME5	Engineering Metallurgy	Theory
BEME305P	Engineering Metallurgy	Practical		3ME5	Engineering Metallurgy	Practical
---	---	---		3ME6	Computer Applications - I	Theory
BEME506P	Computer Applications - I	Practical		3ME6	Computer Applications - I	Practical
BEME507P	Industrial Visit	Practical		3ME7	Industrial Visit	Practical
BEME304T	Manufacturing Processes	Theory		4ME6	Manufacturing Process – II	Theory
BEME304P	Manufacturing Processes	Practical		4ME6	Manufacturing Process – II	Practical
BEME306P	Machine Drawing	Practical		6ME6	Machine Drawing	Practical
BEME307P	Seminar	Practical		5ME7	Seminar	Practical

FOURTH SEMESTER B.E. (Mechanical Engineering)

As Per Credit Grade Semester Scheme				As per Semester Scheme		
Subject Code	**Subject**	**Theory/ Practical**		**Subject Code**	**Subject**	**Theory/ Practical**
BEME401T	Applied Mathematics- IV	Theory		4ME1	Applied Mathematics – IV	Theory
BEME405T	Mechanics of Material	Theory		4ME2	Machine Design - I	Theory
BEME402T	Engineering Thermodynamics	Theory		4ME3	Engineering Thermodynamics	Theory
BEME605T	Dynamics of Machines	Theory		4ME4	Theory of Machines –II	Theory
BEME605P	Dynamis of Machines	Practical		4ME4	Theory of Machines -II	Practical
BEME403T	Hydraulic Machines	Theory		4ME5	Fluid Power – II	Theory
BEME403P	Hydraulic Machines	Practical		4ME5	Fluid Power – II	Practical
BEME304T	Manufacturing Processes	Theory		4ME6	Manufacturing Process – II	Theory
BEME304P	Manufacturing Processes	Practical		4ME6	Manufacturing Process – II	Practical
BEME406T	Environmental Studies	Theory		---	Environmental Studies	Theory
BEME407P	Mini Project	Practical		4ME7	Mini Project	Practical
BEME404T	Machining Processes	Theory		3ME4	Manufacturing Process - I	Theory
BEME404P	Machining Processes	Practical		3ME4	Manufacturing Process - I	Practical
BEME405P	Mechanics of Material	Practical		---	---	---

COURSE SCHEME
EXAMINATION SCHEME
ABSORPTION SCHEME
&
SYLLABUS
of
Seventh & Eighth Semester
(As per Credit Base System)

Of

BACHELOR OF ENGINEERING (B.E.)
in
MECHANICAL ENGINEERING

Of

RASHTRASANT TUKDOJI MAHARAJ
NAGPUR UNIVERSITY, NAGPUR

Annexure - B

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Bachelor of Engineering (Mechanical Engineering)

VII Semester B.E. (Mechanical Engineering)

Subject Code	Subject	Teaching Scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T	P		Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks	Max. Marks University Assessment	Max. Marks College Assesment	Total Marks	Min. Passing Marks
BEME701T	Industrial Engineering	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME702T	Elective-I	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME703T	Computer Aided Design	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME703P	Computer Aided Design	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME704T	Energy Conversion - II	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME704P	Energy Conversion - II	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME705T	Design of Mechanical Drives	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME705P	Design of Mechanical Drives	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME706P	Project Seminar	-	-	03	03	-	-	-	-	-	-	50	50	25
Total		**15**	**05**	**09**	**-**	**-**	**400**	**100**	**500**	**-**	**75**	**125**	**200**	**-**
Semester Total		**29**			**26**	**700 Marks**								

Elective – I (BEME702T):

BEME702T1: Industrial Robotics
BEME702T2: Tool Design
BEME702T3: Automobile Engineering
BEME702T4: Power Plant Engineering
BEME702T5: Synthesis of Mechanisms
BEME702T6: Material Handling System

All subjects pertains to Board of Studies in Mechanical Engineering.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Bachelor of Engineering (Mechanical Engineering)

VIII Semester B.E. (Mechanical Engineering)

Subject Code	Subject	Teaching Scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T	P		Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks	Max. Marks University Assessment	Max. Marks College Assesment	Total Marks	Min. Passing Marks
BEME801T	Industrial Management	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME802T	Elective – II	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME802P	Elective – II	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME803T	Elective – III	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME804T	Automation in Production	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME804P	Automation in Production	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME805T	Energy Conversion - III	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME805P	Energy Conversion - III	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME806P	Project	-	-	06	06	-	-	-	-	-	75	75	150	75
Total		**15**	**05**	**12**		**-**	**400**	**100**	**500**	**-**	**150**	**150**	**300**	**-**
Semester Total		**32**			**29**	**800 Marks**								

Elective – II (BEME802T, BEME802P):

BEME802T1/P1: Finite Element Method
BEME802T2/P2: Computer Integrated Manufacturing
BEME802T3/P3: Industrial Fluid Power
BEME802T4/P4: Management Information Systems
BEME802T5/P5: Refrigeration & Air-Conditioning
BEME802T6/P6: Stress Analysis

Elective – III (BEME803T):

BEME803T1: Advanced Manufacturing Techniques
BEME803T2: Machine Tool Design
BEME803T3: Renewable Energy Systems
BEME803T4: Mechanical Vibrations
BEME803T5: Advance I.C. Engine
BEME803T6: Tribology

All subjects pertains to Board of Studies in Mechanical Engineering.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Engineering and Technology

B.E. (MECHANICAL ENGINEERING)

ABSORPTION SCHEME

SEVENTH SEMESTER B.E. (Mechanical Engineering)

As per Non-Credit Base Scheme (Non-CBS)				As Per Credit Base Scheme (CBS)		
Subject Code	**Subject**	**Theory /Practical**		**Subject Code**	**Subject**	**Theory /Practical**
7ME1	Production Technology - II	Theory		BEME701T	Industrial Engineering	Theory
7ME2	Elective – I: Industrial Robotics	Theory		BEME702T1	Elective - I : Industrial Robotics	Theory
	Elective – I: Tool Design	Theory		BEME702T2	Elective – I: Tool Design	Theory
	Elective – I: Synthesis of Mechanisms	Theory		BEME702T5	Elective – I: Synthesis of Mechanisms	Theory
	Elective – I: Power Plant Engineering	Theory		BEME702T4	Elective – I: Power Plant Engineering	Theory
	Elective – I: Project Evaluation and Management	Theory		---	---	---
	Elective – I: Material Handling System	Theory		BEME702T6	Elective – I: Material Handling Systems	Theory
	Elective – I: Advance I.C. Engines	Theory		BEME803T5	Elective – I: Advance I.C. Engine	Theory
7ME3	Elective – II: Finite Element Method	Theory / Practical		BEME802T1/P1	Elective – II: Finite Element Method	Theory / Practical
	Elective – II: Computer Integrated Manufacturing	Theory / Practical		BEME802T2/P2	Elective – II: Computer Integrated Manufacturing	Theory / Practical
	Elective – II: Industrial Fluid Power	Theory / Practical		BEME802T3/P3	Elective – II: Industrial Fluid Power	Theory / Practical
	Elective – II: Management Information System	Theory / Practical		BEME802T4/P4	Elective – II: Management Information System	Theory / Practical
	Elective – II: Stress Analysis	Theory / Practical		BEME802T6/P6	Elective – II: Stress Analysis	Theory / Practical
	Elective – II: Refrigeration & Air-Conditioning	Theory / Practical		BEME802T5/P5	Elective – II: Refrigeration & Air-Conditioning	Theory / Practical
7ME4	Energy Conversion - II	Theory		BEME704T	Energy Conversion - II	Theory
7ME4	Energy Conversion - II	Practical		BEME704P	Energy Conversion - II	Practical
7ME5	Machine Design - III	Theory		BEME705T	Design of Mechanical Drives	Theory
7ME5	Machine Design - III	Practical		BEME705P	Design of Mechanical Drives	Practical
7ME6	Project Seminar	Practical		BEME706P	Project Seminar	Practical

EIGHTH SEMESTER B.E. (Mechanical Engineering)

As per Non-Credit Base Scheme (Non-CBS)				As Per Credit Base Scheme (CBS)		
Subject Code	**Subject**	**Theory/ Practical**		**Subject Code**	**Subject**	**Theory/ Practical**
8ME1	Industrial Management	Theory		BEME801T	Industrial Management	Theory
8ME2	Elective – III: Advanced Manufacturing Techniques	Theory		BEME803T1	Elective – III: Advanced Manufacturing Techniques	Theory
	Elective – III: Machine Tool Design	Theory		BEME803T2	Elective – III: Machine Tool Design	Theory
	Elective – III: Renewable Energy Systems	Theory		BEME803T3	Elective – III: Renewable Energy Systems	Theory
	Elective – III: Vibrations	Theory		BEME803T4	Elective – III: Mechanical Vibrations	Theory
	Elective – III: Mechatronics	Theory		---	---	---
	Elective – III: Automobile Engineering	Theory		BEME702T3	Elective – I: Automobile Engineering	Theory
	---	---		BEME803T6	Elective – III: Tribology *	Theory
8ME3	Automation in Production	Theory		BEME804T	Automation in Production	Theory
8ME3	Automation in Production	Practical		BEME804P	Automation in Production	Practical
8ME4	Energy Conversion - III	Theory		BEME805T	Energy Conversion - III	Theory
8ME4	Energy Conversion - III	Practical		BEME805P	Energy Conversion - III	Practical
8ME5	Computer Aided Design	Theory		BEME703T	Computer Aided Design	Theory
8ME5	Computer Aided Design	Practical		BEME703P	Computer Aided Design	Practical
8ME6	Project	Practical		BEME806P	Project	Practical

* Additional Subjects in CBS

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Engineering and Technology

B.E. (MECHANICAL ENGINEERING): SEVENTH SEMESTER

BEME701T: INDUSTRIAL ENGINEERING (Theory)

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: The course objective is to introduce the discipline and profession of industrial engineering. This course provides knowledge and skills for designing work system as a form of integrated system, planning and controlling of a production system, ability to design a facility lay out, problem and organization of design process and value engineering and skill to apply methods in value engineering to improve the competitiveness of product/service, to apply ergonomics principles in industry and for planning and controlling maintenance system.

UNIT – I **[8 Hrs.]**

Work Study: Productivity – Concept and objectives of productivity, Types of productivity, factors affecting productivity. Tools and techniques to improve productivity, Measurement of productivity. Work study and methods study : Definitions, objectives, steps in method study, process charts, string diagram, motion study, micro motion study, SIMO Chart.

UNIT – II **[8 Hrs.]**

Work measurement : Objectives, definition, stop watch study, work sampling , PMTs, MTM & Work factor method.
Ergonomics : Objectives, Human factors in Engg., Man machine system, display design, design of controls. Principles of motion economy, work place design.

UNIT – III **[8 Hrs.]**

Forecasting: Need for forecasting, classification of forecasting methods like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method.

UNIT – IV **[8 Hrs.]**

Maintenance: Objectives, Types of maintenance, preventive, predictive, break down maintenance. Reliability and maintainability analysis. Failure data analysis, reliability, MTBT, MTTR, Batch tub curve, series parallel and stand by system.

UNIT – V **[8 Hrs.]**

Quality Control: Definition, function, objective, characteristics. Quality, quality of design quality of conformance, process control charts and process capability. Types of sampling concepts & significance. Acceptance sampling, OC curves, sampling plans, inspection: types & objectives.

UNIT – VI **[8 Hrs.]**

Statistical Quality Control**:** Quality assurance & quality Planning, Quality audit, Vendor quality rating, TQM, ISO: 9000, BIS 14000. Philosophy of Six Sigma, approaches to quality improvement.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Industrial Engineering & Production Management, Martand Telsang, S. Chand & co.
2. Maynard H.B.: Industrial Engineering Handbook, McGraw Hill.
3. Industrial Engineering. & Management, Arun Vishwanath, SciTech Publication.
4. Industrial Engineering and Management, N.V.S. Raju, Cengage Publication.
5. Statistical Quality Control, E. Grant & R. S. Leavenworth, McGraw Hill.

REFERENCE BOOKS:

1. Work Study, ILO.
2. Motion & Time study by R.M. Barnes, John Wiley.
3. Ergonomics by K.F.H. Murell, Springer.

BEME702T1: ELECTIVE-I: INDUSTRIAL ROBOTICS (Theory)

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 aimed to understand Robots, their components, functions, programming and applications. During this course students shall be able to describe industrial robot designs and how they are incorporated in industry. Further student will be able to identify robot classification systems, robot components, tooling, sensors and support systems. He will also learn; how robots are interfaced with other machines in the industrial setting and shall utilize learned techniques to program industrial robots, integrate robotics for different tasks.

UNIT – I **[8 Hrs.]**

Fundamentals of Robotics: Introduction Automation & Robotics robot applications robotic systems, robot anatomy and robot configurations, Joint types used in robots, robot wrists, joint notation schemes, work value for various robot anatomies, robot specifications, introduction to robot arm dynamics.

UNIT – II **[8 Hrs.]**

Robots end-effectors-classification of end-effectors, mechanical grippers, hooking or lifting grippers, grippers for molten metal's, plastics, vacuum cups, magnetic grippers, electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers.

UNIT – III **[8 Hrs.]**

Robot Kinematics - Forward & reverse kinematics, forward and reverse transformation of two DOF & three DOF 2-D manipulator, homogeneous transformations. Robot drives & control-pneumatic power drives, hydraulic systems, electric drives, robot controllers-servo and non servo systems, motion control of robots, point to point and continuous path control, teaching of robots, robot programming methods. Basic control system models, slew motion, joint-interpolated motion and straight line motion.

UNIT – IV **[8 Hrs.]**

Robot Sensors: Scheme of robotic sensors, contact type sensors, force, torque, touch, position, velocity sensors, non-contact type sensors, electro-optical imaging sensors, proximity sensors, range imaging sensors, robot environment and robot input/output interfaces, machine intelligence, safety measures in robots.

UNIT – V **[8 Hrs.]**

Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, error detection and recovery, work cell controller, robot cycle time analysis.

UNIT – VI **[8 Hrs.]**

Quantitative Techniques for economic performance of robots: Robot investment coats, robot operating expenses. General considerations in robot material handling, material transfer applications, pick and place operations, palletizing and related operations, machine loading and unloading, die casting, plastic moulding, forging, machining operations, stamping press operations using robots.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Robotics Technology & Flexible Automation, S. R. Deb, Tata McGraw Hill.
2. Industrial Robotics, M. P. Groover, McGraw Hill.
3. Robotics for Engineers, Y. Koren, McGraw Hill.

REFERENCE BOOKS:

1. Robots & Manufacturing Automation by Asfahal C. Ray, John Wiley.
2. Robotic Engineering, Richard D. Klafter, PHI.
3. Robots & Control, Mittal & Nagrath, Tata McGraw Hill.

BEME702T2: ELECTIVE – I: TOOL DESIGN (Theory)

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 deals with various types of cutting tools, the mechanics of metal cutting, design of gauges, design of metal cutting tools and also to understand various press working operations along with die design for sheet metal working, basics of forging dies and design of jigs and fixtures.

UNIT – I **[8 Hrs.]**

Theory of metal cutting: Introduction, cutting tool materials, different types of cutting tools used for machining, designation of cutting tools, different types of systems used for designating cutting tools, types of chips, Merchant's theory, determination of shear angle, velocity and force relationship, cutting power, energy. Tool wear, tool life criteria, variables affecting tool life, machinability.

UNIT – II **[8 Hrs.]**

Design of cutting tools: Design of single point cutting tools and form tools. Drills- Introduction, types, geometry, design of drills. Milling cutters – Introduction, types, geometry and design of milling cutters. Reamers, taps and broaches – Constructional features only.

UNIT – III **[8 Hrs.]**

Press working (Cutting operation dies): Introduction, different types of operations performed on presses, different types of presses, capacity calculation of presses. Different types of dies- Simple dies, compound dies, progressive dies, combination dies, transfer dies. Cutting operations, cutting force, methods for reducing cutting forces, cutting clearance, effect of cutting clearance on sheet metal, design of various types of dies for cutting operation.

UNIT – IV **[8 Hrs.]**

Press working (Bending. Forming & Drawing dies):

Bending: Bending terminology, types of bending operation, blank development, spring back and its prevention, bending force and design of bending dies.

Forming: Introduction, types of forming dies - Solid form dies, pad type form dies, curling dies, embossing dies, coining dies and its design.

Drawing: Metal flow in drawing operation, factors affecting metal flow, calculation of number of draws, development of blank, drawing force, blank holding force and design of various types of drawing dies i.e. single action draw die, double action draw die and inverted dies.

UNIT – V **[8 Hrs.]**

Forging die design: Introduction, classification of forging dies, single impression dies, multiple impression dies. Forging design factors – Draft, fillet and corner radius, parting line, shrinkage and

die wear, mismatch, finish allowances, webs and ribs. Preliminary forging operations – Fullering, edging, bending, drawing, flattering, blacking, finishing, cut off.

Die design for machine forging - Determination of stock size in closed and open die forging. Tools for flash trimming and hole piercing, materials and manufacture of forging dies.

UNIT – VI **[8 Hrs.]**

Design of jigs and fixtures: Introduction, concept of degrees of freedom, 3-2-1 principle of location, principles of location and clamping for jig and fixtures design, different types of locators and clamps, jig bushes, its types, materials and heat treatments, different types of jigs and its design.

Essential features of different types of fixtures, design of fixtures, indexing jigs and fixtures. automatic clamping devices.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Tool Design, Donaldson, Tata Mc-Graw Hill.
2. Fundamentals of Tool Design, Kempster
3. Computer Aided Fixture design, Rongi Yeming, Marcel Dekker Inc. NY.
4. Unconventional Clamping Systems by Juran and Grant.
5. Jigs and Fixtures Design by Joshi, Tata McGraw Hill.
6. Tool Design, S. K. Basu, India Book House.

REFERENCE BOOKS:

1. Fundamentals of Tool Design, Pollock, Reston Publishing Company.
2. Fundamentals of Tool Design, ASTME, Tata McGraw Hill.

BEME702T3: ELECTIVE – I: AUTOMOBILE ENGINEERING (Theory)

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 automobile and its components. It includes information of different chassis, frame, power plant, clutch, gear box, transmission system, brakes, steering systems, wheels, tyres, suspension systems and electrical systems used in automobile. At the end of this course, students will be able to understand the basics about the vehicle, its components and recent advances in automobiles.

UNIT – I **[8 Hrs.]**

Introduction, Automobile history and development.
Chassis and Frame: Layout of chassis & its main components. Types of frames, conventional frames and unitized chassis, articulated, rigid vehicles, prime movers, hybrid car & electric car.
Power Plant: Constructional features of different types of engines used in automobiles. Fuel supply systems, cooling systems, lubrication systems.

UNIT – II **[8 Hrs.]**

Clutch: Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single & multi plate clutch, fluid clutch.
Gear Box: Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism, lubrication and control. Torque converter, semiautomatic & automatic transmission.

UNIT – III **[8 Hrs.]**

Transmission system: Propeller shaft, universal joint, Hotchkiss drive, torque tube drive. Differential – Need and types. Rear axles and Front axles.
Brakes: Need & types, mechanical, hydraulic & pneumatic brakes, electrical brakes, engine exhaust brakes, drum and disc brakes, comparison and details of components. Brake adjustment.

UNIT – IV **[8 Hrs.]**

Steering systems: principle of steering, center point steering, steering linkages, steering geometry and wheel alignment, power steering.
Suspension systems: Function of spring and shock absorber, conventional and Independent suspension system, Telescopic shock absorber, linked suspension systems, rubber, plastic, hydro & pneumatic suspension system.

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UNIT – V **[8 Hrs.]**

Electrical systems: Battery construction, maintenance, testing and charging, cutout, lighting circuit, horn, side indicator, wiper and panel board instruments. Battery, magneto and electronic ignition systems. Automobile air-conditioning.

Wheels and Tyres: Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, comparison of radial and bias-ply tyres, tyre construction, tyre materials, factor affecting tyre life, precautions regarding the tyres and wheel balancing.

UNIT – VI **[8 Hrs.]**

Body and Safety Considerations and Modern Developments in Automobiles: Requirements of automobile body, materials for body work, safety considerations, crash worthiness. Recent advances in automobiles such as ABS, electronic power steering, Active suspension, collision avoidance, intelligent lighting, navigational aids and electronic brake distribution system.

LIST OF TUTORIALS: (Minimum 8)

1) Introduction, automobile history and development.
2) Study of different types of frames, conventional frames & unitized Chassis.
3) Study of different types of engines used in automobiles.
4) Discussion and demonstration of Clutches.
5) Discussion and demonstration of Gear box.
6) Discussion and demonstration of Brakes.
7) Discussion on different steering systems.
8) Discussion on precautions regarding the tyres and wheel balancing.
9) Study of automobile air-conditioning.
10) Safety considerations, crash worthiness.
11) Recent advances in automobiles.
12) Visit to automobile service station/Industry.

TEXT BOOKS:

1. Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers.
2. Automotive Mechanics, Joseph Heitner, East West Press.
3. Automobile Engineering, R.K.Rajput, Laxmi Publications.
4. Automobile Engineering R.B. Gupta, Satya Prakashan New Delhi
5. Course in Automobile Engineering, Sharma R. P, Dhanpat Rai and Sons.
6. Automobile Engineering, Ramakrishna, PHI Learning Pvt. Ltd.

REFERENCE BOOKS:

1. Automobile Mechanics, Crause, W.H., Tata McGraw Hill.
2. Vehicle and Engine Technology, Heinz Heisler, Arnold London.
3. Automotive Engines, Srinivasan S., Tata McGraw Hill.
4. Motor Vehicle Technology, J.A. Dolan, Heinemann Educational Books.
5. Automobile Engineering Vol. I, II & III, P. S. Gill, Kataria and Sons.
6. Automobile Engineering, K.K. Jain, R.B. Asthana, Tata McGraw Hill.

BEME702T4: ELECTIVE – I: POWER PLANT ENGINEERING (Theory)

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 aims to cover the detailed coverage of steam, hydro, nuclear, diesel and gas turbine power plant. It also introduces emerging technology in power generation like wood/biomass power plant, waste fire power plant. Considering current global environmental scenario, emphasis is stressed over solar hydrogen systems and fuel cell. It also aims to make the students aware about fluidised bed combustion which is one of the best clean coal technology which provides option for biomass conversion. It includes analytical and theoretical treatment of concepts with the right blend of theory design and practice of power stations along with detailing of combined cycle mode of power generation, in depth coverage of thermal, hydroelectric, nuclear, gas turbine and diesel power plant, in depth knowledge of emerging technologies (alternative power plants).

UNIT – I **[8 Hrs.]**

ECONOMICS AND POWER GENERATION:
Energy Introduction: - power and energy, sources of energy, Indian energy scenario.
Fluctuating loads: - Load curves, various terms and definitions, effect of fluctuating loads, Power and energy, sources of energy, numerical.
Economic analysis; - Tarrif load divison, cost of electricity, power plant economics, economic scheduling principle, numerical.

UNIT – II **[8 Hrs.]**

STEAM POWER PLANT:-**.**
Analysis of steam cycles: Ideal working fluid for vapour power cycles, Rankine cycle with regeneration and reheating, optimum degree of regeneration, feed water heaters.
Combine cycle power generation:-Binary vapour power cycles, combined cycle plants, gas turbine, steam turbine power plant, cogeneration.

UNIT – III **[8 Hrs.]**

COAL COMBUSTION AND STEAM GENERATORS:-
Coal –its properties, coal analysis, combustion reactions , actual air fuel ratio, draught, fans.
Combustion equipment for burning coal: - stoker, crushers, pulveriser, cyclone furnace, fuel firing methods, fluidized bed combustion.
Steam generators:- High pressure boilers, economiser, super heater, reheater, air preheater, electrostatic precipitator, fabric filter and bag houses, ash handling system, feed water treatment, steam turbine, condenser, cooling tower, steam power plant layout, pollution from steam power plant.

UNIT – IV **[8 Hrs.]**

HYDROELECTRIC POWER PLANT:-
Hydrology: - Rainfall runoff, hydrograph, flow duration curve, mass curve.

Hydroelectric power plant: - Site selection classification of hydroelectric power plant, details of different component, prime movers, governing, advantages and comparison with other power plants.

UNIT – V **[8 Hrs.]**

NUCLEAR POWER PLANT:-
Introduction to nuclear power plant: - Binding energy, energy release, nuclear reaction and its initiation, fission, component of nuclear reactors and its material, numerical based on energy release.
Nuclear reactor: - Types of reactor, PWR, BWR CANDU, gas cooled liquid metal fast breeder reactor, heavy water reactor and fusion power reactor.
Nuclear waste disposal: - Effect of nuclear waste on environment, its disposal to soil, water, air, sea etc., comparison with other power plants.

UNIT – VI **[8 Hrs.]**

Gas turbine power plant: Introduction, classification, various components, different arrangement, governing, methods to improve efficiency, comparison with other power plants.
Diesel power plant: - Introduction, outline type of engines, different components, performance, plant layout, comparison with other power plant.
Emerging technologies (alternative plants): Solar thermal conversion, photovoltaic power generation, solar hydrogen energy, fuel cell, wind energy, ocean energy, tidal energy, geothermal energy, MHD power generation. Wood/biomass power plant.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill publication.
2. Power Plant Engineering, Domkundwar, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Power Plant Technology, M. M. EI-Wakil, McGraw Hill publication.
2. Power Plant Engineering, S.Gautam, Vikas Publication Pvt. Ltd.

BEME702T5: ELECTIVE – I: SYNTHESIS OF MECHANISMS (Theory)

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 basic concepts of different mechanisms and its applications. The course also develops competency in graphical and analytical methods in solving problems of quantitative kinematic synthesis of mechanism. It also makes the students conversant with concepts of Kinematic synthesis, Path generation, Motion generation and Function generation. At the end of this course, students will be able to synthesize and develop the suitable mechanisms for various purposes/applications.

UNIT – I **[8 Hrs.]**

Introduction to Kinematic Synthesis:
Area of synthesis- Type, number and dimensional synthesis, mobility, Grublers criterion, class I & class II chain, Task of kinematic synthesis - function generation, path generation & motion generation problems with practical applications, concept of transmission angle, limiting conditions, toggle positions, circuit and branches in linkages, Grashof condition, coupler curves, Cognate-Robort-Chebyshev theorem.

UNIT – II **[8 Hrs.]**

Graphical Linkage Synthesis:
P recision points, structural error, mechanical error, Chebyshev spacing, selection of precision points, point position reduction technique, inversion technique, circle point curve, centre point curve, pole triangle, 3 position synthesis for the task of the kinematic synthesis. Path curvature theory- Eular-Savary equation, inflection points & inflection circle, Bobillier construction, Hartmann's construction, 4-position synthesis - point position reduction.

UNIT – III **[8 Hrs.]**

Analytical Linkage Synthesis:
complex number method- Modelling linkages with dyads for the task of kinematic synthesis, ground pivot specifications , Freudenstein's equation, Bloch's method of synthesis, matrix method approach, computer approach for the above problem.

UNIT – IV **[8 Hrs.]**

Optical Synthesis of a Planer Mechanisms:
Powell's search method, least square approximation, formulation for the task of kinematic synthesis.

UNIT – V **[8 Hrs.]**

Kinematic analysis of spatial mechanisms:
Kinematic analysis for linkages like RSSR, RRSS, RCCC Mechanism etc.

UNIT – VI **[8 Hrs.]**

Introduction to kinematics synthesis of Robot arms**:** Identification of task of mechanism for Robot, procedure and steps involved in kinematic synthesis in robotic applications.

LIST OF TUTORIALS:

1) Two problems on Path Generation Problem (Graphical approach).
2) Two problems on Motion Generation Problem (Graphical approach).
3) Two problems on Function Generation Problem (Analytical approach).
4) Two problems on Path Generation Problem (Analytical approach).
5) Two problems on Motion Generation Problem (Analytical approach).
6) Two problems on Function Generation Problem (Freudenstein Equation).
7) Complex number modeling for the mechanism synthesis problem. (Numerical).
8) Formulation for Optimal Synthesis of Function Generation Problem.
9) Formulation for Optimal Synthesis of Path Generation Problem.
10) Formulation for Optimal Synthesis of Motion Generation Problem.

TEXT BOOKS:

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, McGraw-Hill.
2. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw Hill.

REFERENCE BOOKS:

1. Advanced Mechanism Design–Analysis and Synthesis - Vol. I and II, A.G.Erdman and G.N. Sandor, Prentice – Hall.
2. Kinematics and Mechanism Design, C.H. Suh and C.W. Radcliffe, John Wiley & Sons.
3. Kinematics and Linkage Design, Hall, A.S., Balt Publishers.
4. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw Hill.
5. Kinematics and Dynamics of Machinery, R L Norton, McGraw Hill.

BEME702T6: ELECTIVE – I: MATERIAL HANDLING SYSTEM (Theory)

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 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:

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

REFERENCE BOOKS:

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

BEME703T: COMPUTER AIDED DESIGN (Theory)

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 aimed to develop; a framework where the designer works with computer to develop an Engineering system, CAD system that leads to effective use of computers in the entire design process, computer graphics & procedure about the geometrical modeling of engineering objects, controls on modeling parameter and graphics visualization techniques using computer. Further application of numerical method (FEA) for the analysis of mechanical elements is also included. At the end of this course, student will appreciate the importance of computers, computer graphics & numerical methods and will be able to use them for modeling, designing & analysis of mechanical components.

UNIT – I **[8 Hrs.]**

Introduction of CAD, Difference between Conventional & CAD design, Rasterisation techniques frame buffer, N-bit plane buffers, Simple color frame buffer algorithm for the generation of basic geometric entities like line, circle & ellipse by using parametric & non-parametric equations.

UNIT – II **[8 Hrs.]**

Introduction to windowing & clipping (excluding algorithm), Window and Viewport, line clipping & polygon clipping

2D transformation: Translation, Scaling, Rotation, Reflection & Shear, Concept of homogeneous representation & concatenation. Inverse Transformation (enumeration of entity on graph paper)

3D Transformation ; Translation, Scaling, Rotation, Reflection etc.

UNIT – III **[8 Hrs.]**

Techniques for Geometric Modeling:
Graphic standards, parametric representation of geometry, Bezier curves, Cubic spline curves, B-Spline curves, constructive solid geometry, Feature Based modeling, Feature recognition, Design by feature, Wire frame modeling, solid modeling of basic entities like box, cone, cylinder. CSG & B- representation technique using set theory.

Assembly modeling: Representation, mating conditions, representation schemes, generation of assembly sequences and importance of precedence diagram.

UNIT – IV **[8 Hrs.]**

Finite Element Analysis:
One Dimensional Problem: Fundamental concept of finite element method, Plain stress and strain, Finite Element Modeling, Potential Energy Approach, Galerkin Approach, Coordinate and Shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Quadratic Shape Function, Temperature Effects, Torsion of a circular shaft.

UNIT – V **[8 Hrs.]**

Truss & Two Dimensional FEM:
Plane truss problems, two dimensional problems using Constant strain triangle. Derivation of shape functions for CST element. Formulation of stiffness matrices for Truss and CST element. Preprocessing and Post processing.

UNIT – VI **[8 Hrs.]**

Optimization in Design:
Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equation, subsidiary design equations and limit equations, optimum design with normal and redundant specifications of simple machine elements like: tension bar, transmission shaft and helical spring.

LIST OF TUTORIALS: (at least Six)

1) Introduction to CAD softwares and DDA algorithm for Line generation.
2) Algorithm, flow chart and C-Program for Bressenham's Line generation
3) Algorithm, flow chart and C-Program for Bressenham's Circle generation
4) Algorithm, flow chart and C-Program for Bressenham's Ellipse generation or Ellipse generation using parametric equations.
5) Algorithm, flow chart and C-Program for Bezier Curve generation.
6) Two examples of two dimensional transformations.
7) Two examples on three dimensional transformations.
8) FE problems using one dimensional element (bar, temperature effect, torsion).
9) FE problems using plane truss element.
10) FE problems on two dimensional CST element.
11) Two numerical on optimization.

TEXT BOOKS:

1. CAD/CAM Theory and Practice, Zeid Ibrham, Tata McGraw Hill.
2. CAD/CAM, Principles and Applications, P.N. Rao, McGraw Hill.
3. Computer Aided design and Manufacturing, Lalit Narayan, Rao & Sarcar, PHI pub.
4. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A.D., Prentice Hall India.
5. Finite Element Method with application in Engineering, Y.M. Desai, T.I. Eldho, A.H. Shah, Pearson publication.
6. Optimization: Theory and Practice, Joshi M.C, Narosa Publication.

REFERENCE BOOKS:

1. Computer Graphics, D. Hearn & M.P. Baker, Pearson.
2. Computer Graphics, S. Harrington, McGraw Hill.
3. Computer Control of Manufacturing Systems, Yoram Koren, McGraw Hill.

4. First Course in the Finite Element Method, Daryl Logan, Cengage Learning.
5. Mathematical Elements for Computer Graphics, Dravid F Rogers, J. Alan Adams, McGraw Hill.
6. Schaum's Outline Series: Theory & Problems of Computer Graphics, Roy A. Plastock, Gordon Kalley, McGraw Hill.
7. Computer Graphics & Product Modeling for CAD / CAM, S.S. Pandey, Narosa publication.
8. Optimum Design of Mechanical Elements, R. C. Johnson, John Wiley & Sons.

BEME3703P: COMPUTER AIDED DESIGN (Practical)

CREDITS: 01

Teaching Scheme
Practical: 2 Hours/Week

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

LIST OF PRACTICALS:

Minimum **Six** Practicals out of following on the standard CAD/CAE packages like ANSYS / NASTRAN/ UNIGRAPHICS/ CATIA / PRO-E / any other suitable software:

1. 2-D Geometric modeling of an Engineering object, demonstrating Boolean operations like add, subtract and PAN, ZOOM, ROTATE commands
2. 3-D Geometric Modeling of an Engineering object, demonstrating extrude, revolve and loft commands.
3. Generation of at least two simple solid models showing geometric properties using any CAD software.
4. Generation of any Assembly model along with animation.
5. Static structural analysis using 1-D bar element by standard FE package.
6. Static structural analysis using 1-D truss element by standard FE package.
7. Static structural analysis using 2-D CST element by standard FE package.
8. Program for any one of optimization method.
9. Programs for generation of entities like Line, Circle, Ellipse using Bressenham's algorithms.
10. Programs for 2-D & 3-D transformations.
11. Program for Bezier Curve generation.

BEME704T: ENERGY CONVERSION - II (Theory)

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 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 multi cylinder 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) Numerical on Morse test.
7) Analysis of multicylinder engines.
8) Numerical 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.

BEME704P: ENERGY CONVERSION - II (Practical)

CREDITS: 01

Teaching Scheme	**Examination Scheme**
Practical: 2 Hours/Week	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.

BEME705T: DESIGN OF MECHANICAL DRIVES (Theory)

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 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.

BEME705P: DESIGN OF MECHANICAL DRIVES (Practical)
CREDITS: 01

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.

BEME706P: PROJECT SEMINAR

CREDITS: 03

Teaching Scheme
Practical: 03 Hour/Week

Examination Scheme
College Assessment: 50 Marks

Course Objectives and Expected Outcomes: This course is designed to inculcate the habit of learning and work execution as a member of the team to achieve the final objective. This course includes identification of a project topic, collection of literature, schedule preparation and report preparation with seminar delivery.

It is expected to select project topic as per the guidelines of the project to be undertaken in the 8th semester. It is also 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 work on project topic under the Project guide and shall present a seminar using audio-visual aids of about 15 minute duration on their project methodology and schedule of completion. Seminar delivery will be followed by question-answer session. Students shall also be required to submit detailed type written report on his work. Group of students shall be considered for this task.

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Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Engineering and Technology

B.E. (MECHANICAL ENGINEERING): EIGHTH SEMESTER

BEME801T: INDUSTRIAL MANAGEMENT (Theory)

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:

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

REFERENCE BOOKS:

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

BEME802T1: ELECTIVE-II: FINITE ELEMENT METHOD (Theory)

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: The objective of the course is to teach the fundamentals of finite element method with emphasize on the underlying theory, assumption, and modeling issues as well as providing hands on experience using finite element software for modeling & analyzing stresses, strains, deformations, natural frequencies, modal shapes etc. for machine/structural components.

UNIT – I: Introduction [12 Hrs.]

Theoretical background - Brief History of FEM, General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM.

Review of Matrix Algebra - Determinants, Matrices, Bandwidth, Inverse of a Matrix, Eigen values, Solutions of simultaneous equations – banded skyline solutions.

Review of Solid Mechanics – Stress equilibrium equations, Strain-Displacement equations, Stress-Strain-Temperature Relations, Plane stress, plane strain and axisymmetric problems, Strain energy, Total potential energy, Essential and natural boundary conditions

Governing differential equations, Variational and Weighted Residual methods, weak formulation.

Finite element modeling - Node, Element, different types of element – spring, bar, truss, beam, frame, plane stress/strain (CST element) and axi-symmetric elements, Coordinate systems – global, local and natural coordinate systems, Order of element, internal and external node(s), Degrees of freedom, primary and secondary variables, shape functions – linear, quadratic and cubic, properties of shape functions. Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Numbering system to reduce bandwidth, Boundary conditions – elimination method and penalty approach, Symmetric boundary conditions, Calculation of elemental stiffness matrix and load vector (mechanical and thermal load) using energy method Stress calculations. FE Problems on Solid mechanics 1D bar element, composite element, Thermal stress, Torsion of Circular shaft.

UNIT – II: FEM for Plane Truss, Beam and Frames [12 Hrs.]

Introduction, Plane truss formulation of stiffness matrix for truss, problem on truss, temperature stress, Introduction to space truss, formulation of stiffness matrix for space truss.

FEM for Beams and plane frame – Introduction, element formulation, load vector, boundary conditions, shear force and bending moment, Beam on elastic support, Plane frame analysis, problem on beams, problem simple plane frame (max. 2 elements/member).

UNIT – III: Multipoint Constraints 1D Element, 2D CST Element and Isoparametric Elements and Formulations [12 Hrs.]

Problems on Multipoint constraint 1D element**.**

CST ELEMENT - Coordinate mapping Natural coordinates, Area coordinates (for triangular elements), Formulation of stiffness matrix, load vector. Quadrilateral element.

ISOPARAMETRIC ELEMENTS - Isoparametric formulation, coordinate transformation , super parametric and subparametric. Convergence requirements – patch test, Uniqueness of mapping - Jacobian matrix. Formulation of element equations (stiffness matrix and load vector). Numerical integration.

FE Discretisation - Higher order elements vs. refined mesh (p vs h refinements).

UNIT – IV: Steady State Heat Transfer, Dynamic Consideration and Computer Implementation of Finite Element Method [12 Hrs.]

Steady State Heat Transfer Problems - Introduction, steady state heat transfer – 1D and 2D heat conduction and convection Governing differential equation, boundary conditions, formulation of element.

Dynamic Considerations (Undamped Free Vibration) - General dynamic equation of motion, Formulation for point mass and distributed masses – Consistent and lumped element mass matrices for bar element, truss element, beam element, CST element, axisymmetric triangular element and quadrilateral element.

Generalized eigen value problem, Evaluation of eigen values and eigenvectors, Applications to bars, stepped bars and beams for axial, transverse and torsional loading.

Computer Implementation of the Finite Element Method - Pre processing: Model definition – Nodal coordinates, element connectivity, material and element type and property definitions, type of analysis (static/dynamic), loading and boundary conditions.

Meshing techniques - free and mapped meshing, Quality checks – aspect ratio, warp angle, skew, distortion, stretch, included angle, taper.

Processing: Element level calculations, Equation assembly, Equation solver (sparse solvers, factorization, numerical/computational issues).

Post Processing: Strain and stress recovery (integration and nodal points), interpretation of results (results validation and data interpretation) and design modification.

LIST OF TUTORIALS: (at least Six)

1) Matrix Inverse and solution of matrix by Elimination and Penalty methods.
2) A numerical using Variational Methods.
3) A numerical using Weighted Residual method.
4) Any two numerical using Galerkin and Rayleigh-Ritz method.
5) A numerical using Principle of Minimum Potential Energy method.
6) Derivation of Lagrange’s shape functions for 1-D (Linear, Quadratic and Cubic) element.
7) Determinations of primary and secondary variables for bar.
8) Determinations of primary and secondary variables for truss.
9) One numerical on heat transfer.

TEXT BOOKS:

1. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A. D., Prentice Hall.
2. Finite Element Analysis, Bhavikatti S. S., New Age International Publishers.
3. Text book of Finite Element Analysis, Chanakasava Alavala, PHI Learning Private Ltd.
4. Finite Element Method with Application in Engineering, Y.M.Desai, T.I.Eldho, A.H. Shah, Pearson publication.
5. First Course in the Finite Element Method, Daryl Logan, Cengage Learning,
6. An Introduction to the Finite Element Method, J. N. Reddy, McGraw Hill.
7. The Finite Element Method in Engineering, S. S. Rao, Butterworth-Heinemann.
8. Text book of Finite Element Analysis, Seshu P., PHI Learning.

REFERENCE BOOKS:

1. Finite Element Procedures, Bathe K. J., Prentice-Hall of India.
2. Finite Element Analysis, Theory and Practice, Fagan M. J., Pearson Education Limited.
3. Finite Element Modeling for Stress Analysis, Cook R. D., John Wiley and Sons Inc.
4. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press.
5. Finite Element Analysis, Theory and Application with Ansys, S. Moaveni, Pearson.
6. Fundamental Finite Element Analysis and Applications, Asghar Bhatti, John Wiley and Sons Inc.
7. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw Hill Education Pvt. Ltd.
8. The Finite Element Method, Zienkiewicz O. C., Taylor R. I., Butterworth-Heinemann.
9. Finite Element Application, G. Lakshmi Narasaiah, BS Publications.
10. Practical Finite Element Analysis, Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N, Finite to Infinite, Pune.
11. Introduction to Finite Elements Method, Desai and Abel, CBS Publication.
12. Introduction to Finite Element Analysis Using MATLAB® and Abaqus, Amar Khennane, CRC press.

BEME802P1: ELECTIVE-II: FINITE ELEMENT METHOD (Practical)

CREDITS: 01

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

LIST OF PRACTICALS:

Minimum **Six** Practicals on the standard CAE packages like ANSYS, NASTRAN, ABAQUS, MATLAB, CATIA, UNIGRAPHICS, PRO-E or any other relevant software or freeware.

1. Static structural analysis of bar with 1-D elements using standard FEA package.
2. Static structural analysis of truss with 2-D elements using standard FEA package.
3. Static structural analysis with 2-D CST element using standard FEA package.
4. Static structural analysis with 2-D Axi-symmetric element using standard FEA package.
5. Static structural analysis of a beam in transverse loading using standard FEA package.
6. Dynamic structural analysis to determine natural frequency and mode shapes, using standard FEA package.
7. Thermal analysis to estimate nodal temperatures using standard FEA package.
8. Application of finite element analysis in the areas like Contact Mechanics, drop test, Crash Analysis, MEMS etc.
9. Finite Element Analysis of live problem/case reported or identified by an Industry.

BEME802T2: ELECTIVE – II : COMPUTER INTEGRATED MANUFACTURING (Theory)

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 acquaint the students with data bases and numerical analysis related to CIM. Students will understand Computer Aided Manufacturing (CAM) systems. Students will also get introduced with Computer Aided Process Planning (CAPP) Systems, Robotic Systems, Group Technology and Cellular Manufacturing Systems. Students will cultivate understanding about Automated Material Handling Systems, Automated Inspection Systems, Flexible Manufacturing Systems (FMS).

UNIT – I **[8 Hrs.]**

Evolution of CIM, Concept and scope of CIM, Definition of CIM, Components of CIM, benefits, limitations, Difference between Automation and CIMS, Basic Concept of Concurrent Engineering.

UNIT – II **[8 Hrs.]**

Introduction to NC, CNC & DNC, Basic Components of an NC System, classification of CNC machine tools: Based on the motion type, control loops, number of axes & power supply, Major Components of CNC system, CNC Tooling, constructional and operational features, CNC manual part programming, application, advantages & limitation of CNC.

UNIT – III **[8 Hrs.]**

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT. Part families, classification and coding, Production flow analysis, Machine cell design, Benefits.

UNIT – IV **[8 Hrs.]**

Introduction to flexible manufacturing systems: Definition of FMS, Types of FMS: by number of machines, Level of Flexibility. FMS components: Workstations, Material handling & storage system, and computer control systems. FMS Layout Configurations. Application, advantages & disadvantage of FMS.

UNIT – V **[8 Hrs.]**

Manufacturing Planning:
Computer aided process planning (CAPP), Retrieval & Generative CAPP systems. Production Planning: Aggregate Production Planning, Master production schedule, Materials requirement planning(MRP), Capacity planning, Manufacturing Resources planning (MRP II), ERP.

UNIT – VI **[8 Hrs.]**

Manufacturing system control: Computerized statistical process control, Shop floor control, Shop floor data collection techniques, Inventory control, Pull system of Production control. CAQC, Introduction to Automated inspection devices: Coordinate Measuring Machine (CMM), Inspection probes etc.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing, M. P. Groover, Prentice Hall publication.
2. CAD, CAM, CIM, P. Radhakrishnan and S. Subramanyam, New Age International Pvt. Ltd.
3. Computer Integrated Design and Manufacturing, David Bedworth, et. al, McGraw Hill Book Co.
4. Computer Aided Design and Manufacturing, Mikell P. Groover and Zimmers E.W, Prentice Hall Publication.
5. Fundamentals of CAD/CAM/CIM, Vikram Sharma, S.K. Kataria & Son's publication.
6. Robotics Technology & Flexible Automation, S. R. Deb, et. al., McGraw Hill Book Co.
7. Introduction to Robotics, John J. Craig, Pearson Publication.

REFERENCE BOOKS:

1. Computer Integrated Manufacturing Handbook, Eric Teicholz and Joel orr, McGraw Hill Book Co.
2. Computer Integrated Manufacturing, Paul G. Ranky, PHI.
3. CAD/CAM – theory & practice, Ibrahim Zeid, Tata McGraw Hill Publication.
4. Computer Aided Manufacturing, P.N. Rao, N.K. Tewari and T.K.Kundra, Tata McGraw Hill Publication.
5. Systems Approach to Computer Integrated Design and Manufacturing, Nanua Singh, John Wiley publication.
6. Computer Control of Manufacturing Systems, Yoram Koren, McGraw Hill publication.

BEME802P2: ELECTIVE – II : COMPUTER INTEGRATED MANUFACTURING (Practical)

CREDITS: 01

Teaching Scheme	**Examination Scheme**
Practical: 2 Hours/Week	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. Introduction to CIM. (Product Development Cycle, CIM Wheel)
2. Introduction to NC. (Basic components, classification)
3. Manual Part Programming – Lathe.
4. Manual Part Programming – Milling.
5. Manual Part Programming by using Sub routine & Canned Cycles.
6. Part classification and Coding using G.T.
7. Study of F. M. S.
8. Study of CAPP Systems. (Retrieval & Generative)
9. Study of different quality measurement tools.
10. Assignment on implementation of CIM in Industry.

BEME802T3: INDUSTRIAL FLUID POWER (Theory)

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 : Oil Hydraulic systems & pneumatic systems are widely used in all fields of engineering as clean source of motive power. Low cost automation systems with the use of pneumatics have become popular as manufacturing aids. Mechanical engineers come across such systems in all segments of industries.

This course is designed to understand the basic concepts of various components of hydraulic & pneumatic systems, the working principles of various components used for hydraulic & pneumatic systems, selection of appropriate components required for simple hydraulic and pneumatic circuits, listing probable causes of faults or defects in the components of hydraulic & pneumatic circuits. At the end of this course, students will be able to understand, discuss & apply the hydraulic & pneumatic systems in industries/applications.

UNIT – I **[8 Hrs.]**

Fluid power systems: Components, advantages, applications in the field of Machine tools, material handling, hydraulic presses, mobile and stationary machines, clamping and indexing devices, Transmission of power at static and dynamic states. Types of Hydraulic fluid petroleum based, synthetic and water based. Properties of fluids, selection of fluids, additives, effect of temperature & pressure on hydraulic fluids. Seals sealing materials, selection of seals, filters, strainers, sources of contamination of fluid & its control. Hydraulic and pneumatic symbols.

UNIT – II **[8 Hrs.]**

Pumps – Types of Pumps, vane pump, gear pump, gerotor pump, screw pump, radial and axial piston pumps. Power and efficiency calculations, selection of pumps for hydraulic power transmission.

Accumulators & Intensifiers: Types and functions of accumulators, intensifiers, applications, selection and design procedure.

UNIT – III **[8 Hrs.]**

Valves – Necessity of pressure control valves, direction control valves and flow control valves. Construction, working and symbols of pressure control valves – pressure relief valve, pressure reducing valve, pressure unloading valves and method of actuation of valves.
Direction control valves – Check valves, types of DC valves, poppet valve, spool valve, 2 way 2 position DC valve, 3 way 2 position DC Valve, 4 way 2 position D.C, 4 way 3 position D.C valves, rotary spool valves, open center, close center, and tandem center valves. Sequence valves, method of actuation of valves, manually operated, pilot operated and solenoid operated valves.

Flow control valves – Principle of operation, pressure compensated, non pressure compensated flow control valve, temperature compensated flow control valves. Meter in & meter out flow control circuits, bleed off circuits.

UNIT – IV **[8 Hrs.]**

Actuators- Construction, working and symbols of rotary actuators. Hydraulic motors.
Linear Actuators – Cylinders - Single acting, double acting, method of control of acceleration and deceleration. Calculation of piston velocity, thrust under static & dynamic applications.
Accessories – Pipes, hoses, fittings, oil filters, seals and gaskets.

UNIT – V **[8 Hrs.]**

Design of hydraulic circuits: Meter in, meter out circuits, bleed off circuit, sequencing circuit – travel dependant, pressure dependant hydraulic circuits for Milling machine & Shaper machine, motion synchronization circuit. Hydraulic circuits using sequence valves, counter balancing valves, unloading valves with the use of electrical controls. Trouble shooting and maintenance of hydraulic circuits.

UNIT – VI **[8 Hrs.]**

Introduction to pneumatic systems. Applications of pneumatic system, general layout of pneumatic system, merits and limitations of pneumatic systems**.**

Control Valves – Pressure regulating valves, flow Control valves, direction control valves.
Actuators – Rotary - Air motors, types, construction, working principle. Linear- Cylinders- Types, construction & working principle. Accessories – Pipes, Hoses, Fittings, FRL unit.

LIST OF TUTORIALS:

1) Study of hydraulic systems.
2) Demonstration of pneumatic systems.
3) Study of directional control valves.
4) Study of actuators.
5) Study of troubleshooting & maintenance of hydraulic circuit.
6) Study of troubleshooting & maintenance of pneumatic circuit.
7) Demonstration on meter in and meter out circuit.
8) Study of hydraulic circuit of Shaper machine.

TEXT BOOKS:

1. Oil Hydraulic system- Principle and maintenance, S.R Majumdar, Tata Mcgraw Hill Company.
2. Pneumatics Systems Principles and Maintenance, S.R Majumdar, Tata Mcgraw Hill Company.

REFERENCE BOOKS:

1. Introduction to Hydraulic & Pneumatics, S. Lango & V. Soundarajan, Prentice Hall of India.
2. Hydraulics and Pneumatics, H.L. Stewart, Industrial Press.
3. Fluid Power Design Handbook, Frank Yeaple, CRC Press.

BEME802P3: ELECTIVE-II: INDUSTRIAL FLUID POWER (Practical)

CREDITS: 01

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

LIST OF PRACTICALS:

Minimum Eight out of the following areas shall be performed:

1. Demonstration of Working of various types of Valves.
2. Demonstration of working of various types of Hydraulic Actuators.
3. Demonstration of meter in and meter out circuit.
4. Demonstration of sequencing circuit.
5. Demonstration of hydraulic circuit for shaper machine.
6. Demonstration of pneumatic circuit for speed control of double acting cylinders.
7. Demonstration of pneumatic circuit for speed control of pneumatic motor.
8. Study of trouble shooting procedures of various hydraulic and pneumatic circuits.
9. Study on selection of circuit components for simple hydraulic and pneumatic circuits.
10. Case study based on industrial visit to any industry/organization having Hydraulic or Pneumatic Applications.(Preferable)

BEME802T4: ELECTIVE-II: MANAGEMENT INFORMATION SYSTEMS (Theory)

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 management information systems which includes system analysis, system design, system implementation & evaluation, system development etc. At the end of the course student will be able to understand & discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built.

UNIT – I **[8 Hrs.]**

Introduction to MIS:
System & Its components, System Concepts, system control, Types of systems, Date & Information, Nature and scope, Character function & applications, system life cycle design.

UNIT – II **[8 Hrs.]**

System Analysis:
System planning, Information gathering, Structure analysis tools, Feasibility study, cost/benefit analysis.

UNIT – III **[8 Hrs.]**

System Design:
Stages of system design, Input/Output & form design, Database design, Design documentation.

UNIT – IV **[8 Hrs.]**

System Implementation & Evaluation:
System testing, implementation, detailed evaluation, System maintenance.

UNIT – V **[8 Hrs.]**

Systems Development, Business Information Systems, Data Warehousing and Decision Support Systems.
Concepts & Philosophy of DSS, Deterministic System, Artificial Intelligence(AI), Knowledge Based Expert system(KBES). Business Intelligence Systems, CRM.

UNIT – VI **[8 Hrs.]**

M IS Tools & Packages/Areas of MIS:
ERP (Enterprise Resource Planning)
SCM (Supply Chain Management)
CRM (Customer Relationship Management)
Concept of data ware housing and data mining.
SAP

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Management information systems, WS Jawadekar, McGraw Hill education.
2. Management information systems, D. P. Goyal, Laxmi publications.
3. System Analysis and Design, Elias M. Awad, Galgotia publishers.
4. MIS, Nilanjan Chattopadhyay, Bidgoli Hossein, Cengage Learning.
5. Management Information System, Bagchi N., Vikas Publication

REFERENCE BOOKS:

1. System Analysis and Design, Don Yeates, Prentice Hall.
2. Management Information System, Effy oz, Course Technology Ptr(Sd).

BEME802P4: ELECTIVE-II: MANAGEMENT INFORMATION SYSTEMS (Practical)

CREDITS: 01

Teaching Scheme
Practical: 2 Hours/Week

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

LIST OF PRACTICALS:

Minimum Eight shall be performed on Inventory control, MRP, Office Automation by using: MS-ACCESS, VISUAL BASIC, ORACLE or any other database Languages. Software to be introduced on ERP package of SAP.

BEME802T5: ELECTIVE – II: REFRIGERATION AND AIRCONDITIONING (Theory)

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 concept of refrigeration and air conditioning. Students will be able to understand the non conventional refrigeration system and cryogenics through the knowledge of air conditioning which includes psychometric, heat load calculations, design of air conditioning system & transmission and distribution of conditioned air. This will also enhance their knowledge about environmental impact of refrigerants and alternative refrigerants. At the end of the course, students will be conversant with domestic, commercial and industrial applications of refrigeration and air conditioning.

UNIT – I **[8 Hrs.]**

Refrigeration: Introduction, unit of refrigeration, analysis of simple vapour compression refrigeration system, effect of sub cooling, superheating on coefficient of performance.
Study of Vapour Absorption Refrigeration System: Aqua Ammonia, Lithium Bromide- Water system, Refrigerants – Properties, classification, nomenclature, its global warming & ozone depletion potential, montreal protocol, kyoto protocol, alternate refrigerants.

UNIT – II **[8 Hrs.]**

Compound Vapour Compression Refrigeration system and multiple evaporator system:- Compound vapour compression refrigeration system, multiple evaporator system, types of compressor, condenser, evaporator, expansion devices, hermatic compressors, methods of defrosting. Refrigeration controls.

UNIT – III **[8 Hrs.]**

Air cycle refrigeration:
Air cycle refrigeration & its application, types of air refrigeration system, vortex tube, thermoelectric refrigeration, steam jet refrigeration. (Analytical treatment is expected on air refrigeration system).

UNIT – IV **[8 Hrs.]**

Cryogenics: Introduction, application of cryogenics, cascade system, Joules Thomson coefficient, inversion curve, methods of liquefaction of air with analytical treatment.

UNIT – V **[8 Hrs.]**

Advanced Psychometric & Heat Load Calculations:
Introduction to psychometric properties and processes of air. Classification of air conditioning systems, Applications of psychometry to various air conditioning systems, RSHF, ESHF, GSHF, air washers, air coolers.

Heat Load Calculations: Data collection for load calculation, various components of heat load, heat load estimate, cooling load calculations.

UNIT – VI **[8 Hrs.]**

Air Transmission & Distribution: Principle of air distribution, types of grilles & diffusers & their selection criteria, air filtration, types of air filters, distribution of air through ducts, pressure losses in ducts, methods of duct design, duct friction chart, air conditioning controls.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Refrigeration & Air conditioning, Stocker & Jones, McGraw Hill Publication.
2. Refrigeration and Air Conditioning, S.N. Sapali, PHI.
3. Refrigeration and Air Conditioning, R.S.Khurmi, S.Chand and Company.
4. Refrigeration and Air Conditioning, Arora and Domkundwar, Dhanpat Rai and Sons.
5. Refrigeration and Air Conditioning, Arora C P, Tata McGraw Hill.

REFERENCE BOOKS:

1. Principles of Refrigeration, Roy Dossat, Pearson Education.
2. Commercial Refrigeration, Edwin P. Anderson, Taraporevala Sons & Co.
3. ASHRAE Hand Books, Air Conditioning Engineers.
4. Handbook of Refrigeration and Air Conditioning, Shan Wang, McGraw Hill Publications.
5. Refrigeration and Air Conditioning, P.N. Ananthnarayan, Tata McGraw Hill.
6. Air Conditioning Principle and System, PITA, PHI publication.

BEME802P5: ELECTIVE – II: REFRIGERATION AND AIRCONDITIONING (Practical)

CREDITS: 01

Teaching Scheme	**Examination Scheme**
Practical: 2 Hours/Week	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. To perform experiments on vapour compression test rig to determine COP of the system.
2. Study of various types of compressor.
3. Study of various types of condenser, expansion devices and evaporators used in RAC.
4. Study of various types of air conditioning systems
5. To perform experiments on Air-conditioning test rig.
6. Study & performance of window air conditioner.
7. To perform experiments on desert cooler to evaluate its performance.
8. Demonstration of use of various tools and equipments used for installation, maintenance & repair of refrigeration systems.
9. Testing and charging of vapour compression refrigeration system.
10. Report on visit to refrigeration plant/AC plant/cold storage plant.

BEME802T6: ELECTIVE-II: STRESS ANALYSIS (Theory)

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 includes the approach and application of Theory of Elasticity to solve the stress analysis problems. It also covers the experimental techniques for stress & strain analysis like Photoelasticity, Strain gage, Brittle coating etc. At the end of this course, student will be able to analyze and predict the stresses & strains in machine components using analytical & experimental approaches.

UNIT – I **[8 Hrs.]**

Two Dimensional Problems in Cartesian Coordinate system – Fundamentals of stress & strain, stress-strain relationship, Elastic constant, Plane stress, Plane strain, differential equation of equilibrium , Boundary conditions, Saint Venant`s principle, Compatibility equation, Airys stress function, Stress analysis of cantilever subjected to end point loading.

UNIT – II **[8 Hrs.]**

Two dimensional problem in polar coordinate systems – General equations of equilibrium in polar coordinate compatibility equation, stress distribution about symmetric axis, stress analysis of cylinder subjected to – internal & external pressure, Pure bending of curved beams, effect of hole on the stress distribution in plates, Stress analysis of rotating circular disk.

UNIT – III **[8 Hrs.]**

Two Dimensional Photo elasticity – Introduction to basic optics related to photo elasticity, stress optic law, plane & circular polariscope arrangements, effect of stressed model in plane & circular polariscope, Isoclinic & Isochromatics, stress trajectories, calibration of photo elastic material (determination of fringe constant), various photo elastic materials & their properties. Casting of photo elastic models, Tardy`s compensation technique, Separation techniques like, shear difference, oblique incidence & electrical analogy.

Introduction to 3 – D photo elasticity – Phenomenon of Stress freezing, Method of stress freezing, slicing techniques, determination of material fringe constant at critical temperature. Scaling Model – Prototype relations. Birefrigerent coating method – Reflection polariscope. Introduction to fringe sharpening & fringe multiplication.

UNIT – IV **[8 Hrs.]**

Strain gage technique for stress & strain analysis – Introduction to electrical resistance strain gage, gage factor, bridge circuit, bridge balance, output voltage of Wheatstone bridge, balancing of bridge, temperature compensation, various bridge configurations, bonding of strain gages to the specimen, determination of principle strains & stresses using strain rosettes. Environmental effects on performance of strain gages, Strain gages response to dynamic strains, Effect of lead wires.

Introduction to Strain measurement on rotating components, Static & Dynamic Strain measurement, Introduction to semiconductor gages, high temperature strain gages & self–temperature compensated gages, Introduction to commercial strain indicators.

Brittle coating method for stress & strain analysis. Introduction to Moire fringe method for stress & strain analysis.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Theory of Elasticity, S.P. Timoshenko, McGraw Hill.
2. Theory of Elasticity, Sadhu Singh, Khanna publishers.
3. Experimental Stress Analysis, T.K. Ray, S. Chand publications.
4. Experimental Stress Analysis, U.C. Jindal, Pearson publications.
5. Experimental Stress Analysis, Sadhu Singh. Khanna publishers.
6. Experimental Stress Analysis, Mubeen, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Experimental Stress Analysis, L.S. Srinath, Tata McGraw Hill.
2. Experimental Stress Analysis, Daily & Riley, McGraw Hill.

BEME802P6: ELECTIVE-II: STRESS ANALYSIS (Practical)

CREDITS: 01

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

LIST OF PRACTICALS:

Minimum Eight out of the following areas shall be performed:

1. Casting of photoelastic sheet.
2. Preparation of circular disk or any model from photoelastic sheet.
3. Determination of fringe constant using circular disk.
4. Determination of stresses using at least three photoelastic models.
5. Separation of principle stresses using any method of stress separation.
6. Stress freezing of photoelastic model.
7. Fixing of strain gages to the specimen.
8. Stress & strain measurement in cantilever beam using strain gages.
9. Study & demonstration of Reflection Polariscope.
10. Study & demonstration of Fringe Sharpener & Multiplier.

BEME803T1: ELECTIVE-III: ADVANCED MANUFACTURING TECHNIQUES (Theory)

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 provide students with an overview of a wide variety of non traditional machining processes for processing of engineering materials. Students will learn principles, operations, capabilities, process parameters, economics and application of various non traditional machining processes, various unconventional welding techniques, control parameters & also High Energy Rate Forming Process. Upon completion of this course, students shall understand the importance of non traditional machining processes, unconventional welding techniques and be able to select and apply suitable processes for an engineering product.

UNIT – I **[8 Hrs.]**

Non Traditional Machining process: Need, classification & historical development. Economics & application of Non-Traditional process for machining. High speed grinding. Hot & Cold machining.

UNIT – II **[8 Hrs.]**

Abrasive Jet Machining, Mechanics of AJM-process parameters & Machining parameters. Ultrasonic Machining process, mechanics, process parameters & control, effect of USM on materials. Water Jet Machining.

UNIT – III **[8 Hrs.]**

Electro-Chemical Machining: Electrochemistry of ECM. Electrochemical Grinding. Electric Discharge Machining. Electron Beam, Laser Beam and Plasma Arc Machining.

UNIT – IV **[8 Hrs.]**

Unconventional welding techniques such as Inert Gas (MIG & TIG), Electric Resistance welding, Oxyacetylene pressure welding, Laser Beam welding, Electron Beam welding, Plasma Arc welding, Atomic Hydrogen welding & Submerged Arc welding, Stud welding.

UNIT – V **[8 Hrs.]**

Solid Phase welding techniques such as Ultrasonic welding, Friction welding, Friction welding with recent development in Welding, Economics and application of Non-Traditional processes for welding.

UNIT – VI **[8 Hrs.]**

Advance casting process: Metal mould casting, continuous casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting, centrifugal casting, slush casting.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Manufacturing Science, Ghosh & Malik, East West Press.
2. Advanced Machining Processes, V.K. Jain, Allied Publishers.
3. Introduction to Micromachining, V.K. Jain, Narosa Publishers.
4. Non-Conventional Material Removal Processes, V.K. Jain, IGNOU.
5. Modern Machining Processes, Pandey, Tata McGraw Hill.
6. Textbook of Production Engineering, P.C. Sharma, S. Chand & Co.

REFERENCE BOOKS:

1. Advanced Machining Processes (Non-Traditional And Hybrid Machining Processes), Hassan El-Hofy, McGraw Hill.
2. Non-Traditional Manufacturing Processes, G.F.Benedict, Marcel Dekker, New York.
3. Manufacturing Engineering & Technology, Serope Kalpakjian, Pearson.
4. Manufacturing Science, M. l. Khan, PHI.
5. Casting Technology & Casting Alloys, A.K. Chakraborty, PHI.

BEME803T2: ELECTIVE-III: MACHINE TOOL DESIGN (Theory)

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 explore various design principles and aspects of machine tool elements like transmission, structures, material etc. It also includes testing and control of machine tools. At the end of this course, students will be able to understand the design principles and aspects of machine tools.

UNIT – I **[8 Hrs.]**

Machine Tools - Introduction, classification , general requirements, characteristics, technical and economical pre-requisites for machine tool design, machine tool design process, machine tool layout, motions in machine tool, machine tool drives, hydraulic and mechanical drives, types and elements, individual and group drives, devices for intermittent motion , reversing and differential mechanisms.

UNIT – II **[8 Hrs.]**

Regulations of Speed and Feed Rates - Aim of speed and feed regulations, stepped regulations of speed – various laws of stepped regulation, selection of range ratio, standard values of geometric progression ratio and guidelines for selecting proper value, break-up of speed steps, structure diagrams and its analysis, classification of speed and feed boxes, design of feed box, machine tool drives using multiple speed motors, special cases of gear box design-speed box with overlapping speed steps, speed box with combined structures, speed box with broken geometric progression, electro-mechanical system of regulation, friction, pressure and ball variations, epicyclic drive.

UNIT – III **[8 Hrs.]**

Machine Tool Structures- Functions of machine tool structures and its requirements, design criteria for machine tool structures, materials of machine tool structures, static and dynamic stiffness, profiles of machine tool structures, factors affecting stiffness of machine tool structures and method of improving it, basic design procedure of machine tool structures – design for strength, design for stiffness. Design of beds, columns, housings, bases & tables, cross rail, arms, saddles, carriages and rams.

UNIT – IV **[8 Hrs.]**

Design of Guide Ways and Power Screws – Functions and types of guides ways, design of side ways –shapes, materials, methods of adjusting clearances. Design criteria and calculations for side ways, design for wear resistance , design for stiffness. Guide ways operating under liquid frictions conditions – hydrodynamic and hydrostatics side ways, design of aerostatics sideways, design of antifriction guide ways , combination guide ways, protecting devices for side ways. Design of power screws – sliding friction power screws, rolling frictions power screws.

UNIT – V **[8 Hrs.]**

Design of Spindles and Spindles Supports - Functions of spindle unit and requirements, material of spindle, design calculation of spindle-deflection of spindle axes due to bending, deflection of

spindle axes due to compliance of spindle support, optimum spacing between spindle supports, deflection due to compliance of tapered joint, permissible deflection and design for stiffness.
Antifriction Bearing – Preloading of antifriction bearings. Sliding bearings – sleeve bearings, hydrodynamic journal bearings and air lubricated bearings.

UNIT – VI **[8 Hrs.]**

Testing and Control of Machine Tools:
a) **Testing**:- Objects and procedure for acceptance test, instrumentation for acceptance, accuracy of machine tools, accuracy of work pieces.
b) **Control systems**:- Electrical control, push button control, directional control relays, electrical breaks, automation in feed mechanism.
c) **Hydraulic control**: - Positional control, power-pack for lubrication system in hydraulic drive.
d) **Control system** for gear sliding and feed mechanism (open loop or close loop) for NC /CNC machine using stepper motor or D.C. motor.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Technology of Machine Tools, Steve. F. Krar, McGraw Hill.
2. Machine Tool Design and Numerical Control, N. K. Mehta, McGraw Hill.
3. Principles of Machine Tools, Gopal Chandra Sen, Amitabha Bhattacharya, New Central Book Agency.
4. Design of Machine Tools, Basu & Pal, Oxford and IBH Publishing.
5. Principles of Machine Tools, Sen & Bhatacharya, New Central Book Agency.

REFERENCE BOOKS:

1. All about Machine Tools, Heinrich Gerling, New Age Publication.

BEME803T3: ELECTIVE-III: RENEWABLE ENERGY SYSTEMS (Theory)

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 make the students conversant with the non conventional energy sources and their utilization to harness power. The students will learn the solar energy utilization with its applications. The students will also understand the various methods by which energy can be generated from wind, ocean tides, Geo-thermal phenomenon, 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 rotors 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. Khanna pulishers.
4. Industrial Energy Conservation, D. A. Ray, Pergaman press.

REFERENCE BOOKS:

1. Non-Conventional Energy Sources , G.D. Rai, Khanna publishers.
2. Solar Energy, S.P. Shukhatme, Tata McGraw Hill Education.
3. Renewable Energy Sources and Emerging Tech., Kothari. PHI.

BEME803T4: ELECTIVE-III: MECHANICAL VIBRATIONS (Theory)

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 : The objective for this course is to learn analytical, experimental, and numerical treatment of vibration phenomena. Topics include free and forced vibrations of single degree of freedom and two degree of freedom system, vibrations of multi degree of freedom system, continuous vibrations. Finite element method approach for modeling and analyzing mechanical system is also included. At the end of this course, students will be able to understand, analyze & predict the vibrations in machines/structures.

UNIT – I **[8 Hrs.]**

Free & forced vibration, undamped and damped single degree of freedom systems subjected to harmonic and other periodic excitations. Convolution integral and response to arbitary excitation. Vibration isolation and transmissibility. Solution using laplace transform, Runga kutta method, structured damping, estimation of natural frequency for single and two degree of freedom.

UNIT – II **[8 Hrs.]**

Energy method applied to multi degree freedom system. Lagranges equation. Transient response of one degree-of-freedom systems. Generalized formulation of mass, damping and stiffness matrix and its numerical solutions . Vibration absorber, torsional vibration of two and three disc system. Geared rotor system, Influence Coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor. Mode shapes and orthogonality principle, Steady-state response to harmonic excitation.

UNIT – III **[8 Hrs.]**

Numerical techniques for M.d.o.f. systems. Matrix iteration method. Holzer's method for torsional vibration. Dunkeleys method for critical speed determination of multi disc rotor.
Rayleigh Ritz, Stodola method for determination of all the natural frequencies and mode shapes. Modal matrix and expansion theorem. Free and forced response by modal analysis.

UNIT – IV **[8 Hrs.]**

Vibration of continuous system, Vibration of elastic bars. Axial vibration of rod, bending vibration of beam and torsional vibration of shaft. Hamiltons principle and derivation of equation of motion, Rayleigh quotient. Modal co-ordinates and modal forces. Free and forced response through modal analysis.

UNIT – V **[8 Hrs.]**

Finite element method in vibration of continuous system. Variational functional formulation for axial element and Raylrigh-Ritz method. Shape function for rod and beam elements. Derivation of mass and stiffness matrix. Natural frequencies and mode shape computation for simple rod and beam problem. .

UNIT – VI **[8 Hrs.]**

Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FET & DFT (DiscreteFT), vibration measurement, digital vibration measurement, philosophy of vibration condition monitoring.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Theory of Vibration, W.T. Thomson, CBS.
2. Mechanical Vibration, Debabrata Nag, Wiley.
3. Elements of Vibration analysis, L. Meirovitch, McGraw Hill education.
4. Mechanical Vibrations, J.S. Rao, New Age publishers.
5. Mechanical Vibration, Shrikant Bhave, Pearson publications.
6. Mechanical Vibration, Dukkipati & Srinivas, PHI Learning.
7. Mechanical Vibration, S. Graham Kelly, Cengage.

REFERENCE BOOKS:

1. Advanced Theory of Vibration, J.S. Rao, New Age International.
2. Vibration Condition Monitoring of Machines, J.S. Rao, Narosa publications.
3. Random Vibration in Mechanical Systems, Crandall & Mark, Academic press.
4. Mechanical Vibrations, S.S. Rao, Pearson.
5. Mechanical Vibration, William J.Palm, John Wiley.

BEME803T5: ELECTIVE-III: ADVANCE INTERNAL COMBUSTION (IC) ENGINE (Theory)

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 concept of I.C. engine and its components. It includes information of different engine operating cycles, engine lubrication, engine cooling, automobile fuel, fuel supply system, combustion in S.I. & C.I. engine, air pollution and its control. The course also involves performance and testing of I.C. engine. At the end of this course student will be able to understand the basic about I.C. engine, its components, working and recent advancement in I.C. engine.

UNIT – I: Engines types and their operation: **[8 Hrs.]**

Introduction, Engine classification, Engine components and material selection, Different Engine Operating cycles, Comparison of SI and CI engines, comparison of two stroke and four stroke engine, engine lubrication and cooling system. Engine losses- Frictional losses, blow by losses, pumping loss.

UNIT – II: Automotive fuels & Fuel injection: **[8 Hrs.]**

Air Fuel ratio requirement, Stoichiometric ratio (A/F), S.I. Engine fuels characteristics, C.I. Engine fuels characteristics, Rating of engine fuels, Availability – Suitability-merits- demerits and properties of Potential Alternative Fuels (Ethanol, Methanol, Hydrogen, LPG, CNG, Natural Gas, Bio gas and Bio-diesel). Fuel supply system- S.I. Engine introduction to Carburetors, Gasoline Injection – TBI, MPFI, GDI. Fuel supply system- C.I. Engine- Fuel injection pumps, Nozzles, D.I. systems and CRDI. Electronic control module (ECM) control functions. (Problems on simple carburettor and fuel injection system).

UNIT – III: Combustion in S.I. Engine: **[8 Hrs.]**

Charge motion within the cylinder, combustion stages, factors affecting combustion stages, abnormal combustion, combustion chambers- features and design considerations & types, ignition system- conventional- battery & magneto. Modern ignition system- electronic, CDI, supercharging & supercharging limits , scavenging in engines, ignition timing and spark advance .

UNIT – IV: Combustion in C. I. Engines: **[8 Hrs.]**

Charge motion within the cylinder swirl, squish, combustion stages in C. I. Engines, ignition delay, factors affecting delay. Effects of fuel properties. Abnormal combustion, combustion chambers-features and design considerations & types, supercharging & supercharging limits, turbo charging, Auxiliary apparatus- Glow plug. Comparison of abnormal combustion in S.I. & C.I. engine.

UNIT – V: Air pollution & control: **[8 Hrs.]**

Atmospheric pollution from Automotive engines, Global warming – Green house effect and effects of I.C. Engine pollution on environment. Pollutants from gasoline engines, causes of gasoline emission and its control , Diesel emission - Diesel smoke and its control, Exhaust-Gas recirculation (EGR), Positive crankcase ventilation (PCV) system, Evaporation emission control system. After

exhaust treatment system - Secondary air injection system, Catalytic converter, Euro Norms and Bharat stage Norms. Emission measurement equipment, Comparison of diesel and gasoline emission. Stratified charge engine, free piston engine, adiabatic engines & rotary engine.

UNIT – VI: Engine testing and performance parameters: **[8 Hrs.]**

Important engine characteristics of engines - Brake, Torque & Power, Mechanical efficiency, Road -load power, Mean effective pressure, Specific fuel consumption and efficiency, Volumetric efficiency, Specific emission and emission index, Relationship between performance parameters, Measurement and Testing - Measurement of friction power, indicated power, Brake power, Fuel consumption, Air consumption, Engine efficiencies. Variables affecting engine performance characteristics.

LIST OF TUTORIALS:

1) Introduction, I.C. Engine history & development.
2) Study of cooling and lubrication system of I.C. Engine.
3) Study of different types of alternative fuels.
4) Numerical on fuel supply system used in I.C. Engine.
5) Discussion on combustion in S.I. Engine.
6) Discussion on combustion in C.I. Engine.
7) Study of free piston engine, adiabatic engine and stratified charged engine.
8) Numerical on engine performance and testing.

TEXT BOOKS:

1. Internal Combustion Engines, V. Ganesan, Tata McGraw Hill.
2. Internal Combustion Engines, V. M. Domkundwar, Dhanpat Rai & Sons.
3. Internal Combustion Engines, M. C. Mathur, R.D. Sharma, Dhanpat Rai & Sons.
4. Fundamentals of Internal Combustion Engines, H.N. Gupta, PHI Learning.
5. Internal Combustion Engine, R.K. Rajput, Laxmi Publications.

REFERENCE BOOKS:

1. Internal Combustion Engine Fundamentals, John B. Heywood, Tata McGraw Hill.
2. Internal Combustion Engines and Air pollution, Edward F. Obert, Intex Educational.
3. Automobile Engineering Vol.-2, Dr. Kirpal Singh, Standard Publishers.
4. Automobile Mechanics, Crouse & Anglin, Tata McGraw Hill.
5. I.C. Engine Combustion & Emission, Pundir B.P., Narosa publication.

BEME803T6: TRIBOLOGY (Theory)

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 related to tribology. It includes properties and testing of lubricants, viscosity, effect of temperature and pressure on viscosity, basic equations. Study of different types of bearing, electrical analogy method, friction of metals, friction theories, surface contaminants, frictional heating, wear of metals, classification of wear, mechanisms of wear, quantitative laws of wear, wear resistance materials.

UNIT – I **[8 Hrs.]**

Introduction, properties and testing of lubricants, viscosity, effect of temperature and pressure on viscosity, basic equations, generalized Reynold's equation, energy equation of state.

UNIT – II **[8 Hrs.]**

Idealized hydrodynamic bearings, plane slider bearings, slider bearing with pivoted shoes, step bearings, idealized journal bearings, finite bearings, electrical analogy method, analytical solution, numerical solutions, oil flow and thermal equilibrium, circumferential and axial flow, heat balance.

UNIT – III **[8 Hrs.]**

Bearing design, practical considerations, design of journal bearings, squeeze film bearings, parallel surface bearing, step bearings, hydrodynamic instability, stiffness and damping coefficients, stability.

UNIT – IV **[8 Hrs.]**

Externally pressurized oil bearings, circular step bearings, rectangular thrust bearings, opposed pad bearings, multiraces bearings, gas lubricated bearings, governing equations, infinitely long plane slider bearings, infinitely long journal bearings, finite journal bearings, externally pressurized gas bearings, porous gas bearings, elasto-hydrodynamic lubrication, dimensionless parameters, film thickness equations.

UNIT – V **[8 Hrs.]**

Ball bearings, deep groove radial bearings, angular contact bearings, thrust ball bearings, surface roughness on hydrodynamic bearings and elasto-hydrodynamic line contacts, derivation of average Reynolds equation for partially lubricated surface, effect of surface roughness on journal bearings.

UNIT – VI **[8 Hrs.]**

Friction of metals, friction theories, surface contaminants, frictional heating, wear of metals, classification of wear, mechanisms of wear, quantitative laws of wear, wear resistant materials

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Hydrostatic Lubrication, Bassani R. and Piccigallo B., Elsevier Publication.
2. Tribology in Machine Design, Stolarski T.A., Butterworth Heinemann, Oxford.
3. Bearing System - Principles and Practice, Barwell F.T., Oxford University Press.

REFERENCE BOOKS:

1. Friction and Lubrication of Solids, Bowden F.P. and Tobor D., Clarendon Press, Oxford.
2. An Introductory Guide to Industrial Tribology, Denis Summers, Smith J., Mechanical Engineering Publication, London.
3. Handbook of Tribology, Bharat Bhushan & Gupta B.K., McGraw Hill.

BEME804T: AUTOMATION IN PRODUCTION (Theory)

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 acquaint the students with automation. Students will get the understanding regarding how automation is used to increase production. Students will get exposed to introduction to automation, types of automation, numerical control system, NC machines, CNC machines, DNC machines, industrial robotics and robot applications. Students will also cultivate understanding about automated material handling systems, automated storage and retrieval system, automated inspection and group technology, computer aided manufacturing and flexible manufacturing system [FMS].

UNIT – I **[8 Hrs.]**

Automation -Definition, types, reasons, strategies for automating, arguments for and against automation. Organization and information processing in manufacturing. Automated Flow 'Lines-Methods of work part transport, Buffer storage. Analysis of flow lines -General terminology and analysis, analysis of transfer lines without storage, partial automation, manual assembly lines. Line Balancing Problem, Methods of line balancing. (Largest Candidate Rule & RPW) (L.C.R., RPW only)

UNIT – II **[8 Hrs.]**

Numerical Control Production Systems -Basic concepts, coordinate system and machine motion. Types of NC systems -Point to point, straight cut and continuous path. Machine control unit and other components, part programming and tape formats, method of part programming, Introduction of manual part programming (NC words): APT programming in details, Directed numerical control. Computer numerical control. Adaptive control. Applications of NC.

UNIT – III **[8 Hrs.]**

Industrial Robotics -Introduction, robot anatomy, accuracy and repeatability and other specifications, end effectors, sensors, introduction to robot programming, safety monitoring. Robot applications -Characteristics of robot applications, work cell layout, robot applications in material handling, processing, assembly and inspection.

UNIT – IV **[8 Hrs.]**

Automated material handling & storage: Automated Guided Vehicle Systems -Types: Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications. Automated Storage & Retrieval System Types: Unit load AS/RS, mini load AS/RS, man on board AS/RS, automated item retrieval system, deep lane AS/RS - Basic components & special features of AS/RS. Carousel storage systems, work in process quantitative analysis.

UNIT – V **[8 Hrs.]**

Automated inspection & Group technology: Automated inspection principles & methods -100% automated inspection, off-line & on -line inspection, distributed inspection & final inspection; Sensor technologies to; automated inspection, coordinate. measuring Machine Construction, operation & benefits, Machine vision image acquisition & digitization, image processing & analysis, interpretation, machine vision applications; Group Technology: Part families, parts classification & coding, Opitz classification systems production. Flow analysis; Machine cell design -composite pat concept, types of cell design, best machine arrangement, benefits of group technology.

UNIT – VI **[8 Hrs.]**

Computer aided manufacturing - Manufacturing planning, manufacturing control; Computer integrated manufacturing.

Flexible manufacturing systems - Components, Types of systems, FMS layout configuration computer functions, data files, system reports, FMS benefits.

Computer aided process planning - Retrieval CAPP systems, generative CAPP systems, benefits of CAPP.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Automation, Production System & CIMS, M.P, Groover, PHI.
2. CAD/CAM, Zimmers & Groover, Pearson.

REFERENCE BOOKS:

1. Numerical Control and Computer Aided Manufacturing, Kundra, Rao & Tewari, Tata McGraw Hill.
2. Computer Control of Manufacturing Systems, Yoram Koren, McGraw Hill.

BEME804P: AUTOMATION IN PRODUCTION (Practical)

CREDITS: 01

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

LIST OF PRACTICALS:

Minimum Eight out of the following shall be performed:

1. Performance, Simulation on CNC lathe (at least two complex geometries).
2. Performance, Simulation on CNC milling (at least two complex geometries).
3. Practice Programming on Manual Part Program.
4. Practice Programming on APT.
5. Case Study on Automated System of any Industry.
6. Study/Performance on Robot.
7. Part Coding and Group Technology.
8. Study of Automation & Case Study of Automated System of any Industry.
9. Study of NC System.

BEME805T: ENERGY CONVERSION - III (Theory)

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 includes the current energy scenario, various energy conservation techniques, energy auditing, study of various non conventional energy sources and their significance in present energy crises.. This subject also helps the students in understanding various Hydraulics and Pneumatic techniques used in various applications & industries.

UNIT – I **[8 Hrs.]**

Gas Turbines:-Ideal cycles isentropic and small stage efficiency, application of gas turbine pressure losses, effect of intercooling, reheat & regeneration, fuel-air ratio, combustion efficiency, performance calculation, open cycle &closed cycle gas turbine plants cogenerations & combined power cycles.

UNIT – II **[8 Hrs.]**

Principles & working of turbojet, tuboprop, Ramjet & pulse jet, simple turbojet cycle, thrust power, propulsive power. Thermal efficiency, propulsive efficiency, overall efficiency**.**

Nuclear Power Plant: Introduction, nuclear reactor, classification, general components, operation, problems of reactor operation, site selection, comparison of nuclear plants with thermal plants. (analytical treatment is not expected)

UNIT – III **[8 Hrs.]**

Principle of solar energy collection, solar energy and sources of power generation, solar constant, solar geometry, flat plate & concentrating collectors for water and air heating, solar energy storage, solar pond, application of solar energy for cooking, drying, solar photovoltaic system & its applications. Introduction to fuel cell. Working of wind generators & MHD generator (theoretical treatment is expected)

UNIT – IV **[8 Hrs.]**

Energy Auditing: Introduction, global and Indian energy scenario, need of importance of energy conversion. importance of energy audit, uses of energy audit, basic terms of energy audit, types of energy audit, procedure for carrying energy audit, instruments used for energy audit such as power analyzer, multipoint heat flow meter, Lux meter, portable infrared radiation thermometer, thermocouple based temperature indicator. Payback period, Return on Investment (ROI), life cycle costs, Sankey diagram, specific energy consumption.

UNIT – V **[8 Hrs.]**

Hydraulic systems: Introduction, essential elements of a hydraulic system: Flow actuators, directional control valves, pressure control valves, flow control valves, accumulators, basic hydraulic circuit, meter in & meter out circuits. Use of single, double actuator, crane, jacks. Grinding machine.

UNIT – VI **[8 Hrs.]**

Pneumatic Systems : Principle of pneumatics, comparison with hydraulic power transmission. Study of various Compressors used in pneumatic system, air preparatory unit, pneumatic valve. Various Pneumatic circuits.

LIST OF TUTORIALS: Tutorials based on above syllabus.

TEXT BOOKS:

1. Non-Conventional Energy Storage, Rai G.D., Khanna Ppublication.
2. Solar Energy Principles of Thermal Collection and Storage, Sukhatme, S.P., Tata McGraw Hill.
3. Industrial Hydraulics, John J. Pippenger, Tata McGraw Hill.
4. Pneumatic Systems, S. R. Mujumdar, Tata McGraw Hill.
5. Energy Conservation - related booklets published by National Productivity Council (NPC) & Petroleum Conservation Research Association.(PCRA).
6. Efficient Use of Electricity in Industries, B.G. Desai, M.D. Parmar, R. Paraman and B.S. Vaidya, ECQ series Devki R & D. Engineers, Vadodara.
7. Thermal Engineering, P.L. Ballaney, Khanna publishers.
8. Gas Turbine& Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Solar Energy Fundamentals and Applications, Garg, H.P., Prakash J., Tata McGraw Hill.
2. Gas Turbine Theory, Cohen and Rogers, Pearson.

BEME805P: ENERGY CONVERSION - III (Practical)

CREDITS: 01

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

LIST OF PRACTICALS:

Minimum Eight out of the following shall be performed:

1. Study of gas turbine and jet propulsion system.
2. Study of current energy scenario and various techniques of saving energy.
3. Study & demonstration of solar lightning system.
4. Case study on energy conservation opportunities in industry.
5. Study of various hydraulic pumps.
6. Study of various valves, actuators used in hydraulic system.
7. Study of various industrial hydraulic circuits.
8. Study of various compressors used in pneumatic system.
9. Study of air preparatory unit.
10. Study of various industrial pneumatic circuits.

BEME806P: PROJECT

CREDITS: 06

Teaching Scheme
Practical: 06 Hour/Week

Examination Scheme
College Assessment: 75 Marks
University Assessment: 75 Marks

Course Objectives and Expected Outcomes: This course is designed to inculcate the habit of independent learning & work execution and also in a capacity as a member of group to achieve the final intended objectives. Students will be able to apply the acquired knowledge for solving real life engineering problems.

The project work may conform to anyone of the below stated types of broad based work.

1. Detailed design of some mechanical system. This may comprise of machines, thermal/ hydraulic / pneumatic system, design of some small industry and like.
2. Detailed experimental / practical verification of some mechanical engineering systems.
3. Detailed study of some industry manufacturing some product. This study may comprise of various aspects such as plant layout, mechanical handling systems, assembly shop, quality control system, maintenance system, various service systems, design, development and planning functions, techno-economic studies etc., feasibility of small scale industry.
4. Software development for particular application / design / analysis etc.
5. Any other relevant area.

Group of students shall be considered for the project work. Group of Student is expected to prepare a project report and shall present a seminar on it.