

**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 Assessment	Total Marks	Min. Passing Marks
BEME301T	Applied Mathematics- III <sup>#</sup>	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
<b>Total</b>		<b>15</b>	<b>07</b>	<b>08</b>	<b>-</b>	<b>-</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>-</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>-</b>
<b>Semester Total</b>		<b>30</b>			<b>28</b>	<b>Marks 750</b>								

<sup>#</sup> 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 Assessment	Total Marks	Min. Passing Marks
BEME401T	Applied Mathematics- IV <sup>#</sup>	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
<b>Total</b>		<b>18</b>	<b>05</b>	<b>08</b>	<b>-</b>	<b>-</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>-</b>	<b>75</b>	<b>125</b>	<b>200</b>	<b>-</b>
<b>Semester Total</b>		<b>31</b>			<b>25</b>	<b>Marks 700</b>								

<sup>#</sup> 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
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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	---	---	---

**Syllabus for**  
**Applied Mathematics- III (EN/ET/EE/Mech)**  
**Scheme (Theory: 4 hrs, Tutorial: 1hr.)**

**UNIT - I: LAPLACE TRANSFORM (15Hrs)**

Definition, Properties, Evaluation of integrals by Laplace Transform, Inverse Laplace Transform and its Properties, Convolution theorem (statement only), Laplace Transform of Periodic Functions (statement only), Unit Step Function and Unit Impulse Function, Applications of Laplace Transform to solve Ordinary Differential Equations, Simultaneous Differential Equations, Integral Equations & Integro-Differential Equations.

**UNIT – II: FOURIER SERIES & FOURIER TRANSFORM (08 Hrs)**

Periodic functions and their Fourier Expansions, Even and Odd functions, Change of interval, Half Range Expansions.

Fourier Transform: Definition and Properties (excluding FFT), Fourier Integral Theorem, Relation with Laplace Transform, Applications of Fourier Transform to Solve Integral Equation.

**UNIT – III: CALCULUS OF VARIATIONS(05 Hrs)**

Functionals, Maxima and minima of functionals, Euler's equation(statement only), Functionals dependent on First & Second order derivatives, Isoperimetric Problems, Solution of Boundary Value problems by Rayleigh-Ritz method.

**UNIT- IV: FUNCTIONS OF COMPLEX VARIABLE (12 Hrs)**

Analytic function, Cauchy- Riemann Conditions, Harmonic Functions (excluding orthogonal system), Milne-Thomson Method, Cauchy Integral Theorem & Integral Formula (Statement only), Taylor's & Laurent's series (Statement only), Zeros and Singularities of Analytic function, Residue Theorem (Statement only), Contour integration (Evaluation of real definite integral around unit circle and semi-circle).

**UNIT - V: PARTIAL DIFFERENTIAL EQUATIONS(08Hrs)**

Partial Differential Equations of First Order First Degree i.e. Lagrange's form, Linear Homogeneous Equations of higher order with constant coefficients. Method of separations of variables, Simple Applications of Laplace Transform to solve Partial Differential Equations (One dimensional only).

## **UNIT –VI: MATRICES(12Hrs)**

Linear and Orthogonal Transformations, Linear dependence of vectors, Characteristics equation, Eigen values and Eigen vectors, Statement and Verification of Cayley Hamilton Theorem [without proof], Reduction to Diagonal form, Reduction of Quadratic form to Canonical form by Orthogonal transformation, Sylvester's theorem [without proof], Solution of Second Order Linear Differential Equation with Constant Coefficients by Matrix method.

### Text Books

1. Higher Engineering Mathematics by B.S. Grewal, 40<sup>th</sup> Edition, Khanna Publication
2. Advanced Engineering Mathematics by Erwin Kreyszig, 8<sup>th</sup> Edition, Wiley India
3. Applied Mathematics for Engineers & Physicist by L.R. Pipes and Harville,
4. Calculus of variation by Forrey

### Reference Books

1. A Text Book of applied Mathematics, Volume II , by P.N. Wartikar & J.N. Wartikar, Poona Vidyarthi Griha Prakashan
2. Introductory methods of Numerical Analysis, by S.S. Sastry, PHI
3. Mathematics for Engineers by Chandrika Prasad
4. A text book of Engineering Mathematics by N. P. Bali & M. Goyal, Laxmi Publication.

**B.E. (MECHANICAL ENGINEERING): THIRD SEMESTER**

**BEME302T: KINEMATICS OF MACHINE (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:** The study of kinematics is concerned with understanding of relationships between the geometry and the motions of the parts of a machine. The overall objective of this course is to learn how to analyze the motions of mechanisms, design mechanisms to give desired motions. This course includes relative motion analysis, design of gears, gear trains, cams and linkages, graphical and analytical analysis of position, velocity and acceleration, clutches, brakes & dynamometers. Students will be able to understand the concepts of displacement, velocity and acceleration of simple mechanism, drawing the profile of cams and its analysis, gear kinematics with gear train calculations, theory of friction, clutches, brakes & dynamometers.

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**UNIT – I**

**[ 8 Hrs.]**

Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, Difference between machine and mechanism, Inversions, machine, simple & compound chain, Degrees of freedom, Estimation of degree of freedom of mechanism by Grubber's criterion and other methods. Harding's notations, Classification of four bar chain, Class-I & Class-II, Kutzbach theory, Various types of mechanism such as Geneva wheel, Pawl and ratchet mechanism, Exact straight line mechanism, Approx. straight line mechanism, Transport mechanism.

**UNIT – II**

**[ 8 Hrs.]**

Quantitative kinematics analysis of mechanisms: - Displacement, Velocity and Acceleration analysis of planer mechanism by graphical method as well as analytical method. Coriolis component of acceleration, Instantaneous center method, Kennedy's theorem.

**UNIT – III**

**[ 8 Hrs.]**

Concepts of cam mechanism, Comparison of cam mechanisms with linkages. Types of cams and followers and their applications. Synthesis of cam for different types of follower motion like constant velocity, parabolic, SHM, cycloid etc.

**UNIT – IV**

**[ 8 Hrs.]**

Concept of motion transmission by toothed wheels, comparison with cams and linkages, various tooth profiles, their advantages and limitations, gear tooth terminologies, concept of conjugate action, law of conjugate action, kinematics of involute gear tooth pair during the contact duration,

highlighting locus of the point of contact, arc of contact, numbers of pairs of teeth in contact, path of approach and path of recess, interference, undercutting for involute profile teeth.

Kinematics of Spiral and helical gears, Kinematic analysis and torque analysis of simple epicyclic gear train.

#### **UNIT – V**

**[ 8 Hrs.]**

Synthesis of Mechanism:- Introduction to type, Number and dimensional synthesis, Synthesis of Mechanism by graphical method, Transmission angle, Freudenstein's equation, Roberts Cognate Linkage.

#### **UNIT – VI**

**[ 8 Hrs.]**

Laws of friction, Friction of inclined plane, Efficiency of inclined plane, Friction in journal bearing-friction circle, Pivots and collar friction-uniform pressure and uniform wear. Clutches, Brakes & Dynamometers: Single, multiple and cone clutch, Shoe brake, Band brake, Band and Block brake, Absorption and transmission type dynamometers (Numerical are expected on clutches and brakes only).

#### **LIST OF TUTORIALS:**

- 1) Drawing sheets on Inversion of
  - i) Class I & Class II four bar chain
  - ii) Single slider crank chain
  - iii) Double slider crank chain
- 2) Problem on degree of freedom of mechanisms
- 3) Problems on kinematic analysis i) Graphical method ii) Analytical method
- 4) Cam constructions
- 5) Problem on gears
- 6) Analysis of epicyclic gear train with torque analysis
- 7) Problems on synthesis
  - i) Graphical method
  - ii) Analytical method
- 8) Study of construction and working with neat sketch of
  - i) Clutches
  - ii) Brakes
  - iii) Dynamometers

#### **TEXT BOOKS:**

1. Theory of Machine, S. S. Rattan, Tata McGraw Hill.
2. Mechanism and Machine Theory, J.S. Rao & Dukki Patti, New Age International (P) Ltd, Publishers.
3. Theory of Machines, P L Ballaney, Khanna Publications.

**REFERENCE BOOKS:**

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, Oxford University Press.
2. Theory of Machines and Mechanism, Ghosh & Mallik, Affiliated East- West Press, New Delhi.
3. Theory of Machine , Thomas Bevan, Pearson publication
4. Advanced Mechanism Design–Analysis and Synthesis, A.G.Erdman and G.N.Sandor, Vol. I and II, Prentice – Hall
5. Theory of Machines, Sadhu Singh, Pearson publications.



## **BEME303T: FLUID MECHANICS (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 develop an understanding of the behavior of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries as the mechanical engineers has to deal with fluids in various applications. This course will also develop analytical abilities related to fluid flow. It is expected that students will gain conceptual understanding of fluids and their properties and will be able to apply the analytical tools to solve different types of problems related to fluid & fluid flow.

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### **UNIT – I**

**[ 8 Hrs.]**

Fluid Properties :- Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton's Law of Viscosity, Dynamic Viscosity, Stoke's Theorem, Surface Tension, Capillarity, Compressibility, Vapour pressure.

Fluid Kinematics :- Types of Flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates.

### **UNIT – II**

**[ 8 Hrs.]**

Fluid Statics :- Pressure, Measurement of pressure using manometers, Hydrostatic law, Pascal's law, Pressure at a point, Total pressure, Centre of pressure, Pressure on a plane (Horizontal, vertical, Inclined) and Curved Surfaces, Archimedes's principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.

### **UNIT – III**

**[ 8 Hrs.]**

Fluid Dynamics :- Introduction to Navier-Stroke's Equation, Euler equation of motion along a stream line, Bernoulli's equation, application of Bernoulli's equation to pitot tube, venturi meter, orifices, orifice meter.

### **UNIT – IV**

**[ 8 Hrs.]**

Laminar And Turbulent Flow :- Definition, Relation between pressure and shear stresses, Laminar flow through round pipe, Fixed parallel plates, Turbulent flow and velocity distribution.

Dimensional Analysis: - Dimensional Analysis, Dimensional Homogeneity, Rayleigh method & Buckingham's pi Theorem.

### **UNIT – V**

**[ 8 Hrs.]**

Flow Through Pipes :- TEL, HGL, Energy losses through pipe, Darcy-Weisbach equation, Minor losses in pipes, TEL, HGL, Moody diagram, pipes in series and parallel, Siphons, Transmission of power.

## **UNIT – VI**

[ 8 Hrs.]

Boundary Layer Theory :- Development of Boundary Layer on a flat plate, Laminar and Turbulent Boundary Layers, Laminar Sub Layer, Separation of Boundary Layer.

Flow around Immersed Bodies: - Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil.

### **LIST OF TUTORIALS:**

- 1) Applications based on fluid properties such as block sliding over an inclined plane, capillary phenomenon etc.
- 2) Study of Manometers
- 3) Study of stability of floating bodies and submerged bodies
- 4) Determination of coefficient of discharge of flow meters
- 5) Verification of Bernoulli's equation
- 6) Stokes Law
- 7) Case study of pipe network
- 8) Reynold number & its significance
- 9) Losses in pipes (Hagen Pois. Equation)

### **TEXT BOOKS:**

1. Fluid Mechanics, Dr. R.K. Bansal, Laxmi Publication (P) Ltd. New Delhi
2. Engineering Fluid Mechanics, Kumar K.L., S. Chand & company Ltd. Eurasia Publication House
3. Fluid Mechanics & Hydraulic Machines, R.K. Rajput, S. Chand & Company Ltd.
4. Hydraulic and Fluid Mechanics, Modi P.N. and Seth S.M., Standard Book House.

### **REFERENCE BOOKS:**

1. Introduction to Fluid Mechanics, James E.A., John and Haberm W.A., Prentice Hall of India
2. Fluid Mechanics, Jain A.K., Khanna Publication
3. Engineering Fluid Mechanics, Garde R.J. and Miraj Goankar, Nem chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.
4. Fluid Mechanics and Fluid Power Engineering, Dr. D.S. Kumar, S.K. Kataria & sons
5. Fluid Mechanics, Frank M. White, McGraw Hill Publication
6. Introduction to Fluid Mechanics, James A. Fay
7. Fluid Mechanics, Cengel & Cimbala, Tata McGraw Hill
8. Fundamentals of CFD, Anderson, McGraw Hill, International Edition, Mechanical Engineering series
9. Fluid Mechanics, Streeter V.L. and Wylie E.B., McGraw Hill International Book co.

## **BEME304T: MANUFACTURING PROCESSES (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 manufacturing processes for processing of engineering materials. Students will learn principles, operations and capabilities of various moulding, metal casting, metal forming, press working, metal joining processes & also processing on plastics. Upon completion of this course, students shall understand the importance of manufacturing processes and be able to select and apply suitable processes for an engineering product.

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### **UNIT – I**

**[ 8 Hrs.]**

Pattern Making & Moulding: - Pattern making: Types, materials used, Pattern making allowances, color codes. Core making: - Types, core material & its properties. Moulding: Types of sand moulds, moulding sand composition. moulding sand properties, moulding machines. Shell moulding, CO<sub>2</sub> moulding.

### **UNIT – II**

**[ 8 Hrs.]**

Gating System & Casting Processes: - Gating design -Elements of gating systems, pouring equipments, riser design Melting furnaces -Types, Electric furnace, Induction furnace, Cupola-construction & operation. Cleaning, inspection & casting defects. Foundry mechanizing Special casting processes such as investment Casting, Centrifugal Casting, Slush Casting and Die Casting.

### **UNIT – III**

**[ 8 Hrs.]**

Joining Processes: - Introduction to metal Joining- Types of Welding. Arc Welding & Gas Welding Processes, Defects & Inspection of Welding Joints, Electrodes, weldability of Metals, Welding equipments. Fixtures, TIG Welding, MIG Welding, Spot Welding.

### **UNIT – IV**

**[ 8 Hrs.]**

Forming Process for metals:- Rolling, Forging, Extrusion, Drawing, Mechanics of forming process, Determination of Rolling pressure and roll specification force, drive force and torque, power loss in bearing, Determination of forging forces and stresses, Equipment (hammer/press) capacity required. (No analytical treatment)

### **UNIT – V**

**[ 8 Hrs.]**

Press Working: - Classification, types of presses, press terminology, Force analysis in press working, Die cutting operation, types of dies, Die and punch allowance, introduction to shaping operations, bending, forming and drawing.

### **UNIT – VI**

**[ 8 Hrs.]**

Introduction to Plastics, Properties & types, applications, Forming & Shaping of plastics – Extrusion, injection moulding, Blow moulding, wire drawing, Compression moulding, Transfer moulding, Embossing, Calendaring.

Introduction to Joining of Plastics- Mechanical Fastening, Spin Welding, Solvent Bonding, Ultrasonic welding, Induction welding, Dielectric welding, Hot Plate welding, Vibration welding, Hot gas welding.

**TEXT BOOKS:**

1. Workshop Practice, H. S. Bawa, Tata Mc-Graw Hill
2. Manufacturing Engineering & Technology, Kalpakjian, Pearson
3. Modern Materials and Manufacturing Process, R. Gregg Bruce, John E. Neely, Pearson Education
4. Workshop Technology (Volume I), Hajra Chaudhary, Media Promoters & Publishers
5. Workshop Technology (Vol. I & II), B. S. Raghuwanshi, Dhanpat Rai & Co.
6. Manufacturing technology (Vol. I), P. N. Rao, Tata Mc-Graw Hill
7. Manufacturing Science, Ghosh & Malik, East West Press.
8. Textbook of Production Engineering, P.C. Sharma, S. Chand & Co.

**REFERENCE BOOKS:**

1. Workshop Technology, Vol I & II, WAJ Chapman, Elsevier Butterworth-Heinemann.
2. Manufacturing Processes, M. Begman.
3. Processes & Materials of Manufacturing, R. Lindberg, Allyn & Bacon.

## **BEME304P: MANUFACTURING PROCESSES (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum Eight out of the following shall be performed:

1. Study of Cupola Furnace
2. Study of Moulding Techniques
3. Study of Casting Process
4. Study of Pattern Making
5. Study of Joining Processes
6. Study of Forming Processes
7. Study of Drawing Processes
8. One Job – Pattern Making
9. One Job – Casting
10. One Job – Welding

## **BEME305T: ENGINEERING METALLURGY (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 develop fundamental concepts of crystallography, phase transformation and heat treatment processes. Students will learn the atomic structure of metals, imperfections, diffusion mechanisms and mechanism of plastic deformation, various ferrous & non ferrous metals & their alloys. They will also understand equilibrium diagrams, time-temperature transformation curves and heat treatment processes. Upon completion of this course, students will be able to understand the concepts of crystal structure, microstructure and deformation. They will also acquire the knowledge of phase diagrams which are useful for design and control of heat treating processes, various ferrous & non ferrous metals & alloys with engineering applications, non-destructive tests & powder metallurgy with applications.

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### **UNIT – I**

**[ 8 Hrs.]**

Introduction to engineering materials their classification, properties & application. Difference between metals & non metals, Mechanical properties of metal, Study of crystal structure, Polymorphism & allotropy, Macroscopic & microscopic examination; Imperfections in crystal, Miller indices, Mechanism of plastic deformation, slip, dislocation & twinning.

### **UNIT – II**

**[ 8 Hrs.]**

Solidification of pure metal, nucleation & grain growth, directional & progressive solidification, Ingot structure, Dendritic solidification, Solid solution & their types, Alloy & their formation, Mechanical Mixture, Hume Rothery Rule, grain shape & size, its effect on the properties. Binary equilibrium diagrams, Isomorphous system, Study of Fe-Fe-C diagram - uses & limitations, Invariant reactions.

### **UNIT – III**

**[ 8 Hrs.]**

TTT Curve – Construction & limitations, Heat treatment – Principle, purpose, Annealing & its types, Normalizing, Tempering, Austempering, Martempering, Hardening, Retained austenite & its elimination, Maraging, Patenting; Surface hardening such as Carburising, Nitriding, Induction hardening, Jomini End quench test for hardenability

### **UNIT-IV**

**[ 8 Hrs.]**

Plain carbon steel, Classification based on Carbon Percent & application; Limitations, Effect of impurities; Alloy steel, Effects of various alloying elements, Tool steel & its classification, Red hardness; Stainless steel – Classification, composition & application; Hadfield Manganese steel, Maraging Steel, O.H.N.S. Steel, Selection of steel for various applications.

### **UNIT-V**

**[ 8 Hrs.]**

Cast iron – Classification, gray cast iron, white cast iron, nodular cast iron, malleable cast iron, Mottled cast iron, Ni – hard & Ni – Resistant cast iron, Meehanite Alloy;

Study of non-ferrous alloys – Brasses, its types, Cu-Zn diagram; Bronzes, its types, Cu-Sn diagram; Al-Si diagram.

#### **UNIT-VI**

[ 8 Hrs.]

Principles of hardness measurement, Hardness Test – Brinell, Rockwell, Vicker

Non-destructive tests – Ultrasound Test, Die Penetration Test, radiography test

Powder metallurgy – Introduction, metal powder & its production, blending & mixing, compaction, sintering, Hot Isostatic Pressing, Secondary processes, Advantages, limitations & application of powder metallurgy, few products such as self Lubricating Bearing, Gears & Pump Rotors, Electric Contacts & Electrodes, Magnets, Diamond Impregnated Tools etc.

#### **TEXT BOOKS:**

1. Introduction to Physical Metallurgy, Sidney H. Avner, Tata McGraw-Hill
2. Introduction to Engineering Materials, B.K.Agrawal, Tata McGraw-Hill
3. Heat Treatment – Principles & Techniques, T.V.Rajan, C.P. Sharma, Ashok Sharma, Prentice – Hall India
4. Materials Science & Metallurgy, Dr. V.D.Kotgire, Everest Publishing House
5. Text Book of Materials Science & Metallurgy, O.P.Khanna, Dhanpat Rai Publication
6. Engineering Materials & Metallurgy, Srinivasan, Tata Mc-Graw Hill

#### **REFERENCE BOOKS:**

1. Materials Science, William Callister, John Wiley & Sons
2. Material Science, Narula & Gupta, Tata Mc-Graw Hill
3. Material Science & Metallurgy, Parashivamurthy, Pearson
4. A First course on Material Science, Raghavan, PHI Learning
5. Introduction to Material Science for Engineers, Shakeford & Murlidhara, Pearson
6. Engineering Physical Metallurgy and Heat Treatment, Yu M Lakhtin, CBS Publisher
7. Metallurgy for Engineers, E C Rollason, ButterWorth & Heineman Ltd.
8. Engineering Metallurgy, R A Higgins, Viva Books
9. Fundamentals of Solidification, W Kurtz and D J Fisher, Springer
10. Physical Metallurgy, Clark, CBS Publisher

## **BEME305P: ENGINEERING METALLURGY (Practical)**

**CREDITS: 01**

**Teaching Scheme**

Practical: 2 Hours/Week

**Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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**LIST OF PRACTICALS:**

Minimum Eight out of following shall be performed:

1. Study of crystal structure
2. Study of metallurgical Microscope
3. Specimen Preparation
4. Metallography ( Study & drawing of microstructure ) of plain carbon steel
5. Metallography of cast iron
6. Metallography of non-ferrous metals.
7. Metallography of heat-treated specimen.
8. Effect of annealing & normalizing on microstructure & hardness of steel.
9. Hardenability Test
10. Hardness Test by i) Brinell ii) Rockwell test.



# **BEME306P: MACHINE DRAWING (Practical)**

**CREDITS: 04**

## **Teaching Scheme**

Practical: 2 Hours/Week

Tutorial: 2 Hour/Week

## **Examination Scheme**

University Assessment: 50 Marks

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** The objective of this course is to make students understand the principles and requirements of machine & production drawings. This course will provide a way to learn how to assemble and disassemble important parts used in major mechanical engineering applications. After going through this course, students shall be able to draw & understand the drawings of mechanical components and their assemblies.

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## **UNIT – I**

Drawing Standards for following

Drawing Sheets, Name Blocks, Lines, Sections Dimensioning. Dimensioning of Tolerances, Standard Components, Standard Features, Machining Symbols, Welding Symbols, Surface Finish Symbols, Heat Treatment Manufacturing Instructions, Allowances, Materials

## **UNIT – II**

Orthographic Projections of Elements, Orthographic Projections, Sectional Views, Multiple Views, Missing Views, Profiles, Cross sections, References, Alignments, Dimensioning

## **UNIT – III**

Study, qualitative selection of type / size (excluding design calculations) and standard practices for following elements Threads, Bolts, Nuts, Washers , Rivets, Welds, Keys & Keyways, Splines, Couplings

## **UNIT – IV**

Assembly and Dismantling: Principles, Fits and Tolerances (Standards, types, application and selection) Tolerance Charting, Surfaces finish requirement for assembly, Geometries suitable for assembly, Assembly / Dismantling Tools, Bearing Assemblies, Assemblies by fastening

## **UNIT – V**

### **Study of Some standard Assemblies**

Assembly Drawings, Principles, techniques and standards for preparing components drawings Subassembly, Drawings, Full assembly Drawing, Exploded Views

## **UNIT – VI**

Production Drawing Name Plates, Part List, Revisions etc.

Essential Parts / Formats required for production drawing, Process Sheet

## **LIST OF PRACTICALS (Based on above Syllabus):**

Minimum Eight Practicals shall be performed consisting of the following:

1. Conventional representation of Symbols.
2. Pencil Drawings of sectional views of machine components.
3. Pencil Drawings of some standard components. ( e.g. Screw Fasteners)
4. Pencil Drawings of standard assemblies with components.( e.g. Couplings)
5. Pencil Drawing of a small assembly with components (e.g. Screw Jack)
6. Pencil Drawings of detailed drawings of Assembly
7. Pencil Drawings of a large assembly with component drawings, subassembly drawings and assembly drawing using all standard formats ( e.g. Spring Loaded Safety Valve)
8. Sheet on Blue Print Reading.
9. Sheet on Preparation and explanation on Production Drawing.
10. Process Sheets for one component having maximum five operations.
11. Computer Print out on Three Dimension Modeling using CAD software.

### **Note:**

1. Pencil drawings shall be in Full Imperial Sheet. Computer Printouts shall be on a Laser printer in A3 size. All drawings shall be submitted in one folder.
2. During University practical examination of 50 marks, students are expected to solve TWO problems of 30 marks of two hours duration on,
  - Sectional View / Missing View
  - Assembly Drawing/ Sub assembly Drawing
  - Prepare and explain production drawingOral of 20 marks shall be conducted during University practical examination.

### **TEXT BOOKS:**

1. Machine Drawing, K. L. Narayana , New Age International Publishers
2. Machine Drawing, N. D. Bhatt & V M Panchal, Charoter Publications
3. Engineering Graphics with AutoCAD, D. M.Kulkarni, A.P.Rastogi, A.K.Sarkar, PHI Learning Pvt. Ltd
4. PSG Data book
5. CMTI Data Book
6. Jadaan Data Book, I.K. International.
7. Relevant IS Codes.

**REFERENCE BOOKS:**

1. Machine Drawing - N.Sidheshwar, Shastry , Kanhaiah, Tata Mcgraw Hill
2. Fundamentals of Machine Drawing, Sadhu Singh, P. L. Shah, PHI Learning Pvt. Ltd

## **BEME307P: TECHNICAL REPORT & SEMINAR**

**CREDITS: 02**

### **Teaching Scheme**

Practical: 02 Hour/Week

### **Examination Scheme**

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** To inculcate the habit of independent learning among students, this course includes identification of a technical topic beyond curriculum, collection of existing literature and report preparation with seminar delivery. Students will be able to familiarize themselves with new technical topics and can participate in technical seminars and paper contests.

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Technical report & Seminar shall be based on any relevant technical topic with independent topic for each student. Report shall be based on information collected from Books, Handbooks, Journals, Periodicals, Internet etc. Student is expected to submit the report and shall give a presentation on it.

A teacher shall be allotted for each batch (Max 09 & Min. 05 Students) and the workload shall be 1 hour per batch per week.

**Syllabus for**  
**Applied Mathematics- IV (Mech. Engg.)**  
**Scheme (Theory: 4 hrs., Tutorial :1 hr)**

**UNIT – I: NUMERICAL METHODS (08Hrs)**

Error Analysis, Solution of Algebraic and Transcendental Equations: Method of False position, Newton–Raphson method and their convergence, Newton–Raphson method for multiple roots, Solution of system of simultaneous linear equations: Gauss elimination method, Gauss Jordan method, Crout’s method and Gauss-Seidel method.

**UNIT – II: NUMERICAL METHODS (08Hrs)**

Numerical solution of ordinary differential equations: Taylor's series method, Runge- Kutta 4<sup>th</sup> order method, Euler’s Modified Method, Milne’s Predictor-Corrector method, Runge- Kutta method to solve Simultaneous first order differential equations. Largest Eigen value and Eigen vector by Iteration method.

**UNIT – III: Z-TRANSFORM (10Hrs)**

Definition , Convergence of Z-transform and Properties, Inverse Z-transform by Partial Fraction Method, Residue Method (Inversion Integral Method) and Power Series Expansion, Convolution of two sequences. Solutions of Difference Equations with Constant Coefficients by Z- transform.

**UNIT - IV: SPECIAL FUNCTIONS AND SERIES SOLUTION(12Hrs)**

Series solution of differential equation by Frobenius method, Bessel’s functions, Legendre’s polynomials, Recurrence relations, Rodrigue’s formula , Generating functions, Orthogonal properties of  $J_n(x)$  and  $P_n(x)$ .

**UNIT – V: RANDOM VARIABLES & PROBABILITY DISTRIBUTIONS (12Hrs)**

Random variables: Discrete and Continuous random variables, Probability function and Distribution function, Joint distributions. Independent Random variables, Conditional Distribution, Mathematical Expectation, Functions of random variables, Variance & Standard Deviation, Moments, Moment generating function, Characteristic function.

## **UNIT – VI: SPECIAL PROBABILITY DISTRIBUTIONS AND RANDOM PROCESS (10Hrs)**

Geometric, Binomial, Poisson, Normal, Exponential, Uniform and Weibull probability distributions.

Random Processes: Ensemble average and time average, Auto correlation and cross-correlation, Stationary random processes, Power spectrum and Ergodic random processes.

### Text Books:

1. Higher Engineering Mathematics by B.S. Grewal, 40th Edition, Khanna Publication
2. Theory & Problems of Probability and Statistics by Murray R. Spiegel , Schaum Series, McGraw Hills
3. Advanced Engineering Mathematics by Erwin Kreyszig, 8th Edition, Wiley India
4. Probability, Statistics and Random Processes by T. Veerarajan..

### Reference Books

1. Introductory methods of Numerical Analysis by S.S. Sastry, PHI.
2. A Text Book of applied Mathematics, Volume I & II by P.N. Wartikar & J.N. Wartikar, Poona Vidyarthi Griha Prakashan.
3. Advanced Mathematics for Engineers by Chandrika Prasad.
4. Probability and Statistics for Engineers 4<sup>th</sup> Ed. By Miller, Freund and Johnson.
5. Probability, Statistics with Reliability, Queuing and Computer Science Applications by K. S. Trivedi.
6. A text book of Engineering Mathematics by N. P. Bali & M. Goyal, Laxmi Publication.

**B.E. (MECHANICAL ENGINEERING): FOURTH SEMESTER**

**BEME402T: ENGINEERING THERMODYNAMICS (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 provides the basic knowledge about Thermodynamic laws and relations, their application to various processes. At the end of this course, student will be able to understand the thermodynamic laws and their applications, the concept of entropy and availability, thermodynamic relations, and shall understand the various thermodynamic processes & cycles.

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**UNIT – I**

**[ 8 Hrs.]**

Introduction to Thermodynamics: Basic concepts of Thermodynamics, Systems and its forms, Property, State, Process, Cycles, Thermodynamics equilibrium, temperature, Zeroth law of thermodynamics, Introduction to First law of thermodynamics, Energy transfer, Heat and Work, Mechanical form of work, Non-mechanical form of work.

Ideal Gas: Gas laws-Boyle's law, Charles's law, Avagadro's law, Equation of state, Specific Heat, Universal gas constant, Constant pressure, Constant volume, Isothermal, Isentropic and Polytropic process on P-V Diagram.

Calculation of Heat transfer, Work done, Change in Internal Energy and Enthalpy.

**UNIT – II**

**[ 8 Hrs.]**

First law of Thermodynamics for Closed System undergoing a process and cycle (Control Mass System) and Open System (Control Volume System), Steady Flow process apply to Nozzle, Turbine, Compressor, Pump, Boiler, Throttling Device, Heat Exchanger. (Analytical treatment on First law applied to closed and open system is expected).

**UNIT – III**

**[ 8 Hrs.]**

Second Law of Thermodynamics:- Introduction, Thermal Energy Reservoirs, Kelvin-Planck and Clausius Statements, Heat Engine, Refrigerator, Heat Pump, Perpetual Motion Machine I and II, Carnot Cycle, Thermodynamic Temperature scale.

Entropy: Clausius Inequality, Entropy, Principle of increase of Entropy, Change in Entropy for different Thermodynamics Processes with T-S Diagram, Reversible and Irreversible Processes, Availability.(Simple analytical treatment is expected)

**UNIT – IV**

**[ 8 Hrs.]**

Properties of Steam: - Sensible Heat, Latent Heat, Critical State, Triple Point, Wet Steam, Dry Steam, Superheated Steam, Dryness Fraction, Internal Energy of Steam, External Work Done during Evaporation, T-S Diagram, Mollier Chart, Work and Heat Transfer during various

Thermodynamic Processes with steam as working fluid, Determination of Dryness Fraction using various Calorimeter. (Analytical Treatment using steam table and Mollier chart is expected)

**UNIT – V**

**[ 8 Hrs.]**

Vapour Power Cycle:- Introduction, Vapour Carnot Cycle, Rankine Cycle, Method to increase Thermal Efficiency, Reheat-Rankine Cycle, Regenerative Rankine Cycle with opened and closed feed water heaters.

**UNIT – VI**

**[ 8 Hrs.]**

Air Standard Cycles: - Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle, Stirling Cycle, Ericsson Cycle (Work done & efficiency analysis is expected)

**TEXT BOOKS:**

1. Engineering Thermodynamics, P. K. Nag, Tata McGraw-Hill Publications
2. Thermal Engineering, P. L. Ballani, Khanna Publications
3. Engineering Thermodynamics, S.S. Khandare, Charotar Publication House

**REFERENCE BOOKS:**

1. Thermodynamics and Engineering approach, Yunus A. Cengel, Michael A. Boles, Tata McGraw-Hill Publications
2. Engineering Thermodynamics, D. P. Mishra, Cengage Learning Publications
3. Engineering Thermodynamics, Gordon Rogers, Pearson Publications
4. Thermodynamics, S. C. Gupta, Pearson Publications



## **BEME403T: HYDRAULIC MACHINES (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 hydraulic turbines, centrifugal pumps, positive displacement pumps and miscellaneous water lifting devices. At the end of this course, students will understand practical applications of fluid; based on momentum and angular momentum principles involved in hydraulic machines. They will also understand design parameters and performance characteristics of various hydraulic machines & devices.

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### **UNIT – I**

**[ 8 Hrs.]**

Compressible Flow:- Speed of Sound and the Mach Number, Isentropic Nozzle Flow, Normal Shock Wave, Shock Wave in Convergent-Divergent Nozzle, Vapour flow through Nozzle, Oblique Shock Wave, Isentropic Expansion. Introduction to impact of jet.

### **UNIT – II**

**[ 8 Hrs.]**

Theory of turbo machines and their classification, Elements of hydro-electric power plant, Impulse Turbine:- principle, constructional features, Installation of Pelton Turbine, Velocity Diagram and Analysis, Working proportions, Design parameters, Performance characteristics, Governing.

### **UNIT – III**

**[ 8 Hrs.]**

Reaction or pressure Turbine:- principles of operation, Degree of reaction, comparison over Pelton Turbine, Development of reaction turbine, Classification, Draft tube, Cavitation in Turbine, Francis Turbine, Propeller Turbine, Kaplan Turbine:- Types, Constructional features, Installations, Velocity Diagram and analysis, Working proportions, Design parameters, Performance characteristics, Governing, selection of turbines.

### **UNIT – IV**

**[ 8 Hrs.]**

Hydrodynamic pumps:- Classification and Applications, Centrifugal pumps:- Principle of operation, Classification, Component of Centrifugal Pump installation, Priming methods, Fundamental equation, Various heads, Velocity heads, Velocity triangles and their analysis, slip factor, Effect of outlet blade angle, Vane shapes, Losses and Efficiencies of pumps, Multi staging of pumps, Design Consideration, Working proportions, N.P.S.H., Cavitations in pumps, Installation and operation, Performance characteristics, Pump and system matching and Introduction to self priming pumps.

### **UNIT – V**

**[ 8 Hrs.]**

Positive Displacement Pumps:- Basic principle, Classification, Reciprocating Piston / Plunger Pumps:- Types, Main Components, Slip, Work Done, Indicator Diagram, Cavitations, Air vessels, Gear pump, Screw pump, Vane pump.

## **UNIT – VI**

**[ 8 Hrs.]**

Similitude: - Types of similarities, Dimensionless number and their significance, Unit and Specific Quantities, Model Testing: - Application to hydraulic turbine and hydrodynamic pumps, Miscellaneous Water Lifting Device: - Air lift pumps, Hydraulic Ram, Submersible pump, Regenerative pumps.

### **LIST OF TUTORIALS:**

- 1) Selection of Turbine
- 2) Design of centrifugal Pumps
- 3) Design of Francis Turbine
- 4) Design of reciprocating Pumps
- 5) Governing of Turbines
- 6) Study of Hydro-Kinetic System

### **TEXT BOOKS:**

1. Fluid Mechanics & Fluid Power Engineering – D. S. Kumar, S.K. Kataria & Sons Publications
2. Fluid Mechanics & Machines – R. K. Bansal, Laxmi Publications

### **REFERENCE BOOKS:**

1. Fluid Mechanics with Engineering Applications, E. Finnemore & Franzini, Tata Mc-Graw Hill
2. Hydraulic Machines-Theory and Design, V. P. Vasandani, Khanna Publishers
3. Fluid Mechanics, A. K. Jain, Khanna Publishers
4. Hydraulic & Compressible Flow Turbo-machines, A. T. Sayers, Mc-Graw Hill
5. Mechanics of Fluids, Merle C. Potter, CL-Engineering
6. Fluid Mechanics, John F. Douglas, Pearson

## **BEME403P: HYDRAULIC MACHINES (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum Eight out of following shall be performed:

1. To determine the metacentric height of given floating vessel.
2. To verify Bernoulli's theorem.
3. To find the value of co-efficient of given venture meter fitted in a pipe.
4. To find the value of co-efficient of Discharge for a given orifice meter.
5. Performance characteristics of Pelton wheel.
6. Performance characteristic of Francis Turbine.
7. Performance characteristic of Kaplan Turbine.
8. Performance characteristic of Reciprocating pump.
9. Performance characteristic of Variable speed pump.
10. Performance characteristic of Axial Flow Pump.
11. To find friction losses in pipe.
12. To determine co-efficient of discharge in pipes.

## **BEME404T: MACHINING PROCESSES (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:** The study of machine tools & metal cutting is fundamental to mechanical engineering. This course includes the working of mechanisms of various machine tools and machining principles. The learning outcomes include concept of theory of metal cutting & force analysis, understanding the objectives of the various machine tools, constructional details and mechanisms involved in various machine tools. This course is aimed also to identify the machining parameters, different types of cutting tool materials, cutting fluids and their properties. Upon completion of this course, students shall understand the importance of machining processes and be able to apply the suitable machining processes for an engineering product.

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### **UNIT – I**

**[ 8 Hrs.]**

Introduction to Machining Parameters: Introduction to machining, Tool materials, nomenclature and tool geometry of single point cutting tool, tool materials properties, classification, HSS, carbide tool, coated tools, diamond coated tool.

Theory of Metal Cutting: Introduction. Orthogonal and Oblique cutting. Mechanics of Metal Cutting, shear plane, Stress, Strain and cutting forces. Merchant's circle, Chip formation, cutting force calculations, Determination of Torque and power required for turning Drilling and Milling. Influence of tool angle, cutting fluids, cutting speed, feed and depth of cut on power requirement, Estimation of tool life.

### **UNIT – II**

**[ 8 Hrs.]**

Lathe: Introduction. type, construction of simple lathe mechanism and attachments for various operations, machine specifications, basis for selection of cutting speed. feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling. Introduction to Capstan & Turret Lathe.

### **UNIT – III**

**[ 8 Hrs.]**

Shaper: Introduction, type, specification, description of machines, hydraulic drives in shapers, cutting parameters. Mechanism of shaper: Quick return mechanism, Crank & slotted link mechanism, Table feed mechanism, attachments for shaper, work holding devices, shaper operations, time estimation for shaping operations.

Slotter : Introduction, specifications, description, type of drives for slotter, types of slotting machines -production slotter, puncher slotter, tool room slotter, slotter tools. Planer: Introduction, specifications, description. type of planner, open side planner, pit planner Mechanism for planner: Driving mechanism, feeding mechanism, planner cutting tools, cutting parameters.

**UNIT – IV****[ 8 Hrs.]**

Milling: Introduction. Specification, types, column & knee type milling machine, fixed bed type milling machines, production milling machines, special purpose milling machines such as thread milling Machines, profile milling machine, Gear Milling/Hobbing machines. Mechanisms & Attachments for Milling. Cutting, parameters, Types of milling operations, Types of milling cutters, Tool geometry & their specifications. Indexing- simple, compound and differential.

**UNIT – V****[ 8 Hrs.]**

Grinding operations, grinding wheel, specifications & selection, cylindrical & centreless grinding operation, surface grinding, tool & cutter grinding, time estimation for grinding operations. Super finishing process: Honing, Lapping, super finishing, polishing, buffing, 'metal spraying, galvanizing and electroplating. Process parameters and attainable grades of surface finish, surface measurement.

**UNIT – VI****[ 8 Hrs.]**

Drilling: introduction, tools for drilling, classification of drills, twist drills, drill size and specifications, tipped drills, type of drilling machines-portable drilling machine. bench drilling machine, right drilling machine, radial drilling machine, universal drilling machine, multisided drilling machine. Drilling machines operations, time estimation for drilling. Reaming: Introduction, description of reamer, type of reaming operations. Boring: Introduction, types of boring machine, horizontal boring machine, vertical boring machine, jig machine, micro boring. boring operations. Broaching: Introduction, type of broaches, nomenclature of broaches. types of broaching machines.

**TEXT BOOKS:**

1. Workshop technology (Vol. II), V. S. Raghuvanshi, Dhanpat Rai & Sons
2. Manufacturing Science, Ghosh & Mallik, East West Press
3. Manufacturing technology (Metal cutting & Machine tools) Vol. II, P. N. Rao, Tata Mc-Graw Hill
4. Workshop technology, H. S. Bawa, Tata Mc-Graw Hill
5. Introduction to Manufacturing Processes, J. A. Schey, Tata Mc-Graw Hill
6. Workshop Technology (Volume II), Hajra Chaudhary, Media Promoters & Publishers

**REFERENCE BOOKS:**

1. Manufacturing Engineering & Technology, S. Kalpakjian & S.R. Schmid
2. Technology of Machine Tools, Krar & Oswald
3. Manufacturing Processes, M. Begman
4. Processes & Materials of Manufacture, R. Lindberg
5. Production Technology, HMT

## **BEME404P: MACHINING PROCESSES (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum Eight out of following shall be performed:

1. Study of Single Point Cutting Tool.
2. Study of Various forces on single point cutting tools.
3. Study of multiple point cutting tools (milling, drilling)
4. Study of Lathe Machine.
5. Study of Shaper mechanisms.
6. Study of Broaching machines.
7. One Job on Milling.
8. One Job on Drilling, Boring
9. One Job on Thread Cutting, Taper Turning.
10. One Job on Surface Grinding.
11. One Job on Shaper.

## **BEME405T: MECHANICS OF MATERIAL (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 stress, strain and their variations under different types of loading. It includes the basic concepts involved in mechanics of materials, bending moment, shear force, stresses in beams, slope and deflection in beams under different loading and support conditions, understanding of torsional shear stress in shaft, crippling load in struts and columns. At the end of this course, students will be able to analyze different stresses, strains and deflections in a simple mechanical element under various loading and support conditions.

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### **UNIT – I**

**[ 8 Hrs.]**

Concept of simple stresses and strains: Introduction, stress, strain, types of stresses, stress and strain diagram for brittle & ductile material, elastic limit, Hooks law, modulus of elasticity, modulus of rigidity, factor of safety, analysis of tapered rod, analysis of composite section, thermal stress and strain.

Longitudinal strain & stress, lateral stresses and strains, Poisson's ratio, volumetric stresses and strain with uni-axial, bi-axial & tri-axial loading, bulk modulus, relation between Young's modulus and modulus of rigidity, Poisson's ratio and bulk modulus.

### **UNIT – II**

**[ 8 Hrs.]**

Shear force and bending moment: - Types of beam (cantilever beam, simply supported beam, overhung beam etc.), Types of loads (Concentrated and UDL), shear force and bending moment diagrams for different types of beams subjected to different types of loads, sign conventions for bending moment and shear force, shear force and bending moment diagrams for beams subjected to couple, Relation between load, shear force and bending moment.

Stresses in beams: - Pure bending, theory of simple bending with assumptions & expressions for bending stress, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections.

Shear stresses in beams: - Concept, derivation of shear stress distribution formula , shear stress distribution diagram for common symmetrical sections, maximum and average shear stress.

### **UNIT – III**

**[ 8 Hrs.]**

Deflection of beams:- Deflection & slope of cantilever, simply supported, overhung beams subjected to concentrated load, UDL, Relation between slope, deflection & radius curvature Macaulay's method to determine deflection of beam.

Principal stresses and strains:- Definition of principal planes & principal stresses, analytical method of determining stresses on oblique section when member is subjected to direct stresses in one plane in mutually perpendicular two planes, when member is subjected to shear stress and direct stresses in two mutually perpendicular planes, Mohr's circle for representation of principal stresses.

## **UNIT-IV**

[ 8 Hrs.]

Torsion of circular shafts: - Derivation of torsion equation with the assumptions made in it. Torsion shear stress induced in the shaft, when it is subjected to torque. Strength and rigidity criterion for design of shaft. Torque transmitted by solid & hollow circular shaft. Equivalent twisting and bending moment in shaft when it is subjected to bending moment, torque & axial load. Column & Struts: - Failure of long & short column, slenderness ratio, assumptions made in Euler's column theory, end conditions for column. Expression for crippling load for various end conditions of column and derivation on column with both ends hinged. Effective length of column, limitations of Euler's formula, Rankine formula.

## **UNIT-V**

[ 8 Hrs.]

Introduction to fracture mechanics: - Modes of fracture, stress intensity factors, crack propagation, creep phenomenon.

Strain energy & impact loading: - Definition of strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads & impact loads. Strain energy stored in bending & torsion.

## **UNIT-VI**

[ 8 Hrs.]

Factor of safety, Statistical methods in determining factor of safety. Theories of failure, modes of failure, compound stresses, eccentric axial loading, variable stresses in machine parts, Endurance, S-N Curve, stress concentration & stress raisers, notch sensitivity, stress concentration factor, methods for reducing stress concentration. Goodmans criteria, Soderberg criteria, Gerber's criteria, fatigue design for finite and infinite life of the parts subjected to variable loads with uniform cross section.

### **LIST OF TUTORIALS:**

- 1) Two problems on principle stresses
- 2) Two problems on Mohr's circle
- 3) Two problems on Thermal stresses with heat flow
- 4) Three problems on S.F. & B.M. diagrams
- 5) Two problems on Stresses in beam bending
- 6) Two problems on shear stresses
- 7) Two problems on Macaulay's methods
- 8) Two problems on area moment method
- 9) Two problems on shafts
- 10) Two problems on columns & struts
- 11) Two problems on compound loading
- 12) Two problems on fatigue & variable loads

### **TEXT BOOKS:**

1. Elements of Strength of Materials, S. Timoshenko and O.H.Young, East West Press Private Ltd.
2. Strength of Materials, R K Bansal, Laxmi Publications
3. Strength of Materials, Ramamurtham, Dhanapat Rai Publication.
4. PSG Data Book.
5. Design Data for Machine Elements, B.D. Shiwalkar, Denett & Company
6. Strength of Material, R.K. Rajput, S.Chand Publication



**REFERENCE BOOKS:**

1. Strength of Material, Ferdinand L. Singer, Harper and Row, New York
2. Elements of Strength of Materials, V. Natarajan, Oxford & IBH Publishing Company
3. Strength of Materials, S S Rattan, Tata McGraw-Hill
4. Mechanics of Material, Beer & Johnson, Tata Mc-Graw Hill

## **BEME405P: MECHANICS OF MATERIAL (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum Eight Practicals out of following areas shall be performed:

1. Study of Universal Testing Machine

1. Tension test on metals.

2. Compression test on materials.

3. Shear test on metals.

4. Impact test on metals.

5. Hardness test on metals.

6. Torsion test on metals.

7. Deflection of beams.

8. Modulus of rupture test.

9. Buckling of columns.

10. Deflection of springs.

## **BEME406T: ENVIRONMENTAL STUDIES (Theory)**

**CREDITS:** Nil (College Assessment in Grades)

### **Teaching Scheme**

Lectures: 3 Hours/Week

### **Examination Scheme**

College Assessment: Grades  
(Grades: O, A, B, C)

**Course Objectives and Expected Outcomes:** This course provides an integrated and interdisciplinary approach to the study of environment and solutions to environmental problems. This course will spread awareness among the students about environmental issues and shall alert them to find solutions for sustainable development.

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### **UNIT – I**

[ 6 Hrs.]

#### **Introduction:**

Definition, scope and importance; Need for public awareness -Institutions in environment, people in environment.

#### **Natural Resources:**

Renewable and non-renewable and associated problems; Role of an individual in conservation of natural resources; equitable use of resources for sustainable lifestyles.

### **UNIT – II**

[ 6 Hrs.]

#### **Ecosystems:**

Concept of an ecosystem - understanding ecosystems, ecosystem degradation, resource utilization, Structure and functions of an ecosystem- (producers, consumers) and decomposers.

Energy flow in the ecosystem - water, carbon, oxygen, nitrogen; and energy cycles, integration of cycles in nature.

Ecological succession; Food chains, food webs and ecological pyramids; Ecosystem types - characteristic features, structure:, and functions of forest, grassland, desert and aquatic ecosystems.

### **UNIT – III**

[ 6 Hrs.]

#### **Bio-diversity:**

Introduction - biodiversity; at genetic, species and ecosystem levels Bio-geographic classification of India

Value of biodiversity - Consumptive use value, productive use .value, social, ethical, moral, aesthetic and optional value of biodiversity.

India as a mega-diversity nation; hotspots of biodiversity

Threats to bio-diversity - habitat loss, poaching of wildlife, man-wild life conflicts. Common endangered and endemic plant and animal species of India. Insitu and Exsitu conservation of biodiversity

#### **UNIT – IV**

[ 6 Hrs.]

##### **Pollution :**

Definition; Causes, effects and control measures of air, water, soil, marine, noise and thermal pollutions and nuclear hazards.

Solid waste management - Causes, effects and control measures of urban and industrial waste. Role of individual and institutions in prevention of pollution.

Disaster management Floods, Earth quacks, Cyclone and land slides.

#### **UNIT – V**

[ 6 Hrs.]

##### **Social Issues and the Environment:**

Unsustainable to sustainable development; Urban problems, related to energy; Water conservation, rainwater harvesting, watershed management; Problems and concerns of resettlement and rehabilitation of affected people.

Environmental ethics - issues and possible solutions – Resource consumption patterns and need for equitable utilization; Equity disparity in Western and Eastern countries; Urban and rural equity issues; need for gender-equity.

Preserving Resources for future generations. The rights of animals; Ethical basis of environment education and awareness; Conservation ethics and traditional value systems of India.

Climate change, global warming, acid-, rain, Ozone layer depletion, nuclear accidents and holocausts. Wasteland Reclamation; Consumerism and Waste products.

Environment legislations - The Environment (protection) Act; The water (Prevention and Control of Pollution) Act; The Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislations - environment impact assessment (EIA), Citizens actions and action groups.

Public awareness — Using an environmental calendar of activities, self initiation.

#### **UNIT – VI**

[ 6 Hrs.]

##### **Human Population and the Environment:**

Global population growth, variation among nations, population explosion; Family Welfare Programmes.- methods of. sterilization; Urbanization.

Environment and human health - Climate and health, Infectious diseases, water-related diseases, risk due to chemicals in food, Cancer and environment.

Human rights — Equity, Nutrition and health rights, intellectual property rights (IPRS), Community Biodiversity registers (CBRs).

Value education - environmental values, valuing nature, valuing cultures, social justice, human heritage, equitable use of resources, common property resources, ecological degradation.

HIY/AIDS; Women and Child Welfare; Information technology in environment and human health.

**GUIDELINES FOR EVALUATION OF ENVIRONMENTAL STUDIES SUBJECT (As per Ordinance No. 2 of 2012):**

At the end of the course, the student shall be evaluated for 100 marks with distribution as below:

Field note book	-	25 Marks
Objective Questions	-	50 Marks (50 questions, each of one mark)
Essay type question	-	25 Marks
Passing marks	-	40 Marks

OR

In view of the above entire course the students in terms of batches of 20 students each may be assigned a project work encompassing People's Bio-diversity Register (PBR) of any Gram Panchayat as per the format of Bio-diversity Authority of India under the guidance of a teacher. The PBR should be evaluated for 100 marks.

The result shall be declared in grades as follows:

Grade O: above 75 Marks; Grade A: 61–75 Marks; Grade B: 51-60 Marks; Grade C: 40-50 Marks

**TEXT BOOKS:**

A Text Book of Environmental Studies for Undergraduate Courses, Erach Bharucha, University Press (India) Pvt. Ltd., Hyderabad

## **BEME407P: MINI PROJECT**

**CREDITS: 02**

### **Teaching Scheme**

Practical: 2 Hour/Week

### **Examination Scheme**

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** The objective of this course is to convert an idea or concept into a simple working physical model. During this course, student will learn regarding fabrication/construction of a simple mechanical or electro-mechanical working model using various manufacturing processes.

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A group of students (not more than 10 students) shall prepare a working model of any mechanical or electro-mechanical system. Computer / mathematical model or simulation is not acceptable. Student shall submit a report with photograph of the model.

A teacher shall be allotted for each batch (Max 09 & Min. 05 Students) and the workload shall be 1 hour / batch per week.

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

**V 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 Assessment	Total Marks	Min. Passing Marks
BEME501T	Industrial Economics and Entrepreneurship Development	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME502T	Design of Machine Elements	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME503T	Advanced Production Processes	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME504T	Heat Transfer	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME504P	Heat Transfer	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME505T	Mechanical Measurement & Metrology	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME505P	Mechanical Measurement & Metrology	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME506P	Computer Applications – I	-	02	02	04	-	-	-	-	-	50	50	100	50
BEME507P	Industrial Visit	-	-	02	Audit Course									
<b>Total</b>		<b>15</b>	<b>07</b>	<b>08</b>		<b>-</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>-</b>	<b>100</b>	<b>100</b>	<b>200</b>	<b>-</b>
<b>Semester Total</b>		<b>30</b>			<b>26</b>	<b>Marks 700</b>								

Industrial Economics and Entrepreneurship Development (BEME501T) subject pertains to Board of Studies in Applied Sciences & Humanities and all the remaining subjects pertain to the 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)**

**VI 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 Assessment	Total Marks	Min. Passing Marks
BEME601T	Energy Conversion- I	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME602T	Control Systems Engineering	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME603T	Operations Research	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME604T	Mechatronics	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME604P	Mechatronics	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME605T	Dynamics of Machines	03	01	-	04	03	80	20	100	40	-	-	-	-
BEME605P	Dynamics of Machines	-	-	02	01	-	-	-	-	-	25	25	50	25
BEME606T	Functional English	02	-	-	02	02	40	10	50	20	-	-	-	-
BEME607P	Computer Applications - II	-	02	02	04	-	-	-	-	-	50	50	100	50
BEME608P	Industrial Case Study	-	-	02	02	-	-	-	-	-	-	50	50	25
<b>Total</b>		<b>17</b>	<b>07</b>	<b>08</b>	<b>-</b>	<b>-</b>	<b>440</b>	<b>110</b>	<b>550</b>	<b>-</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>-</b>
<b>Semester Total</b>		<b>32</b>			<b>30</b>	<b>800 Marks</b>								

Functional English (BEME606T) subject pertains to Board of Studies in Applied Sciences & Humanities and all the remaining subjects pertain to the Board of Studies in Mechanical Engineering. Mechatronics (BEME604T/P) subject can also be taught by a teacher from Electronics/Instrumentation/Mechatronics/relevant disciplines.



Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Engineering and Technology

**B.E. (MECHANICAL ENGINEERING): FIFTH SEMESTER**

**BEME501T: INDUSTRIAL ECONOMICS AND ENTREPRENEURSHIP  
DEVELOPMENT (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 create awareness about economics terminology and business organization, to understand relationship between business, market and society, to create awareness about entrepreneurship as a career avenue; financial agencies and government support systems for entrepreneurship. This course shall stimulate the potential to develop entrepreneurial orientation through innovation, creativity & students will understand the concept of innovation, invention, creativity and discovery in engineering context and shall also get awareness about IPR and Patents.

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**UNIT – I**

**[ 8 Hrs.]**

Industrial Economics : Economics, classification of economics, Basics concepts, Law of demand, Demand analysis, Types of demand, Determinants of demand, Methods of demand forecasting, Supply, Law of diminishing marginal utility, Elasticity of demand, Types of elasticity of demand.

**UNIT – II**

**[ 8 Hrs.]**

Factors of production, Production function, Firm and Industry, Law of return, Cost concepts, Fixed variable, Average, Marginal and Total cost, Break even analysis Depreciation and methods for depreciation.

**UNIT – III**

**[ 8 Hrs.]**

Inflation, effect of inflation, Monetary and fiscal measures to control inflation, deflation, stagflation direct and indirect taxes. Market and market structures, Perfect competition, Monopoly, Monopolistic competition, Oligopoly, Price determination in these Situations. Concept & overview of share market, Effect of share market on economy, Share market terminologies.

**UNIT – IV**

**[ 8 Hrs.]**

**Innovation & Creativity:** Concept of creativity, innovation, invention, discovery. Methods for development of creativity, convergent & divergent thinking etc. Introduction to Intellectual Property Rights (IPR), Patent and laws related to patents.

## UNIT – V

[ 8 Hrs.]

Concept of entrepreneurship, its relations in economic developments, Eventuation of concept of entrepreneur, characteristics of an Entrepreneur, Types of entrepreneurs, Qualities of entrepreneur, Factors affecting growth of entrepreneurship. Theory of achievement, motivation, Medelland's experiment, Women entrepreneurship, Role of SSI, it's advantages & limitations, policies governing small scale industries, Procedure to set up small scale industrial unit, Advantages and limitations of SSI.

## UNIT – VI

[ 8 Hrs.]

**Preparation of project report:** Factors governing project selection, Market survey, Preparation of project report. Financial, technical & market analysis of project. Entrepreneurial support systems, Role of consultancy organization like, District Industrial Centre, State Industrial Development Corporation, Financial institution, Latest SSI schemes of DIC (to be confirmed from DIC from time to time)

**Note:** Group of students (Min 05 & Max 09) are expected to prepare a project report for business / industry on the knowledge acquired.

## TEXT BOOKS:

1. Modern Economics, H. L. Ahuja, S.Chand Publishers
2. Modern Economic Theory, K. K. Dewett., S. Chand Publishers
3. Engineering Economics, D. N. Dwivedi, A. Dwivedi, Vikas Publishing House
4. Entrepreneurship Development, S. S. Khanka, S. Chand Publishers
5. Creativity Innovation & Entrepreneurship, Zechariah James Blanchard, Needle Rat Business Publishers.

## **BEME502T: DESIGN OF MACHINE ELEMENTS (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 machine element design. It includes the procedure of design (w.r.t. basic failures) under various loading conditions. Students shall understand design of various mechanical joints, machine components such as shaft, keys, brakes clutches, power screws etc. Apart from this, students shall learn spring design & pressure vessel design. At the end of this course, students will get familiar with design of these mechanical components under various loading conditions.

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### **UNIT – I**

**[ 12 Hrs.]**

Introduction to Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics Consideration in design , Material properties and their uses in design , Basic 'principles of Machine Design, Modes of failures, I. S. codes, Preferred Series and numbers. Design of Knuckle joint, Socket & Spigot type cotter joint. Design of riveted joint.

### **UNIT – II**

**[ 12 Hrs.]**

Design of bolted and welded joints under axial and eccentric loading conditions. Design of Brackets & Levers.

Design of Cylinder & Pressure Vessels: Types of pressure vessel, stresses induced in pressure vessel, Lamé's, Clavarino's and Bernie's equations. Design of cylindrical & spherical pressure vessels. Design of nut, bolt, gasket & covers for pressure vessel.

### **UNIT – III**

**[ 12 Hrs.]**

Design of shaft for power transmission, static and fatigue criteria for shaft design, ASME codes for shaft design, Design of keys.

Design of Springs: Spring material, Helical compression & tension springs under static and variable loads, Leaf spring, Laminated Springs.

### **UNIT – IV**

**[ 12 Hrs.]**

Design of power screw: Thread forms, multiple threaded screws, terminology of power screw, design of screw jack.

Design of clutches and brakes: Single and multiple plate clutch, constant wear and constant pressure theory for plate clutches, Internal and external shoe brakes.

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**TEXT BOOKS:**

1. Design of Machine Elements, B.D.Shiwalkar, Central Techno Publications
2. Design of Machine Elements, V. B. Bhandari, Tata McGraw Hill Pub.
3. Mechanical Engineering Design, J. E. Shigley, McGraw Hill.
4. Design Data Book, B.D.Shiwalkar, Central Techno Publications.
5. Design Data Book, PSG.
6. Design Data Handbook Book, K. Mahadevan, CBS Publishers.
7. Mechanical Design of Machine Elements & Machines, J.A.Collins, Wiley India
8. Machine Components Design, Robert C., Juvinall & Kurt M. Marshek, Wiley India
9. Machine Design, U.C. Jindal, Pearson Publications
10. Machine Design : An Integrated Approach, Robert L Norton, Pearson Publications
11. Machine Design Fundamental and Applications, P.C. Gope, PHI Learning.
12. Design of Machine Elements, Sharma C.S. & Purohit K, PHI Learning.

**REFERENCE BOOKS:**

1. Design of Machine Elements, Spotts M. F. and Shoup T. E., Pearson Publications.
2. Machine Design, Black P. H. and O. Eugene Adams, McGraw Hill Book Co Inc.

## **BEME503T: ADVANCED PRODUCTION PROCESSES (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 subject is designed to make conversant with non conventional machining processes, advanced Joining Processes, Die Cutting Operations, Jig and Fixtures, Super -finishing operations & Machining centre. Upon completion of this course, student shall understand the unconventional machining processes and will be able to select and apply suitable processes for engineering products.

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### **UNIT – I**

**[ 8 Hrs.]**

Non- conventional machining Processes: Introduction & classification, Electrochemical machining, Electrical Discharge machining, Ultrasonic machining, Laser beam machining, Electron beam machining, Water jet machining, Abrasive jet machining. Advantages, disadvantages and applications of above processes.

### **UNIT – II**

**[ 8 Hrs.]**

Advanced joining Processes : Introduction and classification of welding techniques, Advanced welding processes such as TIG, MIG welding, Plasma arc welding, Plasma welding, Oxyacetylene welding , Atomic hydrogen welding , Laser beam welding , Electron beam welding , Electro slag welding.

### **UNIT – III**

**[ 8 Hrs.]**

Advanced machining Processes: Introduction, Classification, Capstan and turret lathe, Tool layout for capstan and turret lathe, Machining center.  
Introduction to micromachining, nanofabrication, high energy rate forming.

### **UNIT – IV**

**[ 8 Hrs.]**

Die cutting operations: Introduction, Sheet metal cutting, Sheet metal forming, Sheet metal drawing, defects in drawn parts, Spinning, Equipments for sheet metal working, Die and punch.

### **UNIT – V**

**[ 8 Hrs.]**

Jigs and fixtures: Introduction, principles of jig and fixture, Principle of location, jig bushes, drilling jigs, type of clamps, classification of fixtures.

### **UNIT – VI**

**[ 8 Hrs.]**

Super finishing processes: Introduction, Principle of super finishing process, Lapping, Honing, Buffing & Electroplating.  
Principle of operation, advantages, disadvantages and applications of above processes.  
Application of LASER in surface modification.

Note: All the teachers are advised to show the relevant videos for the above processes.

**TEXT BOOKS:**

1. Production Technology, P.C. Sharma, S.Chand Publication.
2. Manufacturing Engineering and Technology, Serope KalpakJan, Pearsons.
3. Manufacturing Technology, D.K. Singh, Pearsons.
4. Unconventional Manufacturing Processes, M.K. Singh, New Age Publications.
5. Non-Conventional Manufacturing Processes, H.S. Shan, Tata Mc-Graw Hill.

## **BEME504T: HEAT TRANSFER (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 learn the various modes of heat transfer and laws associated with it. During this course, students can distinguish between steady state and unsteady state heat transfer; will be able to apply their knowledge of Dimensional Analysis to forced and free convection. Students will also be able to analyse radiation with and without radiation shield. Apart from this, students will also be able to analyse & design heat exchangers.

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### **UNIT – I**

**[ 8 Hrs.]**

Introduction to basic modes of heat transfer, conduction, convection & radiation. Laws of heat transfer & conservation of energy requirement. General heat conduction equation in cartesian, cylindrical and spherical coordinates. One dimensional steady state heat conduction equation for the plane wall, cylinder and sphere, overall heat transfer coefficient. Thermal resistance of composite structure, contact resistance, variable thermal conductivity, critical thickness of insulation.

### **UNIT – II**

**[ 8 Hrs.]**

Conduction with internal heat generation for plane wall, cylinder and sphere. Extended surface, types of fins. Fins of uniform cross section area, temperature distribution and heat transfer rate, fin efficiency & effectiveness. Error in temperature measurement. Unsteady state heat transfer, lumped heat capacity analysis, Heisler's charts. Biot Number, Fourier's Number & its significance.

### **UNIT – III**

**[ 8 Hrs.]**

Forced convection, physical significance of non-dimensional parameter. Flow of high, moderate & low Prandtl number, fluid flow over a flat plate. Concept of hydrodynamics & thermal boundary layer thickness, local and average heat transfer coefficient. Empirical co-relations for external, internal flows, laminar & turbulent flow through conduits. Dimensional analysis applied to forced convection.

### **UNIT – IV**

**[ 8 Hrs.]**

Free or natural convection. Grashoff's number, Rayleigh number, flow over horizontal and vertical plate, Empirical Co-relations for cylinders and spheres, heat transfer with phase change, pool boiling curve & regimes of pool boiling, Film & Drop wise condensation, laminar film condensation on vertical surface, on horizontal tubes, effect of super heated & non-condensable gases on condensation heat transfer, Dimensional analysis applied to free or Natural convection.

### **UNIT – V**

**[ 8 Hrs.]**

Radiation, spectrum of radiation, black body radiation, radiation intensity, laws of radiation-Kirchoffs, Plancks, Weins displacement law, Stefan Boltzmann & Lamberts Co-sine law. Emissivity, Absorbitivity, Transmissivity, Reflectivity, Radiosity, Emissive power, Irradiation. Radiation network, radiation exchange between parallel plate cylinder & sphere, shape factor & its laws, radiation between parallel plates, cylinder & spheres. Radiation shields.

## **UNIT – VI**

**[ 8 Hrs.]**

Heat exchanger : Classification, overall heat transfer coefficient, fouling factor, LMTD & effectiveness, NTU method of heat exchanger analysis for parallel, counter flow & cross flow arrangement, design aspect of heat exchangers, Introduction to compact heat exchanger, Heat Pipe, Introduction to mass transfer.

### **TEXT BOOKS:**

1. Heat Transfer, J.P. Holman, McGraw Hill Book Company, New York.
2. Fundamentals of Heat and Mass Transfer, K. N. Seetharam & T.R. Seetharam, Willey.
3. A Text Book of Heat Transfer, S.P. Sukhatme, University Press.

### **REFERENCE BOOKS:**

1. Fundamentals of Heat and Mass Transfer, Venkanna B.K., PHI Publication.
2. Principles of Heat Transfer, Frank Kreith, Harper and Row Publishers, New York.
3. Heat Transfer - A Practical Approach, Yunus A. Cengel, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Heat & Mass Transfer, M.N. Ozisik, Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. Heat & Mass Transfer, R.K. Rajput, Laxmi Publication.

**DATA BOOK:** Heat & Mass Transfer, Domkundwar, Dhanapat Rai & Sons Publication.



## **BEME504P: HEAT TRANSFER (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

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

1. To determine the thermal conductivity of composite wall.
2. Determination of thermal conductivity of an insulating powder.
3. Determination of thermal conductivity of metal bar.
4. Determination of Stefan Boltzmann constant.
5. Determination of temperature distribution & heat transfer rate from fin under forced convection.
6. Determination of heat transfer coefficient in natural convection for vertical tube.
7. Determination of condensation heat transfer coefficient in film wise & drop wise condensation.
8. Determination of emmissivity of non black body.
9. Study of various types of heat exchangers.
10. Computerized analysis of various parameters of heat exchanger using shell and tube heat exchanger.
11. Study of heat pipe.

# **BEME505T: MECHANICAL MEASUREMENT & METROLOGY (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 study various measurement systems and their significance along with the characteristics and order of the instruments. At the end of this course, students will be able to understand various instruments for the measurement of different parameters, tolerances, advanced concepts involved in measuring technology (Measurements) & use of precision measuring instruments. Students will appreciate the importance of accuracy and its effects on results and its uncertainty.

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## **UNIT – I**

**[ 8 Hrs.]**

Purpose, structure and elements of measuring system. Static characteristics of measurement system, elements including systematic, statistical characteristics, generalized model of system elements and calibration. Error measurement, error probability density function, error reduction. Introduction to dynamic characteristics of measurement system. Introduction to noise in measurement system.

## **UNIT – II**

**[ 8 Hrs.]**

Classification, Principle, Sensing elements, Signal conditioning elements, Construction, Range and working of instruments for measurement of Linear and Angular Displacement, Speed, Load, Strain, Force, Torque and Power. (Analytical treatment not included)

## **UNIT – III**

**[ 8 Hrs.]**

Classification, Principle, Sensing elements, Signal conditioning elements, Construction, Range and working of instruments for measurement of Pressure, Vacuum, Sound, Light and Temperature. (Analytical treatment not included)

## **UNIT – IV**

**[ 8 Hrs.]**

Standards of Measurement, Line, End and Wavelength standard. Working standards, Requirement of interchangeability, Allowance and Tolerance, Selective assembly. Measurement of Straightness and Flatness. Instruments for Linear and Angular Measurement. (Vernier, Angle gauge, Sine bar, Level indicator, Clinometers and Taper gauge)

## **UNIT – V**

**[ 8 Hrs.]**

Limits and Fits, Tolerance analysis of Limits and Fits, Types of limit gauges, Types of fit, Shaft and Hole basis system, Design of Limit gauge and Process planning sheet (Numerical treatment is expected).

## **UNIT – VI**

**[ 8 Hrs.]**

Comparators: Mechanical, Optical, Electrical, Electronic, Pneumatic.

Study and use of Optical profile projectors, Tool maker's microscope and Autocollimator. Measurement of Screw thread and Gear tooth.

**LIST OF TUTORIALS:**

- 1) Study of Linear and Angular measurement instrument.
- 2) Study of various types of Comparators.
- 3) Preparation of Process Planning sheet.

**TEXT BOOKS:**

1. Mechanical Measurement and Control, D.S. Kumar, Metropolitan Book Co.
2. Instrumentation Measurement and Analysis, B.C. Nakra, K.K. Choudhary, TMH
3. Measurement Systems, Ernest O. Doebelin, Dhanesh N. Manik, TMH
4. Mechanical Measurement, Thomas G. Beckwith, Pearson
5. Metrology and Measurement, Anand K. Bewoor, Vinay A. Kulkarni, TMH
6. Metrology, R. K. Jain, Khanna Publishers.
7. A Textbook of Engineering Metrology, I. C. Gupta, Dhanpat Rai & Sons Publication.

**REFERENCE BOOKS:**

1. Principles of Measurement Systems, John P. Bentley, Pearson

# **BEME505P: MECHANICAL MEASUREMENT & METROLOGY (Practical)**

**CREDITS: 01**

## **Teaching Scheme**

Practical: 2 Hours/Week

## **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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## **LIST OF PRACTICALS:**

Minimum Eight out of the following shall be performed:

1. Static characteristic of at least one Instrument.
2. Static calibration of at least one Instrument.
- 3, 4 & 5. – Measurement of parameters by minimum three different types of Instruments.
6. Measurement of Linear, Angular dimensions (Using Vernier, Sine bar, Clinometers)
7. Measurement of Flatness & Straightness.
8. Study and Measurement of Parameters using Toolmaker's microscope.
9. Study and Measurement of Parameters using Optical profile projector.
10. Use of Optical flat.
11. Design of Limit gauge.

## **BEME506P: COMPUTER APPLICATIONS – I (Practical)**

**CREDITS: 04**

### **Teaching Scheme**

Practical: 2 Hours/Week

Tutorial: 2 Hour/Week

### **Examination Scheme**

University Assessment: 50 Marks

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** This course is designed to acquaint the students to solve engineering problems using computers with knowledge of C/C++ programming. Students will be able to write the programs for Numerical Methods & for problem solving in the area of Mechanical Engineering. Students will also understand the concept of OOPs and will get introduced with mathematical softwares.

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Review – C/C++ Programming basics, algorithm, types of algorithms, data type, variables, control structures, arrays, vectors, pointers, functions, file handling etc., Basic of OOPS, and Object modeling.

Exposure to Software/s like MATLAB/ MATHCAD/ SCILAB / MATHEMATICA or any other relevant commercial software/s or freeware/s.

### **LIST OF PRACTICALS:**

Minimum eight practicals in following areas shall be performed.

1. Development of application programs in C / C++ exploring use of functions, vectors, arrays etc.
2. Development of programs in C / C++ for any Numerical methods like Newton Raphson, Gauss-Elimination, Gauss-Jordan, Crout's method and Gauss-Seidel Method.
3. Development of programs in C / C+ + for any Numerical methods like Taylor's series method, Runge Kutta method, Euler's modified method, Milne's predictor corrector method, Iterative methods for eigen value & eigen vector determination.
4. Development of programs in C / C++ to solve the problem in the following areas of Mechanical Engineering like, Mechanics, Kinematics of Machines, Engineering Thermodynamics, Hydraulic Machines, Mechanics of Material, Design of Machine elements, Heat Transfer etc.
5. Application of Mathematical Software/s for solution of problems in the areas of Mechanical Engineering.

### **Note:**

During University practical examination of 50 marks, students are expected to prepare & execute computer program/s in C/C++ and/or problem solving using mathematical softwares

of total 30 marks in two hours duration. Viva-Voce of 20 marks shall be conducted during University practical examination.

**TEXT BOOKS:**

1. An Introduction to Data Structures with Applications, Trembly J. P. And Sorenson P. G., Tata McGraw Hill Pub. Co. Ltd.
2. Fundamentals of Computer Algorithms, Horowitz E. And Sahani S., Galgotia Publications Ltd.
3. Programming in C, Gotterfield B., Schaums Outline Series.
4. Mastering C, R. Venu Gopal Prasad, Tata McGraw Hill Pub. Co. Ltd.

**REFERENCE BOOKS:** User/Command/Tutorial Manuals of relevant Softwares.

## **BEME507P: INDUSTRIAL VISIT**

**CREDITS: Nil (Audit Course)**

### **Teaching Scheme**

Practical: 02 Hour/Week

**Course Objectives and Expected Outcomes:** This subject aims at giving practical exposure to students and to provide opportunities for acquiring knowledge regarding manufacturing and service industries/organizations and to acquaint them with industrial culture. Upon completion of this course, students will be able to describe the usage of different technologies/tools/concepts related to Design process, operation of various machines, mechanical drives, manufacturing processes, machining processes, various process equipments, production techniques, quality control, maintenance practices, automation in industries, management etc.

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Students shall visit different industries (at least two). Students shall be preferably divided into small groups to tour around the industry.

After each visit, each batch of students is required to submit a written report and shall give a brief oral presentation.

**Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur**

**Faculty of Engineering and Technology**

**B.E. (MECHANICAL ENGINEERING): SIXTH SEMESTER**

**BEME601T: ENERGY CONVERSION- I(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 expose the students to the practical applications of thermodynamics. At the end of this course students will gain the knowledge of various components of the thermal power plant like boiler, nozzles, turbines and condensers and will be able to assess the performance of these components.

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**UNIT – I**

**[ 8 Hrs.]**

Introduction to layout of thermal power plant, principle of steam generation, fuel for steam generators, necessity of water treatment, classification of steam generators, fire tube and water tube boilers, high pressure boilers, boiler mountings and accessories.

**UNIT – II**

**[ 8 Hrs.]**

Draught and its classification, calculations for chimney height, chimney diameter & efficiency. Condition for maximum discharge. Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency.

**UNIT – III**

**[ 8 Hrs.]**

Fluidized bed boiler: Bubbling fluidized bed boilers, circulating fluidized bed boilers (Elementary treatment expected), coal handling, ash handling.

Cogeneration: Introduction to cogeneration, need, working principle and applications. Topping cycle and bottoming cycle.

**UNIT – IV**

**[ 8 Hrs.]**

Steam nozzles: Adiabatic expansion in nozzles, maximum discharge, critical pressure ratio and effects of friction, calculation of throat and exit areas, supersaturated flow, Wilson Line.

Steam turbines: Working principle of steam turbines, classification of steam turbines, comparison of impulse and reaction turbines, compounding of steam turbines, governing of turbines.

**UNIT – V**

**[ 8 Hrs.]**

Energy losses in steam turbines, flow of steam through turbine blades, reheat factors, velocity diagrams, graphical and analytical methods, work done, thrust and power, dimensions and proportioning of the blades, steam turbine efficiencies, condition for maximum efficiencies, reheat and regenerative cycles.



## **UNIT – VI**

[ 8 Hrs.]

Steam condensers: Types of condensers, classification of condensers, quality and quantity of cooling water required, calculations for surface condenser, Dalton's law of partial pressure, sources of air leakages and air removal, air ejectors.

Cooling towers: wet cooling towers, dry cooling towers, cooling ponds.

### **LIST OF TUTORIALS:**

- 1) Three problems on draught.
- 2) Two problems on performance of boiler.
- 3) Two problems on heat balance sheet of boiler.
- 4) Two problems on nozzle.
- 5) One problem on metastable flow.
- 6) Two problems on impulse turbine.
- 7) Two problems on reaction turbine.
- 8) One problem on reheat cycles.
- 9) One problem on regenerative cycle.
- 10) Two problems on condenser.

### **TEXT BOOKS:**

1. Thermal Engineering, P.L. Ballaney, Khanna Publications.
2. A Course in Power Plant Engineering, Arora & V.M. Domkundwar, Dhanpat Rai & Sons
3. Thermal Engineering, R. K. Rajput, Laxmi publications.
4. Thermal Engineering, M.M. Rathode, TMH publication.
5. A Course in Thermal Engineering, Anand Domkundwar, C.P. Kothandaraman, S. Domkundwar, Dhanpat Rai & Sons.

### **REFERENCE BOOKS:**

1. Thermal Engineering, Mathur & Mehtra, Jain Brothers Publications, New Delhi.
2. Heat Engineering, V.P. Vasandani & D.S. Kumar, Metropolitan Book Publishers.
3. Power Plant Engineering, A.K. Raja, Shrivastava and Dwivedi, New age International Publishers.
4. Fluidized Bed Combustion, S. Oka and E. Anthony, Marcel Dekker Inc.
5. Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International.

## **BEME602T: CONTROL SYSTEMS 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 formulated to familiarize the students with concepts related to the operation, analysis and stabilization of control systems. The main objective of this course is to make understanding of various control systems and its stability analysis using analytical and graphical techniques, to understand the concepts of Time Domain and Frequency Domain analysis of control system, Mathematical modeling and Transfer function of engineering systems. At the end of this course, student will be able to understand various control systems & their stability analysis.

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### **UNIT – I**

**[ 8 Hrs.]**

Control System controls: Study of Control System components such as hydraulic actuators, Servomechanism D.C. and A.C. motor, liquid level control, Automobile Power Steering Control, Speed Control, Position control of Robotic Manipulator etc. Study and Analysis of performance characteristics, the concept of various types of system like machine tools, Prime movers, system generators, etc.

Modeling of Mechanical System: Basic Elements of Control System – Open loop and Closed loop systems – Differential equation – Laplace Transform – Transfer function, Modeling of physical system like Translational, rotational mechanical systems, Electric systems, Electronic system and Electro-mechanical system. Concept of transfer function & its determination for physical systems.

### **UNIT – II**

**[ 8 Hrs.]**

Transfer Function system Representation through Block Diagram and Signal Flow Graph: Block Diagram representation, Reduction Techniques for single and multiple input/output, Conversion of Block Diagram into Signal Flow Graph, Conversion of algebraic equation into Block Diagram and Signal Flow Graph. Transfer function through Block Diagram Simplification using Masons Gain Formula.

### **UNIT – III**

**[ 8 Hrs.]**

System Response & Time Domain Response Analysis: First and second order systems response to impulse, ramp and sinusoidal inputs, properties of unit step response of second order system, systems with velocity lag, Steady state errors and Error constants.

Signals: Step, Ramp, Impulse, Parabolic and Periodic signals with their mathematical representation and characteristics.

Mode of Controls: Basic control actions and Industrial controllers, Introduction to P, PI and PID controllers their characteristics, representation and applications. Classification of industrial automatic controllers, control actions, proportional controllers, obtaining derivative and integral control action, effects of integral and derivative control action on system performance.

Controller Mechanisms: Pneumatic, hydraulic and electric controllers, general principles for generating various control actions.

#### **UNIT – IV**

[ 8 Hrs.]

Control system analysis: Concept and types of stability, Routh-Hurwitz Criterion and its application for determination of stability, limitations.

Root locus plot: Simple transfer functions transient response from root locus. Concept of stability, necessary condition for stability, Root locus concept, construction of Root loci.

#### **UNIT – V**

[ 8 Hrs.]

Frequency Domain analysis - Correlation between time and frequency responses of a second order System.

Bode & Polar plot: Determination of Gain Margin, Phase Margin and their Stability from Bode and Polar plots. Inverse Bode Plot, Transportation lag, System Identification from Bode plot.

#### **UNIT – VI**

[ 8 Hrs.]

State space representation of Continuous Time systems: State equations, Transfer function from State Variable Representation – Solutions of the state equations, Concepts of Controllability and Observability, State space representation for Discrete time systems.

Stability criterion: Introduction to control system design lag lead compensation, Feed Back Compensation and Pole -Zero placement.

#### **LIST OF TUTORIALS:**

- 1) Mathematical Modeling of Mechanical and Electrical System.
- 2) Numerical examples of Block Diagram Reduction Technique and Signal Flow Graph.
- 3) Numerical of Time response analysis.
- 4) Numerical of Frequency Domain analysis.
- 5) Numerical of Routh's Criteria.
- 6) Numerical of Polar Plot.
- 7) Numerical of Root Locus.
- 8) Numerical of Bode plot.
- 9) Numerical of State space representations.
- 10) Numerical of Root Locus using MATLAB.

At least **six** exercises are expected.

#### **TEXT BOOKS:**

1. Control System Engineering, J. Nagrath and M.Gopal, New Age International Publishers, 5th Edition, 2007
2. Control System – Principles and Design, M. Gopal, Tata McGraw Hill, 2nd Edition, 2002.
3. Control Systems Engineering, S. K. Bhattacharya, Pearson.
4. Control System Engineering, Baxi and Goyal, Technical Publication, Pune.
5. Control Systems, Dhanesh N. Manik, Cengage Learning.
6. Control Systems -Theory & Application, Smarajit Ghosh, Pearson.
7. Control Systems, Anand Kumar, PHI.

## REFERENCE BOOKS:

1. Automatic Control Systems, Benjamin. C. Kuo, Prentice Hall of India, 7th Edition, 1995.
2. Digital Control and State Variable Methods, M. Gopal, 2nd Edition, TMH, 2007.
3. Feedback and Control Systems, Stubberud, Schaum's Outline Series, Tata McGraw-Hill, 2007.
4. Linear Control System Analysis and Design, John J. D'azzo & Constantine H. Houppis, Tata McGraw-Hill, Inc., 1995.
5. Modern Control Systems, Richard C. Dorf & Robert H. Bishop, Addison – Wesley, 1999.
6. Modern Control Engineering, K. Ogata, Prentice Hall of India.
7. Control System Engineering Using MATLAB, S.N. Sinanandam, S.N. Deepa, Vikas Publication.
8. Digital Control System, V.I. George, C.P. Kurian, Cengage Learning.
9. Control Systems - Problem and Solutions, K.R. Varmah, McGraw Hill Education.

# **BEME603T: OPERATIONS RESEARCH(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:** The objectives of this course are to provide a formal quantitative approach to problem solving and perception about situations where such an approach is appropriate, to introduce some widely used mathematical models and to provide tools that students can use to solve management problems. After going through this course, students will gain proficiency with tools for optimization, simulation, including fundamental applications of those tools in industry in context of uncertainty and scarce or expensive resources.

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## **UNIT – I**

**[ 8 Hrs.]**

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

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

## **UNIT – II**

**[ 8 Hrs.]**

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

Assignment Model – Introduction, Variants of Assignment Problems.

Traveling Salesman Problem – Branch & Bound Technique.

## **UNIT – III**

**[ 8 Hrs.]**

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

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

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

## **UNIT – IV**

**[ 8 Hrs.]**

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

## **UNIT – V**

**[ 8 Hrs.]**

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

**UNIT – VI****[ 8 Hrs.]**

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

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

**TEXT BOOKS:**

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

## **BEME604T: MECHATRONICS(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 key elements of mechatronics systems, to identify various inputs and output devices in an automated system, to understand and draw ladder diagrams, to understand interfacing of input and output devices, to get awareness about actuating systems, microprocessors & microcontroller. At the end of this course students shall be able to understand the working of mechatronics systems & shall acquire the insight to build the mechatronics systems.

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## **UNIT – I**

**[ 8 Hrs.]**

### **Introduction to mechatronics:**

Review of sensors, transducers and solid state electronic devices (*Only review, no questions to be set on these topics*).

Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of feedback control system.

Examples of Mechatronics Systems such as Boat Autopilot, High-Speed Tilting trains, Automatic Car Park system, Coin counter, Engine management system, Antilock braking system (ABS) control, traffic controller, temperature controller, weigh-bridge, weather prediction, Automatic washing machine etc. General remarks on applications.

## **UNIT – II**

**[ 8 Hrs.]**

### **System Interfacing and Data Acquisition:**

**DAQs:** Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

**I/O hardware and Software at the Microprocessor:** Level and commutation, I/O operations, Data width, interfacing requirement, Buffers, Handshaking, Polling and interrupt, Digital communication, Parallel communication, Serial communication, Peripheral interface device (PIA), Analogue interfacing.

**Analogue to Digital and Digital to Analogue Conversations:** Introduction to digital signal processing (DSP), Data flow in DSPs, Block diagrams and typical layouts.

**Components of interconnections and Impedance Matching:** Impedance characteristics, Cascade connection of devices, Impedance matching in mechanical systems, interfacing microcontroller output with actuators.

**Interfacing Motor Drives:** Drives units- DC drives, Variable frequency drives (VFD), Scalar and Vector drives, Stepper motor driver and controller.

## UNIT – III

[ 8 Hrs.]

### Actuating Systems:

**Review of Mechanical Actuating Systems:** Mechanical systems, Types of motion, Cams, Gears, Ratchet and Pawl, Belt & chain drives, Bearings, Preload, Mechanical aspects of motor selection. (*Only review, no questions to be set on these topics*)

**Electrical Actuating Systems:** Mechanical switches and relays, solenoids, state switches-solenoids, DC Servomotors, Stepper motor, Induction Motors, speed control , pulse four- quadrant servo drives, Pulse width modulation (PWM) frequency drive, vector drive.

**Pneumatics & Hydraulic Actuating Systems:** Pneumatics & Hydraulic Systems, directional control valves, pressure control valves, servo and proportional control valves, Process control valves, cylinder sequencing and cascade control, rotary actuators, Identifications of graphical symbols for Pneumatic and Hydraulic circuits.

## UNIT – IV

[ 8 Hrs.]

**Digital logic:** Number system, Logic gates, Boolean algebra, Karnaugh map, Applications of gates, Sequential logic.

**Introduction – Components of Microprocessors:** Number systems, arithmetic operations on binary numbers, 8-bit, 16-bit, 32-bit microprocessors.

**8085 Microprocessor:** Pin configurations of 8085, architecture of the execution unit, memory segmentation in 8085, architecture of bus interface unit of 8085, building of microprocessor subsystems.

## UNIT – V

[ 8 Hrs.]

**Programmable Logic Controller:** Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.

**Application of PLC control:** Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

## UNIT – VI

[ 8 Hrs.]

**Introduction to SCADA:** Functionality, applications, development, evaluation and benefits of SCADA.

**Introduction to Electronics Interface Subsystems:** Transistor- Transistor logic (TTL), Complimentary metal-oxide semiconductor (CMOS) interfacing, sensor interfacing, motor isolation schemes, buffer IC breakers, over current sensing, resettable fuses.

**Introduction to Micro Electro Mechanical Systems (MEMS):** Fabrication methods - Working and applications of MEMS based accelerometer, pressure sensor and gyroscope.



**TEXT BOOKS:**

1. Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
2. Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi.
3. Programmable Logic Controllers, John W Webb and Ronald A Reis, Prentice Hall, Inc., 1999.
4. Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.
5. Pneumatic Application, Kemprath Reihe, Wemer Depper and Kurt Stoll, Vogel Buch Verlag Wurzburg, 1987.
6. An Introduction to MEMS Engineering, Nadim Maluf & Kirt Willams.
7. RF MEMS & their Applications, Vardhan, Willey India Pvt. Ltd.
8. MEMS: Introduction and Fundamentals, Mohamed gad-el-hak, CRC Press, 2<sup>nd</sup> ed.

**REFERENCE BOOKS:**

1. Pneumatic Application, Wemer Deppert and Kurt Stoll, Kemprath Reihe, Vovel Verlag , Wurzburg, 1976.
2. Pneumatic Tips, Festo K G, Festo, Germany, 1987.
3. Mechatronics, N. P. Mahalik, Mc Graw-Hill Education.
4. Mechatronic Systems Fundamentals, Rolf Isermann, Springer, 2003.
5. Mechatronics: Introduction, Robert H Bishop, Taylor and Francis, 2006.
6. Mechatronics System Design, D. Shetty, Cengage Learning (Indian Ed.)

## **BEME604P: MECHATRONICS (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum Eight practicals out of the following areas shall be performed:

1. Identification & study of solid state electronic devices.
2. Identification, study & demonstration of different sensors.
3. Identification, study & demonstration of different actuators.
4. Demonstration of working of various digital to analog and analog to digital Converters.
5. Development of ladder diagram, programming using PLC for any of the following.
  - a) Motor start and stop by using two different sensors.
  - b) Simulation of a pedestrian traffic controller.
  - c) Simulation of four road junction traffic controller.
  - d) Lift / elevator control.
  - e) Washing machine control.
  - f) Tank level control.
  - g) Soft drink vending machine control
  - h) Any other suitable application.
5. Trace, interpret and demonstrate working of electro pneumatic systems.
6. Trace, interpret and demonstrate working of electro hydraulic systems.

## **BEME605T: DYNAMICS OF MACHINES (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 method of dynamic force analysis of machinery, the concept of vibratory systems and their analysis and also to study the effect of undesirable effects of unbalances in rotors and engines.

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### **UNIT – I**

**[ 8 Hrs.]**

Concepts in machine element dynamics. D'Alembert principle. Application of these approaches for simple two degree of freedom systems. Simple precession and gyroscopic couple. Gyroscopic effect on airplane, ship, vehicles and grinding mills.

### **UNIT – II**

**[ 8 Hrs.]**

Dynamic force analysis of planar linkages such as four bar chain and reciprocating mechanism by graphical method, virtual work method. Cam dynamics and jump-off phenomenon.

### **UNIT – III**

**[ 8 Hrs.]**

Static & Dynamic balancing in rotating machines. Balancing machines and field balancing by vector diagram.

Balancing in reciprocating mechanism.

### **UNIT – IV**

**[ 8 Hrs.]**

Turning moment Vs crank angle diagram for single- cylinder and multiple-cylinder engines, punching machines etc. Flywheel selection.

Speed governors, centrifugal and inertia type, Watt, Portal, Proel, Hartnell governors, operating characteristics of governors.

### **UNIT – V**

**[ 8 Hrs.]**

Derivation of equation of motion for vibratory system. Free vibration of single-degree-of-freedom system with and without damping. Logarithmic decrement and damping estimation. Forced vibration of single-degree-of-freedom system and vibration isolation, whirling of shaft and critical speed of rotors.

### **UNIT – VI**

**[ 8 Hrs.]**

Equation of motion for two-degree-of-freedom system. Natural frequencies and mode shapes, vibration absorber. Torsional oscillation of two-disc and three disc rotors. Introduction to FFT analyzer for vibration measurements.

**TEXT BOOKS:**

1. Mechanical Vibrations, S. S. Rao, Addison Wesley Publishing.
2. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & Sons.
3. Mechanical Vibrations, G. K. Grover, Nem Chand & Bros.
4. Fundamentals of Mechanical Vibration, Graham Kelly, Tata McGraw Hill.
5. Theory of Machines, Jagdish Lal, Metropolitan Publishers.
6. Theory of Machines, Rattan S. S, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Vibration and Noise for Engineering, Pujara, K, Dhanpat Rai and Company.
8. Theory of Machine, Thomas Bevan, Pearson Publications.
9. Mechanics of Machines, V. Ramamurti, Narosa Publications.
10. Mechanism & Machine Theory, A.G. Ambekar, PHI Publication.

**REFERENCE BOOKS:**

1. Theory of Mechanisms and Machines, Ghosh A. and Mallick A.K., Affiliated East-West Press Pvt. Ltd., New Delhi, 1988.
2. Theory of Machines and Mechanisms, Shigley J.E. and Uicker J.J., McGraw-Hill, Inc., 1995.
3. Mechanism and Machine Theory, Rao J.S. and Duggipati R.V., Wiley-Eastern Limited, New Delhi, 1992.
4. Mechanics of Machines, John Hannah and Stephens R.C., Viva Books.
5. Theory of Machines, Sadhu Singh, Pearson Education.

## **BEME605P: DYNAMICS OF MACHINES (Practical)**

**CREDITS: 01**

### **Teaching Scheme**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **LIST OF PRACTICALS:**

Minimum eight out of the following shall be performed:

1. Determination of jump-of speed of a typical cam- follower system.
2. Dynamic balancing of rotating masses(study of wheel balancing machine along with performance by visiting any automobile workshop).
3. Balancing of reciprocating mechanism.
4. Critical speed of shafts.
5. Performance characteristics of Gyroscope.
6. Free vibration of single DOF and two DOF spring mass system.
7. Natural frequency determination of cantilever beam.
8. Damping determination through free vibration logarithmic decay of a simple damped system.
9. Natural frequency determination of two and three rotor system.
10. Torsional vibration of bifilar or trifilar pendulum.
11. Transmissibility of single degree of freedom system
12. Dynamic vibration absorber.
13. Dynamic force analysis of four bar mechanisms.
14. Dynamic force analysis of slider crank mechanism.
15. Flywheel selection and parameter design for a typical multi-cylinder engines.
16. Performance characteristics of governors.
17. Study of any mechanism in workshop/industry..
18. Use of FFT analyzer for determination of natural frequencies of machine components.

## **BEME607P: COMPUTER APPLICATIONS – II (Practical)**

**CREDITS: 04**

### **Teaching Scheme**

Practical: 2 Hours/Week

Tutorial: 2 Hour/Week

### **Examination Scheme**

University Assessment: 50 Marks

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** This course is designed to give theoretical & practical exposure to DBMS. During this course, students will understand the concepts & applications of DBMS.

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An Introduction to DBMS, concept and meaning, Disadvantages of file systems. Advantages and Disadvantages of DBMS. Database languages, database administrator & user, system structure.

Entity Relationship Model: Entities and Entity sets, Relationship and sets, Mapping constraints, Keys, E-R diagrams, E-R diagrams diagram to table, Generalization, Aggregation, Design of an E-R database scheme.

Relational database & SQL, set operations, aggregate functions Nested sub queries, derives relations. Modification of the database, Data Definition language (DDL), Embedded SQL.

### **LIST OF PRACTICALS:**

At least eight Practicals in applications like Material Management, Inventory Management, Office automation etc. based on above syllabus shall be conducted using suitable DBMS packages like ORACLE, MS ACCESS etc. or relevant freeware/s.

### **Note:**

During University practical examination of 50 marks, students are expected to workout problem/s of total 30 marks using DBMS software in two hours duration. Viva-voce of 20 marks shall be conducted during University practical examination.

### **TEXT BOOKS:**

1. An Introduction to Database System, C.J. Date, Perarson
2. Database and System Concept, A Silberschatz, H F Korth, A Sudarshan., TMH publications
3. User/Command/Tutorial manuals of relevant softwares.

## **BEME608P: INDUSTRIAL CASE STUDY**

**CREDITS: 02**

### **Teaching Scheme**

Practical: 02 Hour/Week

### **Examination Scheme**

College Assessment: 50 Marks

**Course Objectives and Expected Outcomes:** This course is designed to acquaint the students with various industrial/organizational problems and how they can be solved using methods/techniques/theories etc. studied in curriculum.

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Industrial case study should be based on the study of some specific case/issue/problem related to any industrial/business establishment. Data should be collected from industry or organization with objective of studying some specific case/issue/problem. The collected data should be analyzed using one or more theories studied in curriculum. The results should be worked out and conclusions should be drawn. The industrial case study can be also be based on the study of report prepared by any industry/business organization related to issues/problems. Group of students (Max 09 & Min 05) can be considered for this study. A report should be submitted. The report should consist of the problem/issue identified, methodology of data collection, data collected, methods of analysis, results and conclusions. Student is expected to give presentation based on this report.

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



**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 Assessment	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
<b>Total</b>		<b>15</b>	<b>05</b>	<b>09</b>	<b>-</b>	<b>-</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>-</b>	<b>75</b>	<b>125</b>	<b>200</b>	<b>-</b>
<b>Semester Total</b>		<b>29</b>			<b>26</b>	<b>700 Marks</b>								

**Elective – I (BEME702T):**

BEME702T1: Industrial Robotics  
BEME702T4: Power Plant Engineering

BEME702T2: Tool Design  
BEME702T5: Synthesis of Mechanisms

BEME702T3: Automobile Engineering  
BEME702T6: Material Handling System

All subjects pertain 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 Assessment	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		<b>15</b>	<b>05</b>	<b>12</b>		-	<b>400</b>	<b>100</b>	<b>500</b>	-	<b>150</b>	<b>150</b>	<b>300</b>	-
<b>Semester Total</b>		<b>32</b>			<b>29</b>	<b>800 Marks</b>								

**Elective – II (BEME802T, BEME802P):**

BEME802T1/P1: Finite Element Method  
 BEME802T4/P4: Management Information Systems

BEME802T2/P2: Computer Integrated Manufacturing  
 BEME802T5/P5: Refrigeration & Air-Conditioning

BEME802T3/P3: Industrial Fluid Power  
 BEME802T6/P6: Stress Analysis

**Elective – III (BEME803T):**

BEME803T1: Advanced Manufacturing Techniques  
 BEME803T4: Mechanical Vibrations

BEME803T2: Machine Tool Design  
 BEME803T5: Advance I.C. Engine

BEME803T3: Renewable Energy Systems  
 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

**B.E. (MECHANICAL ENGINEERING): SEVENTH SEMESTER**

**BEME701T: INDUSTRIAL 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:** 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.

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**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.

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## **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 grippers, 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 costs, 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**

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 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.

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### **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, flatterring, 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, ASTM, 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.

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## **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.

## **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**

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 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).

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## **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**

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 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.

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### **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-Robert-Chebyshev theorem.

### **UNIT – II**

**[ 8 Hrs.]**

Graphical Linkage Synthesis:

Precision 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- Euler-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**

Lectures: 3 Hours/Week

Tutorial: 1 Hour/Week

## **Examination Scheme**

Duration of Paper: 03 Hours

University Assessment: 80 Marks

College Assessment: 20 Marks

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

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## **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-Wiley 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.

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## **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 Bresenham's Line generation
- 3) Algorithm, flow chart and C-Program for Bresenham's Circle generation
- 4) Algorithm, flow chart and C-Program for Bresenham'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 Ibrahim, 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, David 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

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## **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 Bresenham'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**

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 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.

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## **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, choking, 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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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.

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## **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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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.

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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.

**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**

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 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.

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**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 trends 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**

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:** 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.

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### **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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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).

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### **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**

Practical: 2 Hours/Week

**Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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**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**

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 :** 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.

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### **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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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.

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### **UNIT – I [ 8 Hrs.]**

Introduction to MIS:

System & Its components, System Concepts, system control, Types of systems, Data & 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.]**

MIS 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

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**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.

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### **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, hermetic 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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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.

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### **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. Birefringent 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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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 Polariscopes.
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.

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### **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. I. Khan, PHI.
5. Casting Technology & Casting Alloys, A.K. Chakraborty, PHI.

## **BEME803T2: ELECTIVE-III: MACHINE TOOL 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 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.

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### **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 & Bhattacharya, 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.

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### **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 photovoltaics. 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 Resources: 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 publishers.
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**

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 :** 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.

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### **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 arbitrary excitation. Vibration isolation and transmissibility. Solution using laplace transform, Runge 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. Dunkleleys 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 Raylrih-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.

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**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.

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### **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].

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### **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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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**

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 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.

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### **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, turbo-prop, 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**

Practical: 2 Hours/Week

### **Examination Scheme**

University Assessment: 25 Marks

College Assessment: 25 Marks

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### **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.

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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.