# CHOICE BASED CREDIT SYSTEM

# EVALUATION SCHEME

# AND

# COURSE OF STUDY

# IN

# B.TECH.

# MECHANICAL ENGINEERING

**(2024-25 (Odd Semester))**

**SCHEME OF EXAMINATION & SYLLABUS**

## FACULTY OF ENGINEERING AND TECHNOLOGY

## GURUKULA KANGRI DEEMED TO BE UNIVERSITY, HARIDWAR

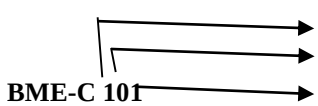
**GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR**
**Faculty of Engineering & Technology**
**Mechanical Engineering**
**B. Tech. First Year**
**Syllabus in accordance with AICTE Model Curriculum**

## B.Tech. I Year
## Semester - I

| DSC/ SEC/ AECC | Subject | Periods | | | Evaluation Scheme | | | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Continuous Internal Assessment | | CIA Total | ESE | | |
| | | L | T | P | CT | TA | | | | |
| **THEORY** | | | | | | | | | | |
| BAC-C102/ BAC-C202 | Engineering Chemistry | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| BEM-C102 | Engineering Mathematics– I | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| BCE-C102/ BCE-C202 | Programming for Problem Solving | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| BME-C103 | Basic Mechanical Engineering | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 3 |
| BEN-A103 | Environmental Studies | 2 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 0 |
| | **Induction Program** | **Only for first 3 weeks** | | | | | | | | |
| **PRACTICAL** | | | | | | | | | | |
| BAC-C151/ BAC-C251 | Engineering Chemistry Lab | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 50 | 1 |
| BCE-C151 BCE-C251 | Programming for Problem Solving Lab | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 50 | 1 |
| BME-C153/ BME-C253 | Engineering Graphics and Design Lab | 1 | 0 | 2 | 10 | 5 | 15 | 35 | 50 | 2 |
| BEG-A151/ BEG-A251 | Technical Communication | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 50 | 1 |
| | TOTAL | 14 | 4 | 8 | 140 | 70 | 210 | 490 | 700 | 20 |

**Coding:**

| | | | | | |
|---|---|---|---|---|---|
| BME | : Mechanical Courses | BET | : Electronic Courses | BEM | : Mathematics |
| BEE | : Electrical Courses | BHU | : Humanities Courses | BCE | : Computer Courses |
| BAC | : Applied Chemistry | BAP | : Applied Physics | BEN | : Environment Science |
| C | : Discipline Specific Courses | A | : Ability Enhancement Compulsory Courses | S | : Skill Enhancement Courses |
| E | : Discipline Elective Courses | | | ESE | : End Semester Examination |




L- LECTURE; T- TUTORIAL; P- PRACTICAL; CT- CUMULATIVE TEST; TA- TEACHER ASSESSMENT; ESE–ENDSEMESTER EXAMINATION

# Course Code: BAC-C102/C202
# Course Name: Engineering Chemistry

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 4** |

| | |
|---|---|
| **Prerequisites:** | **Engineering Chemistry** |
| **Objectives:** | 1. To acquire knowledge about the periodic properties, oxidation number, hydrogen bonding and hybridization.<br>2. To understand the general concepts of thermodynamics, chemical kinetics and acid-base equilibrium.<br>3. To gain the knowledge of polymers, conducting polymers, synthesis, properties and uses of some common polymers, nylons and rubbers.<br>4. To learn the significance of Nanochemistry and different approaches to synthesis of Nanoparticles.<br>5. To understand the organic reactions like addition reactions, elimination reactions, substitution reactions and oxidation-reduction reactions.<br>6. To understand the synthesis of some common drugs like Aspirin, Phenacetin & Paracetamol. |
| **Course Coordinator** | **Dr. Ajay Kumar** |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Sec.-A and Sec.-B). Section-A shell contain ten short type questions of six marks each and the student shall be required to attempt any five questions. Section-B shall contain eight descriptive type questions of ten marks each and students shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper. |

| UNIT | Module | Course Content | No. of Hours | POs mapped |
|---|---|---|---|---|
| **UNIT-1** | *Module-1* | Shielding and effective nuclear charge, Penetration of orbitals, Division of elements into s, p, d and f blocks, Variation of s, p, d and f orbital energies of atoms in the periodic table, Atomic and Ionic sizes, Ionization potential, Electron affinity, Electronegativity, Dipole moment, Polarizability. | **05** | PO1/ PO2/ PO3/ PO4/ PO5… |
| | *Module-2* | Oxidation states, Coordination numbers and geometries, Hydrogen bonding, Concept of hybridization. | **03** | PO1/ PO2/ PO3/ PO4/ PO5… |
| **UNIT-2** | *Module-3* | Introduction, Rate of reaction, Factors influencing rate of reaction, Rate law and reaction order, Differentiate between molecularity and reaction order, Arrhenius equation, Activation energy and its determination, Transition state theory of reaction rates. | **04** | PO1/ PO2/ PO3/ PO4/ PO5… |
| | *Module-4* | Thermodynamic functions: Energy, Enthalpy, Entropy and Free energy, Physical significance of entropy, Estimations of entropy and free energies, Free energy and emf, Cell potentials, Nernst equation and applications (without derivation) Acid-base, solubility and solubility product. | **04** | PO1/ PO2/ PO3/ PO4/ PO5… |
| **UNIT-3** | *Module-5* | Basic concepts of polymers, Classification of polymerization, Industrial applications of polymers, Differentiate between (i) Addition and condensation polymers, (ii) Thermoplastic and thermosetting polymers, Elementary idea of biodegradable and conducting polymers. | **06** | PO1/ PO2/ PO3/ PO4/ PO5… |
| | *Module-6* | **Plastics:** Synthesis, properties and uses of Polyvinyl chloride (PVC), Polytetrafluoroethylene (PTFE)/Teflon, Polymethyl methacrylate (PMMA), Bakelite.<br>**Nylons:** Introduction to Nylons, Preparation, properties and | **02** | PO1/ PO2/ PO3/ PO4/ PO5… |

| | | | | |
|---|---|---|---|---|
| | | uses of Nylon 6, and Nylon 6,6.<br>**Rubbers:** Natural rubber and synthetic rubber, Vulcanization of rubber, Advantages of vulcanized rubber. | | |
| **UNIT-4** | *Module-7* | Introduction, Characteristic properties of nanomaterials, Synthesis of nanomaterials (Top-down and bottom-up approach), Introduction, properties and applications of Fullerenes (C60), Carbon nanotubes (CNT's), Nanorods and Nanowires, Applications of nanomaterials in Medicine, Energy science, Bio-sensors, Electronics, Catalysis and Fabrics. | **08** | PO1/ PO2/ PO3/ PO4/ PO5… |
| **UNIT-5** | *Module-8* | Introduction to reactions involving Addition, Elimination, Substitution and Oxidation and Reduction.<br>Isomerism: Basic concept of geometrical and optical isomerism. | **06** | PO1/ PO2/ PO3/ PO4/ PO5… |
| | *Module-9* | Definitions of different classes of common drugs, Synthesis and uses of Aspirin, Paracetamol and Phenacetin. | **02** | PO1/ PO2/ PO3/ PO4/ PO5… |
| **Total No. of Hours** | | | **40** | |

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|---|---|
| **Learning Outcomes:** | The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. The course will enable the student to:<br>o **Define** the shielding effect, effective nuclear charge, dipole moment, oxidation-reduction, oxidation number, coordination number, hydrogen bonding, hybridization, reaction rate, molecularity, reaction order, internal energy, entropy, enthalpy, free energy, cell potentials, acids-bases, polymers, nylons, nanotechnology, nanoscale, and nanoparticles (**L1**).<br>o **Illustrate** the periodic properties, Arrhenius equation, activation energy, solubility product, Nernst equation, biodegradable polymer, conducting polymer, vulcanization of rubber, nanomaterials, Fullerenes, Carbon nanotubes, nanorods, nanowires, addition reaction, elimination reaction, substitution reaction, geometrical isomerism and optical isomerism (**L3**).<br>o **Describe** the trends of periodic properties in the periodic table (**L2**).<br>o **Calculate** the oxidation number and coordination number (**L4**).<br>o **Determine** the hybridization, reaction rate, molecularity, reaction order, solubility product, activation energy, entropy and free energy (**L3**).<br>o **Discuss** the factors affecting the periodic properties, consequences due to hydrogen bonding, factors affecting the reaction rate, theories of reaction rates, significance of entropy, applications of Nernst equation, characteristic properties of nanomaterials, electrophilic and nucleophilic addition, E1 and E2 elimination, $S_N1$ and $S_N2$ substitution (**L2**).<br>o **Differentiate** between molecularity and reaction order, addition and condensation polymers, thermoplastics and thermosetting polymers, E1 and E2 elimination, $S_N1$ and $S_N2$ substitution, geometrical and optical isomerism (**L4**).<br>o **Explain** the process of vulcanization, advantages of vulcanized rubber, applications of polymers, and nanomaterials (**L2**).<br>o **Illustrate** the synthesis of PVC, PMMA, Teflon, Bakelite, Nylon 6, Nylon 6,6, Aspirin Paracetamol and Phenacetin (**L3**). |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1 | B.H. Mahan, R.J. Myers, University Chemistry, 4th Edition, (Addison-Wesley) Thomson Press (India) LTD. (ISBN: 0-201-45576-5). | 1998 |
| 2 | P.W. Atkins, Physical Chemistry, Oxford University Press, New York (ISBN: 0-19-566902-9). | 2005 |
| 3 | B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, 44th Edition, Vishal Publishing Co., Jalandher, India (ISBN: 81-88646-74-1). | 2009 |
| 4 | P.C. Jain & M. Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company (P) LTD., New Delhi (ISBN: 978-93-5216-000-6). | 2015 |
| 5 | S.S. Dara, A Textbook of Engineering Chemistry, S. Chand & Company LTD., Ram Nagar, New Delhi (ISBN: 81-219-0539-9). | 2002 |

| | | |
|---|---|---|
| 6 | Dr. Rajshree Khare, A textbook of Engineering Chemistry, S.K. Kataria & Sons, New Delhi, India. | 2019 |
| 7 | A Text Book of Engineering Chemistry, 16th Edition, by Jain & Jain - Dhanpat Rai & Sons, New Delhi, India. | 2015 |
| 8 | A Text Book of Engineering Chemistry by Dr. Rajshree Khare – S.K. Kataria & Sons, India. | 2019 |

## BAC-C102/202
## Engineering Chemistry
## CO-PO/PSO MAPPING

## CO-PO/PSO MAPPING

| Course Outcomes (COs) | Action Verb (CO) | Bloom's Level | Program Outcomes (POs) | | | | | | | | | | | | Program Specific Outcomes (PSOs) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Engineering Knowledge | Problem Analysis | Design/ Development of Solutions | Conduct Investigations of Complex Problems | Modern Tool Usage | The Engineer and Society | Environment and Sustainability | Ethics | Indidual and Team Work | Communication | Project Management and Finance | Life Long Learning | | | |
| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | Define | Remember L1 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | | 3 | | 3 | | | |
| CO2 | Illustrate | Apply L3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | | | |
| CO3 | Describe | Understand L2 | 3 | 3 | 3 | 3 | | | | | 3 | 3 | | | | | |
| CO4 | Calculate | Analyze L4 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | | | | | |
| CO5 | Determine | Apply L3 | 3 | 3 | 3 | 3 | 3 | 3 | | | 3 | 3 | | | | | |
| CO6 | Discuss | Understand L2 | 3 | 3 | 3 | 3 | 2 | 3 | | | 3 | 3 | | 3 | | | |
| CO7 | Differentiate | Analyze L4 | 3 | 3 | 3 | 3 | | 3 | 3 | | 3 | 3 | | 3 | | | |
| CO8 | Explain | Understand L2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| CO9 | Illustrate | Apply L3 | 3 | 2 | 2 | 2 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| | Average | | 3 | 2.6 | 2.7 | 2.5 | 2.8 | 3 | 2.8 | 2.5 | 3 | 3 | 2.6 | 3 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Mapping %age** | | ***0 - 5 = --*** | | ***6 - 40 = 1*** | ***41 - 60 = 2*** | | ***61 - 100 = 3*** |
| | | | | | | | |
| **Mapping Correlation** | | ***No correlation*** | | ***Low/ Slight*** | ***Moderate*** | | ***Substantial / High*** |

| Mapping Correlation | *No correlation* | *Low / Slight* | *Moderate* | *Substantial / High* |
|---|---|---|---|---|
| | -- | 1 | 2 | 3 |

## Course Code: BEM-C102
## Course Name: ENGINEERING MATHEMATICS-I

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|---|---|
| **MM: 100** | **Sessional: 30** |
| **Time: 3 Hr.** | **ESE: 70** |
| **L T P** | **Credit : 3** |
| **3 0 0** | |

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|---|---|
| ***Prerequisites:*** | *Fundamental of Calculus* |
| ***Objectives:*** | 1. Introduction to differential calculus, Leibnitz theorem asymptotes, tracing of curves.<br>2. Introduction to partial differential calculus, Jacobians, Maxima, Minima and their application in engineering problems.<br>3. Introduction to double and triple integrals and its application to find area and volume, centre of gravity of plane and solids.<br>4. Introduction to vector calculus, curl, divergence and their application in engineering problems.<br>5. Introduction to matrices and their properties. |
| ***Course Coordinator*** | *Dr Vivek Geol* |
| ***Course Faculty*** | *Dr Vivek Goel* |
| ***Lectures*** | *40* Hours |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| Module | Course Content | No. of Hours | POS Mapped |
|---|---|---|---|
| *Module-1* | **Differential Calculus I:** Successive differentiation, Leibnitz theorem, Taylor's & Maclaurin's, Expansion, Indeterminate forms, Radius of curvature, Asymptotes, Double points and their classification, Tracing of curves. | *10* | *PO1/PO2/PO3/PO4/PO5/PO6/PO10/PO12* |
| *Module-2* | **Differential Calculus II :**Partial Differentiation of functions, Normal to surfaces and tangent plane, Change of variables, Jacobian, Taylor's series of two variables, Truncation errors, Extrema of function of two and more variables, Method of Lagrange's multipliers | *8* | *PO1/PO2/ PO6/PO7/ PO12* |
| | ***Syllabus after Sessional 1 & before Sessional 2(21 _Lectures &4 _Tutorials/ Practical's)*** | | |
| *Module-3* | **Multiple Integrals :**Fundamental Theorem of integral calculus, Differentiation under the integral sign, Double and triple integrals, Change of order of integration, change of variables. Application to arc length, area , volume, centroid and moment of inertia. Gamma and Beta functions, Dirichlet's integral. | *6* | *PO1/PO2/ PO3/PO6/ PO8/PO10 /PO12* |
| *Module-4* | **Vector Calculus :**Differentiation of a vector, Scalar and vector fields, Gradient, Divergence, Curl and their physical meanings, Differential operator and identities, Line, Surface and Volume integrals, Green's theorem in plane. Gauss and Stoke's theorems (without proof). Simple applications. | *6* | *PO1/PO2/ PO4/PO5/ PO6/PO7/ PO9/PO10 /PO12* |
| ***Syllabus after Sessional 2 (7_Lectures &2 _Tutorials/ Practical's)*** | | | |
| *Module5* | **Matrices :**Elementary row/ column operations, Rank of a matrix and its applications, Eigen-values and Eign vectors, Cayley-Hamilton theorem, Diagonalisation of Matrices, Linear dependence and independence, Normal matrices, Complex matrices and unitary matrices | *10* | *PO1/PO2/ PO3/PO4/ PO5/PO6/ PO8/PO9/ PO10/PO12* |
| **Total No. of Hours** | | *40* | |

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| | Understand the concept of nth differentiation, Leibnitz theorems, |

| | |
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| Learning Outcomes | Identify the application of partial differentiation and apply for evaluating maxima, minima, series and Jacobians.<br>2. To understand the concept of multiple integral and apply for finding area, volume, centre of mass and centre of gravity.<br>3. The concept of vector and apply for directional derivatives, tangent and normal planes. Also evaluate line, surface and volume integrals and its application.<br>4. Understand the concept of matrices and their applications to solve linear simultaneous equations. The concept of eigen value and eigen vector and complex matrices. |

**Suggested books: (*According to the reference style decided by departmental Board of Studies)***

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Prasad C., A first course in mathematics for Engineers, Prasad Mudranalaya | |
| 2. | Kreyszig E., Advanced Engineering Mathematics, John Wiley, New York, | 1999 |
| 3. | Grewal B.S., Higher Engineering Mathematics, Khanna, New Delhi, | 2000 |
| 4. | Srivastava R.S.L., Engineering Mathematics Vol.I | |

# Course Code: BCE-C102/ BCE-C202
# Course Name: PROGRAMMING FOR PROBLEM SOLVING

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 4** |

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|---|---|
| **Prerequisites:** | None |
| **Objectives:** | |
| **Course Coordinator** | Dr. Aman Tyagi |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections A, B. Section A contains 10 short type questions of 6 marks each, and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. |

| Module | Course Content | No. of Hours | POs mapped | PSOs mapped |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| *Module-1* | **Introduction to Computers:** Block diagram of computers, functions of its important components, Memory and I/O devices. Concept of assembler, interpreter, compiler & generation of languages.<br>**Number System:** Decimal, Binary, Octal, and Hexadecimal numbers and their arithmetic (addition, subtraction, multiplication, and division): 1's and 2's complements | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-2* | **Programming in C:** History, Introduction to C Programming Languages, Structure of C Programs, Compilation and Execution of C Programs, debugging techniques, Data Type and sizes, Declarations of variables, Modifiers, Identifiers and keywords, Symbolic Constants, Storage classes (automatic, external, register and static), Enumerations, command line parameters, Macros, The C Pre-processor.<br>**Operators:** Unary operators, Arithmetic & Logical operators, Bit wise operators, Assignment operators and expressions, Conditional expressions, Precedence and order of evaluation.<br>**Control Statements:** If-else, switch, break, continue, the coma operator, go to statement.<br>**Loops:** while, do-while, for loop. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-3* | **Arrays:** One-dimensional arrays: declaration, initialization and application. Two-dimensional array: declaration, initialization and application, Multidimensional arrays.<br>**Handling of Character Strings:** Declaring and initializing string variables, reading strings, Writing strings, Arithmetic operation on strings, comparison of two strings and string handling functions.<br>**Pointers:** Accessing the address of the variable, Declaring and initializing pointers, accessing a variable through its pointer expression, pointer increment and scale factor, pointers and array, pointers and character strings. | **08** | PO1/ PO2/ PO3 | PSO1 / PSO2 |
| *Module-4* | **Functions:** Need for user defined function, return value and its type, function calls, no argument and No return values function, Argument and No return values functions, argument and return value functions. Handling of non-integer function, Scope and life time of variable in functions.<br>**Recursion**: Recursive Definition and processes, recursion in C, example of recursion, Tower oh Hanoi Problem, simulating recursion, Backtracking, recursive algorithms, principles of recursion, tail recursion, removal of recursion. | **08** | PO1/ PO2/ PO3 | PSO1 / PSO2 |
| *Module-5* | **Structures:** Structures definition, giving value to members, structure initialization, array of structures, array within structures, structures within structures, structures and functions, Structure Pointers.<br>**File Handling:** Creating and Deleting a File, Updating File, Copying File, Searching & Sorting in a File. | **08** | PO1/ PO2/ PO3 | PSO1 /PSO 2 |
| **Total No. of Hours** | | **40** | | |

## Suggested books:

| S. No. | Name of Authors /Books /Publisher/Year |
|---|---|
| 1. | Rajaraman V.(3/e), Fundamental of Computers, PHI, New Delhi, 1999 |
| 2. | Sanders,D.H., Computers Today, Mcgraw Hill, 1998 |
| 3. | Kris Jamsa, DOS the complete reference, Tata McGraw Hill |
| 4. | J.Peek Tim O'reilly & M.Locekides, UNIX POWER TOOLS, BPB Publication |
| 5. | Yashwant Kanetkar, Let Us C, BPB |
| 6. | Yashwant Kanetkar, C In Depth, BPB |

## Course Code: BME-C103
## Course Name: BASIC MECHANICAL ENGINEERING

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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|---|---|
| **Prerequisites:** | None |
| **Objectives:** | |
| **Course Coordinator** | |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections A, B. Section A contains 10 short type questions of 6 marks each, and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. |

| Module | Course Content | No. of Hours | POs mapped | PSOs mapped |
|---|---|---|---|---|
| *Module-1* | **Thermodynamics I**: Introduction to SI units, Definition of thermodynamic system, Surrounding and Universe, Quasi static process, Energy interaction Zeroth law, Concept of temperature First law of thermodynamics, Application to closed and open system, Concept of Enthalpy, steady flow energy equation, Throttling process. | **08** | PO1/ PO2/PO3 | PSO1/ PSO2 |
| *Module-2* | **Thermodynamics II:** Second law, reversible and irreversible process, Thermal reservoir, heat engines and thermal efficiency, COP of heat pump and refrigerator, Carnot cycle, Claudius inequality, Concept of entropy, Entropy change for ideal gases. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-3* | **Thermodynamics III:** Generation of steam at constant pressure, Properties of steam, Use of property diagram, Process of vapor in closed and open system, Rankine cycle. Stroke clearance ratio, Compression ratio, Definition and calculation of mean effective pressure (no proof) for air standard cycles (Otto and diesel cycles | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-4* | **Mechanics: Trusses:** Plane structure, (Method of Joints and Sections only) Beams: Bending moment and shear force diagram for statically determinate beams. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-5* | **Strength of Materials:** Simple stresses and strain, strain energy, stress- strain diagram, elastic constants. Compound stress and strain: state of stress at a point, Simple tension, pure shear, general two-dimensional stress system, principal planes, principal stresses and strains, Mohr's stress circle, Poisson's ratio, maximum shear stress. | **08** | PO1/ PO2/ PO3 | PSO1/PSO 2 |
| **Total No. of Hours** | | **40** | | |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher/Year |
|---|---|
| 1. | Kumar DS (2/e), Thermal Science and Engineering, S.K.Kataria, New Delhi,2001 |
| 2. | P.K.Nag (2/e), Engineering Thermodynamics, TMH, New Delhi,2001 |
| 3. | R.Yadav(7/e), Thermal Engineering, Central Publishing House, Allahabad, 2000 |
| 4. | Shames Irving H.(4/e), Engineering Mechanics, PHI, New Delhi, 1994 |
| 5. | Hibler (1/e), Statics and Dynamics, Pearson Education, Singapore, 2000 |

## Course Code: BEN-A103
## Course Name: ENVIRONMENTAL STUDIES

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit: 4** |

| | |
|---|---|
| **Prerequisites:** | None |
| **Objectives:** | |
| **Course Coordinator** | |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections A and B. Section A contains 10 short type questions of 6 marks each and student shall be required to attempt any five questions. Section B contains 8 long type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. |

| Module | Course Content | No. of Hours | POs mapped | PSOs mapped |
|---|---|---|---|---|
| *Module-1* | **The Multidisciplinary Nature of Environmental Studies & Ecosystems:** (a) Definition, scope and importance of ecology and environment (b) The ecological components: (i) Abiotic components: soil, water, light, humidity and temperature (ii) Biotic components & their relationships- symbiosis, commensalisms, parasitism, predation and antibiosis (c) Concept of an ecosystem (d) Structure and function of an ecosystem (e) Producers, consumers and decomposers (f) Energy flow in the ecosystem<br>(g) Ecological succession (h) Food chains, food webs and ecological pyramids (i) Introduction, types, characteristic features, structure and function of the following ecosystems: (i) Forest ecosystem (ii) Grassland ecosystem (iii) Desert ecosystem (iv) Aquatic ecosystems (pond, river, ocean estuaries, streams, lakes) (j) Need for public awareness | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-2* | **Natural Resources:** (a) Renewable and Non-Renewable resources (b) Natural resources and associated problems: (i) Forest resources: use and over-exploitation, deforestation case, timber extraction, mining, dams and their effects on forest and tribal people (ii) Water resources: use and over-utilization of surface and ground floods, drought, conflicts over water, dams benefits and problem (iii) Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, case studies (iv) Food resources : world food problems, changes caused by agriculture overgrazing, | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |

| | | | | |
|---|---|---|---|---|
| | effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies (v) Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies (vi) Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification (vii) Biodiversity & its conservation: definition- genetic, species and ecosystem diversity, values of biodiversity- consumptive use, productive use, social, ethical, aesthetic and option values (viii) Biodiversity at global, national and local levels, India as a mega-diversity nation, hot-spots of biodiversity, threats to biodiversity- habitat loss, poaching of wildlife, man-wildlife conflicts; endangered and endemic species of India, conservation of biodiversity: *in-situ* & *ex-situ* conservation of biodiversity (ix) Bio-geographical classification of India (x) Role of an individual in conservation of natural resources (xi) Equitable use of resources for sustainable lifestyles. | | | |
| *Module-3* | **Environmental Pollution:** (a) Definition, causes, effects and control measures of: air pollution, water pollution, soil pollution, noise pollution, thermal pollution and nuclear hazards (b) Solid waste management- causes, effects and control measures of urban and industrial wastes (c) Role of an individual in prevention of pollution (d) Pollution case studies (e) Disaster management: floods, earthquake, cyclone & landslides. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-4* | **Social Issues and the Environment:** (a) From unsustainable to sustainable development (b) Urban problems related to energy (c) Water conservation, rain water conservation, rain water harvesting, management (d) Resettlement & rehabilitation of people- its problems and concerns, case studies (e) Environmental ethics- issues and possible solutions (f) Wasteland reclamation (g) Consumerism and waste products (h) Population growth, variation among nations, family welfare program (i) Environment and human health, human rights, value education (j) HIV/AIDS (k) Role of information technology (IT) in environment and human health (l) Case studies. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| *Module-5* | **Environmental policies and laws:** Salient features of following acts (a) Environment Protection Act 1986 (b) Air (Prevention and Control of Pollution) Act 1981 (c) Water (Prevention and Control of Pollution) Act 1974 (d) Wildlife Protection Act 1972 (e) Forest Conservation Act 1980 (f) Issues involved in enforcement of environmental legislation (g) Public awareness. | **08** | PO1/ PO2/ PO3 | PSO1/ PSO2 |
| **Total No. of Hours** | | **40** | | |

| | |
|---|---|
| **Learning Outcomes:** | |

## Suggested books:

| S. No. | Name of Authors /Books /Publisher/Year |
|---|---|
| 1. | Asthana, D. K. (2006). Text Book of Environmental Studies. S. Chand Publishing. |
| 2. | Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India |
| 3. | Basu, R. N., (Ed.) (2000). Environment. University of Calcutta, Kolkata |
| 4. | Bharucha, E. (2013). Textbook of Environmental Studies for Undergraduate Courses. Universities Press. |
| 5. | De, A.K., (2006).Environmental Chemistry, 6th Edition, New Age International, New Delhi. |

## Course Code: BAC-C151/C251
## Course Name: Engineering Chemistry Laboratory

| | |
|---|---|
| **MM: 50**<br>**Time: 2 Hr.**<br>**L T P**<br>**0 0 2** | **Sessional: 15**<br>**ESE: 35**<br>**Pass : 40%** |

| | |
|---|---|
| **Prerequisites:** | **Engineering Chemistry Lab.** |
| **Objectives:** | The objective of the chemistry laboratory sessions is to:<br>1. Enable the students to get hands-on practice and to understand the applications of "qualitative and quantitative analysis" in engineering.<br>2. Develop the experimental skills by manual and by instrumentation.<br>3. Make students aware about the fundamental and experimental knowledge of chromatographic techniques like ascending paper chromatography and thin layer chromatography.<br>4. Learn the students to analyze the turbidity, pH, conductivity and refractive index instrumentally. |
| **Course Coordinator** | **Dr. Ajay Kumar** |

| | |
|---|---|
| **NOTE:** | In practical examination, the student shall be required to perform one experiment which carries 20 marks and 15 marks shall be reserved for practical record and viva-voce examination. The number of students in a batch allotted to an examiner for practical examination shall not exceed 30 students. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean. |

**LIST OF EXPERIMENTS**

**Choice of 10-12 experiments from the followings:**

1. Chemical analysis of a salt (mixture of one acidic radical and one basic radical).
2. Determination of relative surface tension of given liquid by drop count method using stalagmometer.
3. Determination of relative viscosity of given liquid using Ostwald's viscometer.
4. Separation of given binary mixture by thin layer chromatography (TLC).
5. Separation of given binary mixture by ascending paper chromatography.
6. Determination of moisture content present in hydrated copper sulphate ($CuSO_4.5H_2O$).
7. Titration between a strong acid and strong base.
8. Titration between potassium permanganate and oxalic acid/Mohr's salt solution.
9. Determination of chloride content of given water sample by Mohr's method.
10. Determination of total hardness of a water sample by using standard EDTA solution.
11. Determination of turbidity of given sample using Nephelo turbidity meter.
12. Determination of conductance of different KCl solutions and calculation of the specific and equivalent conductance of each solution.
13. Determination of the pH of unknown solutions using a digital pH meter.
14. Determination of total dissolved solids (TDS) of given water samples.
15. Determination of refractive index of a liquid sample using the Abbe's refractometer.
16. Determination of molar mass of an unknown solid using the colligative property of freezing point depression.
17. Study of adsorption of acetic acid on charcoal and to verify Freundlich isotherm.
18. Preparation of a polymer (Polyvinyl chloride/Bakelite).

| | |
|---|---|
| **Learning Outcomes:** | **Laboratory Outcomes**<br>The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:<br>○ **Analyze** a salt sample (**L4**).<br>○ **Measure** molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, pH, turbidity, refractive index, etc. (**L5**)<br>○ **Determine** the concentration of unknown sample via acid-base/redox titrations (**L3**).<br>○ **Separate** the components present in a mixture by TLC/Paper chromatography (**L4**).<br>○ **Estimate** the moisture content of a salt, chloride content, TDS and total hardness of water sample (**L4**).<br>○ **Prepare** a polymer (Polyvinyl chloride/Bakelite) (**L3**). |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1 | Advanced Practical Physical Chemistry, by J.B. Yadav – Krishna Prakashan Media. | 2016 |
| 2 | Analytical Chemistry Vol. I, II, III, by Dr. Subhash Kumar Agarwala & Dr. Keemti Lal – Pragati Prakashan. | --- |
| 3 | Applied Chemistry: Theory & Practice, Second Edition, by O.P. Virmani & A.K. Narula – New Age International Private Limited. | 2017 |

**GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR**
**Faculty of Engineering & Technology**
**Mechanical Engineering**
**B. Tech. Second Year**
**Syllabus in accordance with AICTE Model Curriculum**

## B.Tech. II Year
## Semester – III

| S.NO. | COURSE CODE | COURSE OPTED | SUBJECT | Period per week | | | EVALUATION SCHEME | | | | Credit | Subject TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SESSIONAL EXAM. | | | EXAM. ESE | | |
| | | | | L | T | P | CT | TA | TOTAL | | | |
| **THEORY SUBJECTS** | | | | | | | | | | | | |
| 1 | BEM-C302 | BSC-5 | Engineering Mathematics-III | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 4 | 100 |
| 2 | BME-C306 | ESC-6 | Materials Engineering | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 3 | BME-C308 | ESC-8 | Engineering Mechanics | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 4 | BME-C309 | ESC-9 | Fluid Mechanics | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 5 | BME-O341 | ESC-10 | MOOCS-I | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| | | | | | | | | | | | | |
| PRACTICAL / TRAINING / PROJECT | | | | | | | | | | | | |
| 6 | BME-C356 | ESC-6 Lab | Materials Engineering Lab | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 1 | 50 |
| 7 | BME-C358 | ESC-8 Lab | Engineering Mechanics Lab | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 1 | 50 |
| 8 | BME-C359 | ESC-10 Lab | Fluid Mechanics Lab | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 1 | 50 |
| 9 | BME-C370 | | Project-I | 0 | 0 | 2 | 10 | 5 | 15 | 35 | 1 | 50 |
| | | | TOTAL | 15 | 2 | 8 | 140 | 70 | 210 | 4900 | 20 | 700 |

**L**-Lecture; **T**-Tutorial; **P**-Practical; **CT**-Cumulative Test; **TA**- Teacher Assessment; **ESE**–End Semester Examination; **BSC**-Basic Science Course; **ESC**- Engineering Science Courses; **PEC**-Program Elective Course; **SEC**- Skill Enhancement Course; **AECC-** Ability Enhancement Compulsory Course; **HSMC-**Humanities, Social Science & Management Course

**Grading & Grade Points: O(**Outstanding**)= 10; A$^{+}$(**Excellent**)= 9; A(**Very Good**)= 8; B$^{+}$(**Good**)= 7; B(**Above Average**)= 6; C(**Average**)= 5; P(**Pass**)= 4; F(**Fail**)= 0; Ab(**Absent**)= 0**

# Course Code: BEM-C302
# Course Name: Engineering Mathematics-III

**MM: 100** **Sessional: 30**
**Time: 3 hrs** **ESE: 70**
**L T P** **Credits 4**
**3 1 0**

**NOTE:** The question paper shall consist of three sections (Sec.-A, Sec.-B and Sec.-C). Sec.-A shall contain 10 objective type questions of one mark each and student shall be required to attempt all questions. Sec.-B shall contain 10 short answer type questions of four marks each and student shall be required to attempt any five questions. Sec.-C shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

## UNIT I

**Laplace Transform:** Laplace transform of elementary functions, shifting theorems, transform of derivatives, Differentiation and Integration of transforms, Heaviside unit step and Dirac Delta functions, Convolution theorem, Solution of ordinary linear differential equations used in Mechanics, Electric circuits and bending of beams.

## UNIT II

**Fourier Transform:** Definition of Fourier transform, Fourier sine and cosine transforms. Fourier integral formula, Parseval's identity, Applications of Fourier transform in solving heat equations.

## UNIT III

**Z transform:** Definition, Linearity property, Z transform of elementary functions, Shifting theorems, Initial and final value theorem, Convolution theorem, Inversion of Z transforms, Solution of difference equations by Z transforms.

## UNIT IV

**Functions of Complex Variable:** Limit and Continuity of functions of Complex Variables: Analytic Functions, Harmonic Conjugate, Cauchy-Riemann Equations (without proof), Line Integral, Cauchy Goursat theorem (without proof), Cauchy Integral formula (without proof), Singular Points, Poles & Residues, Residue Theorem, Application of Residues theorem for Evaluation of Real Integral (Unit Circle).

## UNIT V

**Errors and Roots of Equations:** Absolute, relative, round-off and truncation errors. Significant digits. Algebraic and Transcendental Equations, Numerical solution, Method of bisection, Newton-Raphson method, Direct iterative method, convergence.

### Text Books / References


1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, New York, 1999
2. Gerald, C.F., Wheatley P.O., Applied Numerical Analysis, Pearson, 2007.
3. Grewal B.S., Higher Engineering Mathematics, Khanna, New Delhi, 2000.
4. Jain R. K., Iyenger S.R.K., Advanced Engineering Mathematics, Narosa , 2002.
5. Jain R. K., Iyenger S.R.K., Jain M.K., Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 2012.

# Course Code: BME-C306
# Course Name: MATERIAL ENGINEERING

**MM: 100**
**Time: 3 Hr.** **Sessional: 30**
**L T P** **ESE: 70**
**3 0 0** **Credit : 3**

**NOTE:** The question paper shall consist of three sections (Sec.-A, Sec.-B and Sec.-C). Sec.-A shall contain 10 objective type questions of one mark each and student shall be required to attempt all questions. Sec.-B shall contain 10 short answer type questions of four marks each and student shall be required to attempt any five questions. Sec.- C shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

**UNIT-I**

Crystal Structure: Crystal structure determination technique, Miller Indices, Diffusion, Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems. **8**

**UNIT-II**

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. **8**

**UNIT-III**

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Fick law, Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT). **8**

**UNIT-IV**

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid andmonotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron. **8**

**UNIT-V**

Heat treatment of Steel: Annealing, tempering, normalising and spheroid sing, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening. **8**

**Suggested book:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Higdon, A., Ohlsen, E.H., Stiles, W.B., Weese, J.A., and Riley, W.F., "Mechanics of Materials", John Wiley & Sons, ISBN: 978-0-470-50873-2. | 1989 |
| 2. | Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers, ISBN: 9788123908946. | 2002 |
| 3. | W. D. Callister, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India, **ISBN-10:** 0471736961 | 2006 |
| 4. | Hearn, E.J., "Mechanics of Materials", 3rd Ed., Pergamon, **SBN:** 9780750632669. | 2003 |

# Course Code: BME-C308
# Course Name: ENGINEERING MECHANICS

**MM: 100** **Sessional: 30**
**Time: 3 Hr.**
**L T P** **ESE: 70**
**3 0 0** **Credit : 3**

**NOTE:** The question paper shall consist of three sections (Sec.-A, Sec.-B and Sec.-C). Sec.-A shall contain 10 objective type questions of one mark each and student shall be required to attempt all questions. Sec.-B shall contain 10 short answer type questions of four marks each and student shall be required to attempt any five questions. Sec.- C shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

**UNIT-I**

Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in pace – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy. 8

**UNIT-II**

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack. 6

**UNIT-III**

Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines. 8

**UNIT-IV**

Centroid of simple figures from first principle. centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.9

**UNIT-V**

Introduction to Kinetics of Rigid Bodies, Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Irving H. Shames, Engineering Mechanics, 4th Edition, Prentice Hall, ISBN: 0133569241 | 2006 |
| 2. | P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill, ISBN: 9781260085006 | 2011 |
| 3. | Bansal R.K., A Text Book of Engineering Mechanics, Laxmi Publications, ISBN-10: 8131804097. | 2010 |
| 4. | Khurmi R.S., Engineering Mechanics, S. Chand & Co., ISBN-10: 8121931002. | 2010 |
| 5. | Tayal A.K., Engineering Mechanics, Umesh Publications,5SBN 9789380117386. | 2010 |

# Course Code: BME-C309
# Course Name: FLUID MECHANICS

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | NILL |
| **Objectives:** | • To understand the properties of fluids and fluid statics<br>• To derive the equation of conservation of mass and its application<br>• To solve kinematic problems such as finding particle paths and stream lines<br>• To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems . |
| **Course Coordinator** | Mr. Yogesh Kumar |

| Module | Course Content | No. of Hours |
|---|---|---|
| *Module-1* | Introduction**:** Fluids and continuum; Physical properties of fluids: Viscosity, Compressibility, Surface Tension, Capillarity, Vapour Pressure; Cavitation; Classification of fluids including rheological classification | **4** |
| *Module-2* | Pascal's law; Pressure-density-height relationship; Measurement of pressure by Manometers and mechanical gauges; Pressure on plane and curved surfaces; The Hydrostatic law; Total Pressure and Centre of pressure; | **4** |
| *Module-3* | Buoyancy; Stability of immersed and floating bodies; Fluid masses subjected to uniform horizontal and vertical accelerations | **2** |
| *Module-4* | Description of Fluid flow: Lagrangian and Eulerian approach; Types of fluid Flows: Steady and unsteady, Uniform and non-uniform, Laminar and turbulent flows, 1, 2 and 3-D flows; Stream lines, Path lines and Streak lines | **4** |
| *Module-5* | Differential and Integral form of Continuity equation; Rotation, Vorticity and Circulation; Elementary explanation of Stream function and Velocity potential | **4** |
| *Module-6* | Fluid Dynamics-I: Concept of control volume and control surface, Reynolds Transport Theorem, Introduction to Navier-Stokes Equations, Euler's equation of motion along a streamline and its integration, Bernoulli's equation and its applications – Pitot tube, Flow through orifices, Mouthpieces, Nozzles, Free and Forced vortex motion. | **4** |
| *Module-7* | Fluid Dynamics-II**:** Impulse-Momentum Principle; Moment of momentum equation; flow measurements, Venturimeter, Orificemeter, determination of coefficients of discharge, velocity and contraction and energy loss.<br>Laminar Flow: Reynolds Experiment; Equation of motion for laminar flow through pipes; Flow between parallel plates; Kinetic energy and Momentum correction factors; Stokes law; Flow through porous media; Measurement of viscosity; Transition from laminar to turbulent flow. | **4** |
| *Module-8* | Boundary Layer Analysis**:** Boundary layer thicknesses; Boundary layer over a flat plate; Laminar boundary layer; Application of Von-Karman Integral Momentum Equation; Turbulent boundary layer;<br>Laminar sub layer; Hydro-dynamically Smooth and rough boundaries; Local and average friction coefficient; Total drag; Boundary layer separation and its control. | **4** |
| *Module-9* | Flow Through Pipes**:** Nature of turbulent flow in pipes; Equation for velocity distribution over smooth and rough surfaces; Major and Minor energy losses; Darcy's Law; Resistance coefficient and its variation; Hydraulic gradient and total energy lines. Flow in sudden expansion, contraction,diffusers, bends, valves and siphons; Concept of equivalent length; Branched pipes; Pipes in series and parallel; Simple pipe networks. | **6** |

| | | |
|---|---|---|
| *Module-10* | Flow Past Submerged Bodies: Drag and lift, Types of drag force, Drag on sphere, Cylinder and airfoil; Magnus effect. | **4** |
| **Total No. of Hours** | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | • Understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid statics and dynamics.<br>• Calculate the forces that act on submerged planes and curves.<br>• Identify and analyse various types of fluid flows. •<br>• Apply the integral forms of the three fundamental laws of fluid mechanics to turbulent and laminar flow through pipes and ducts in order to predict relevant pressures, velocities and forces.<br>• Draw simple hydraulic and energy gradient lines. |

References


| S.No. | Book/Author/ Publication | Year of Publication |
|---|---|---|
| 1. | R K Bansal: Fluid Mechanics and Hydraulic Machines, laxmi publication | 2000 |
| 2. | Modi and Seth: Fluid Mechanics and Fluid Machines | 2002 |
| 3 | V Gupta and S K Gupta, Fluid Mechanics and its Applications, Wiley eastern ltd. | 2001 |


# Course Code: BME-C356
# Course Name: MATERIALS ENGINEERING LAB

**MM: 50** **Sessional: 15**
**Time: 2 Hr.** **ESE: 35**
**L T P** **Credit: 1**
**0 0 2**

**LIST OF EXPERIMENTS**

1. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
2. Grain Size determination of a given specimen.
3. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, cooper etc.)
4. Heat treatment experiments such as annealing, normalizing, quenching, case hardening andcomparison of hardness before and after.
5. Material identification of say 50 common items kept in a box.
6. Faradays law of electrolysis experiment.
7. Study of corrosion and its effects.
8. Study of microstructure of welded component and HAZ. Macro & Micro examination.
9. Other tests such as shear, bend tests on UTM.
10. Hardness testing of given specimen using Rockwell and Vickers/Brinell testing machines.
11. Spring index testing on spring testing machine.
12. Fatigue testing on fatigue testing machine.

13. Torsion testing of a rod on torsion testing machine.
14. Study of non-destructive testing methods like magnetic flaw detector, ultrasonic flaw detector,eddy current testing machine, dye penetrant tests.
15. To conduct the Impact test (Izod / charpy) on the Impact testing machine and to find the impact strength.

**NOTE**

1. In practical examination the student shall be required to perform one experiment.
2. A teacher shall be assigned 20 students for daily practical work in laboratory.
3. No batch for practical class shall consist of more than 20 students.
4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students.
5. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

# Course Code: BME-C358
# Course Name: ENGINEERING MECHANICS LAB

**MM: 50** **Sessional:15**
**Time: 2 Hr.** **ESE: 35**
**L T P** **Credit: 1**
**0 0 2**

**LIST OF EXPERIMENTS**

1. To determine the efficiency of a machines
2. To determine the mechanical advantage and efficiency of screw jack
3. To measure coefficient of friction of different surfaces
4. To study the forces acting on trusses
5. To study the moment of inertia of a flywheel
6. To study Lami's theorem using universal force table apparatus
7. To study the equilibrium of parallel forces – simply supported beam reactions
8. To determine the velocity ratio, mechanical advantage and efficiency of worm and worm wheel.
9. To verify the parallelogram law of forces.
10. To verify the moment area theorem for slope anddeflection of beam.
11. To study and verify the behavior of strutswith various end conditions.
12. To study the performance of differential axle and wheel and find itsvelocity ratio, efficiency and law of machine.
13. To study of forces in the members of jib crane.

Note:

1. Each student shall be required to perform one experiment in the practical examination.
2. A Teacher shall be assigned 20 students for daily practical work in laboratory.
3. No batch for practical class shall consist of more than 20 students.
4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students.
5. Every student shall have to perform minimum eight experiments during the semester.
6. Any Experiment based on syllabus may be added by permission of Head / Dean.

# Course Code: BME-C359
# Course Name: FLUID MECHANICS LAB

| | |
|---|---|
| **MM: 50**<br>**Time: 2 Hr.**<br>**L T P**<br>**0 0 2** | **Sessional: 15**<br>**ESE: 35**<br>**Credit: 1** |

| | |
|---|---|
| **Prerequisites:** | NIL |
| **Objectives:** | 1. To obtain resultant of various forces.<br>2. To calculate support reactions through conditions of equilibrium for various structures.<br>3. To understand role of friction in equilibrium problems.<br>4. To know fundamental laws of machines and their applications to various engineering problems |
| **Course Coordinator** | Mr. Yogesh Kumar |

| Module | Course Content | No. of Hours |
|---|---|---|
| *Experiment-1* | To determine the metacentric height of a ship model experimentally. | **02** |
| *Experiment-2* | To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number. | **02** |
| *Experiment-3* | To verify the Bernoulli's theorem. | **02** |
| *Experiment-4* | To calibrate an orifice meter and venturimeter and to study the variation of the coefficient of discharge with the Reynolds number. | **02** |
| *Experiment-5* | To calibrate and to determine the coefficient of discharge for rectangular and triangular notches. | **02** |
| *Experiment-6* | To determine the loss coefficients for the various pipe fittings. | **02** |
| *Experiment-7* | To study the flow behavior in a pipe bend and to calibrate the pipe bend for discharge measurement | **02** |
| *Experiment-8* | To measure the surface tension of a liquid. | **02** |
| *Experiment-9* | To determine the coefficients of velocity, contraction and discharge of an orifice (or a mouth piece) of a given shape. To plot the flow net for a given model using the concept of electrical analogy | **02** |
| *Experiment-10* | To verify Darcy's law and to find out the coefficient of permeability of the given medium | **02** |
| *Experiment-11* | To study the variation of friction factor, 'f' for turbulent flow in smooth and rough commercial pipes | **02** |
| *Experiment-12* | To verify the momentum equation. | **02** |
| **Total No. of Hours** | | |

| | |
|---|---|
| **Learning Outcomes:** | At the end of this course students will be able to:<br>❖ Understand the knowledge about the basic terminologies and will able to find out various conditions related to stability of floating bodies.<br>❖ Understand the knowledge about the fluid motion and will be able to distinguish between them based on Reynolds no.<br>❖ Apply Bernoulli's equation in flow measuring devices together with there calibration |

**GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR**
**Faculty of Engineering & Technology**
**Mechanical Engineering**
**B. Tech. Third Year**
**Syllabus in accordance with AICTE Model Curriculum**

## B.Tech. III Year
## Semester – V

| S.NO. | COURSE CODE | COURSE OPTED | Course Name | Period per week | | | EVALUATION SCHEME | | | | Credit | Subject TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SESSIONAL EXAM. | | | EXAM. ESE | | |
| | | | | L | T | P | CT | TA | TOTAL | | | |
| **THEORY SUBJECTS** | | | | | | | | | | | | |
| 1 | BME-C511 | PCC | Heat Transfer | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 4 | 100 |
| 2 | BME-C512 | PCC | Measurement & Metrology | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 3 | BME-C513 | PCC | Solid Mechanics | 3 | 1 | 0 | 20 | 10 | 30 | 70 | 4 | 100 |
| 4 | BME-P5XX | PEC | Program Elective-I | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 5 | BME-O5XX | OEC | Open Elective-I | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 6 | BME-M001 | HSMC | Universal Human Values | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 0 | 100 |
| PRACTICAL / TRAINING /PROJECT | | | | | | | | | | | | |
| 7 | BME-C561 | PCC Lab | Heat Transfer Lab | 0 | 0 | 2 | 10 | 05 | 15 | 35 | 1 | 50 |
| 8 | BME-C562 | PCC Lab | Measurement & Metrology Lab | 0 | 0 | 2 | 10 | 05 | 15 | 35 | 1 | 50 |
| 9 | BME-C570 | PCC Lab | Project-I (Summer Training) | 0 | 0 | 2 | 10 | 05 | 15 | 35 | 1 | 50 |
| | | | TOTAL | 18 | 4 | 6 | 150 | 75 | 225 | 525 | 20 | 750 |

- For the Summer Training and Internship program done in summer break after IV semester examination, A certificate of completion to be submitted along with the report and presentation in the department. In case a student is unable to do an internship in some company, he may do any one extra online skill enhancement course

**L**-Lecture; **T**-Tutorial; **P**-Practical; **CT**-Cumulative Test; **TA**- Teacher Assessment; **ESE** End Semester Examination; **BSC-**Basic Science Course; **ESC**- Engineering Science Courses; **PEC**-Program Elective Course; **SEC-** Skill Enhancement Course; **AECC-** Ability Enhancement Compulsory Course; **HSMC-**Humanities, Social Science & Management Course

**Grading & Grade Points: O(**Outstanding**)= 10; A$^{+}$(**Excellent**)= 9; A(**Very Good**)= 8; B$^{+}$(**Good**)= 7; B(**Above Average**)= 6; C(**Average**)= 5; P(**Pass**)= 4; F(**Fail**)= 0; Ab(**Absent**)= 0**

## Program Elective -I (Fifth semester)

| | |
|---|---|
| BME-P521 | Manufacturing System Design |
| BME-P522 | Soft Computing |
| BME-P523 | Advanced Thermodynamics |
| BME-P524 | Machine Tool Design |

**Open Elective -I (Fifth semester)**

| | |
|---|---|
| BME-O531 | Engineering Economy |
| BME-O532/BCE-C514 | Cloud Computing |
| BME-O533 | Automatic Control System |
| BME-O534 | Composite Materials |
| BME-O535 | Machine Learning |

# Course Code: BME-C511
# Course Name: Heat Transfer

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 4** |

| | |
|---|---|
| **Prerequisites:** | Fundamental knowledge of Thermodynamics |
| **Objectives:** | 1. Basic Concepts of Heat Transfer<br>2. Design and Rating of Heat exchangers with and Without Phase Change.<br>3. Design and Rating of Compact Heat Exchangers |
| **Course Coordinator** | Mr. Mayank Pokhriyal |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction to Heat Transfer:** Concepts of the mechanisms of heat flows: conduction, convection and radiation; effect of temperature on thermal conductivity of materials; introduction to combined heat transfer mechanism. | **03** |
| | *Module-2* | **Conduction:** One-dimensional general differential heat conduction equation in the rectangular, Cylindrical and spherical coordinate systems; initial and boundary conditions. | **03** |
| | *Module-3* | **Steady State one-dimensional Heat conduction:** Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; thermal resistance concept; Analogy between heat and electricity flow; thermal contact resistance; critical thickness of insulation. | **03** |
| UNIT-2 | *Module-4* | Fins of uniform cross-sectional area; errors of measurement of temperature in thermometer wells. | **02** |
| | *Module-5* | **Transient Conduction:** Transient heat conduction Lumped capacitance method, Time constant Unsteady state heat conduction in one dimension only, Heisler charts**.** | **04** |
| UNIT-3 | *Module-6* | **Forced Convection:** Basic concepts; hydrodynamic boundary layer; thermal boundary layer, flow over a flat plate; flow across a single cylinder and a sphere; flow inside ducts; empirical heat transfer relations; relation between fluid friction and heat transfer; liquid metal heat transfer. | **05** |
| | *Module-7* | **Natural Convection:** Physical mechanism of natural convection; buoyant force; empirical heat | **05** |

| | | | |
|---|---|---|---|
| | | Transfer relations for natural convection over vertical planes and cylinders, horizontal plates and Cylinders, and sphere | |
| UNIT-4 | *Module-8* | **Thermal Radiation:** Basic radiation concepts; radiation properties of surfaces; black body radiation laws; shape factor; black-body radiation exchange; Radiation exchange between diffuse non-black bodies in an enclosure; radiation shields; solar radiation | **06** |
| UNIT-5 | *Module-9* | **Heat Exchanger:** Types of heat exchangers; fouling factors; overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; effectiveness-NTU method; compact heat exchangers. | **05** |
| | *Module-10* | **Condensation and Boiling:** Introduction to condensation phenomena; heat transfer relations for Laminar film condensation on vertical surfaces and on a horizontal tube; boiling modes pool boiling, curve, forced convective boiling. | **04** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | At the end of the course students are able to:<br>1. To be able to understand various modes of heat transfer in solid liquid and gas.<br>2. To be able to understand and apply general heat conduction equation in Cartesian, cylindrical and spherical co-ordinates system and their composite structure also.<br>3. To be able to understand the heat flow in unsteady state condition.<br>4. To understand and learn various concepts of forced convection, momentum equation and its solution for hydrodynamic boundary layer over a flat plate.<br>5. To be able to understand the heat exchanger, types of heat exchanger and thermal radiation in black, grey and real surfaces. Planks distribution law, vein's law, Stephen', Boltzmann law, Kirchhoff's law, radiations shield and shape factor.<br>6. Design double pipe heat exchanger, Shell and tube heat exchanger, finned tube and other compact heat exchangers. |

| | |
|---|---|
| **CO1** | **Define-Concepts of the mechanisms of heat flows: conduction, convection and radiation, ntroduction to condensation phenomena** |
| **CO2** | **Illustrate-Fins of uniform cross-sectional area; errors of measurement of temperature in thermometer wells** |
| **CO3** | **Categorize-Types of heat exchangers** |
| **CO4** | **Determine-overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; effectiveness NTU method** |
| **CO5** | **Explain-Basic radiation concepts; radiation properties of surfaces; the devices of intermittent motion, reversing and differential mechanisms** |
| **CO6** | **Prove-Analogy between heat and electricity flow; thermal contact resistance; critical thickness of insulation** |
| **CO7** | **Choose-hydrodynamic boundary layer; thermal boundary layer, flow over a flat plate; flow across a single cylinder and a sphere** |
| **CO8** | **Construct-One-dimensional general differential heat conduction equation in the rectangular** |
| **CO9** | **Utilize-boiling modes poolboiling, curve, forced convective boiling.** |
| **CO10** | **Select -Radiation exchange between diffuse non-black bodies in an enclosure; radiation shields;solar radiation** |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Elements of Heat transfer by Bayazitouglu & Ozisik, McGraw-Hill Book Company. ISBN-0071001328 | 1998 |

| | | |
|---|---|---|
| 2. | Heat Transfer By J.P. Holman, McGraw-Hill International edition. ISBN 0070586748 | 2004 |
| 3. | Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill International edition<br>ISBN-9780071764292 | 2011 |
| 4. | Principles of Heat Transfer by Frank Kreith, McGraw-Hill Bo ok co. ISBN-1305387104 | 2017 |

# Course Code: BME-C512

# Course Name: Measurement & Metrology

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Basic Knowledge of Metric and SI unit of physical quantities, Statistics. |
| **Objectives:** | 1. This course provides standard methodology for inspection and also discusses the equipment required for the inspection process so as to see that the designer's specifications are met.<br>2. To understand the statistical concepts in quality control and quality assurance and to appreciate the concepts of on-line and off-line quality control in today's Manufacturing, subsequently applying these concepts to various situations through problem solving. |
| **Course Coordinator** | Mr. Mayank Pokhriyal |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Introduction to Metrology and its relevance, importance of dimensional measurement, line and end standards. Need of inspection, sources of errors, basic types of errors precision and accuracy. Method of estimating accuracy and precision, standard and their evolutions. Simple measurement tools: Rules, calipers, height gauges, micrometers, depth gauge dial indicator, slip gauges, sine bar. | **08** |
| UNIT-2 | *Module-2* | **Limits, fits and tolerances-** interchangeability, selective assembly, limits of size, types of fits, Indian standard specifications for the design fits. Limit gauging- Taylor's principles of limit gauging, design of gauges, classification of gauges. Interferometers: Types of light sources and interferometers, Types of scale and grading, optical flats. | **08** |
| UNIT-3 | *Module-3* | **Metrology of Screw Thread Gear Metrology**: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool markers microscope. Advancements in Metrology: Co- ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology. | **08** |
| UNIT-4 | *Module-6* | **Metrology and Inspection:** Standards of linear measurement, line and end standards. | **04** |
| | *Module-7* | Linear and angular measurements devices and systems Comparators: Sigma, Johansson's | **04** |

| | | | |
|---|---|---|---|
| | | Microkrator. Limit gauges classification, Taylor's Principle of Gauge Design. | |
| UNIT-5 | *Module-8* | **Measurement of Geometric Forms:** Straightness, flatness,roundness.Tool makers microscope,profile project autocollimator. Interferometry: principle and use of interferometry, optical flat. Measurement of screw threads and gears, Surface texture: quantitative evaluation of surface roughness and its measurement. | **08** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | At the end of the course students are able to:<br>1. Identify techniques to minimize the errors in measurement<br>2. Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.<br>3. Choose limits for plug and ring gauges.<br>4. Explain methods of measurement in modern machineries<br>5. Select quality control techniques and its applications<br>6. Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools. |

Course Outcomes

CO1: Explain Importance of dimensional measurement, line and end standards, Taylor's principles of limit. Interferometry: principle and use of interferometry, Measurement of Geometric Forms, Gear Tooth Vernier; Profile Projector, Tool makers microscope. Advancements in Metrology: Machine, Universal Measuring Machine, Laser in Metrology

CO2: Define Precision and accuracy, interchangeability, Gear error, Comparators,Sigma, Linear and angular measurements devices and systems.

CO3: How Estimating accuracy and precision, Gear measurement Co- ordinate Measuring, Measurement of screw threads and gears,

CO4:Identify Rules, calipers, height gauges, micrometers, depth gauge dial indicator, slip gauges, sine bar. Handling, Material Handling, equipment's.

CO5: Classify Basic types of errors, types of fits, Types of light sources and interferometers, Types of scale and grading, optical flats.

CO6: Analyze quantitative evaluation of surface roughness and its measurement. Limit gauging, Simple measurement tools,: Straightness, flatness, roundness.

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | R. K. Jain, Engineering Metrology**,** Khanna Publications, 17th edition. ISBN-9788174091536 | 1975 |
| 2. | V. A. Kulkarni, A. K. Bewoor, Metrology & Measurements, Tata McGraw Hill Co. Ltd., 1st edition. ISBN-9788126519071 | 2009 |
| 3. | Gupta. I.C., "Engineering Metrology", Dhanpat Rai Publications. ISBN-8189928457 | 2005 |

# Course Code: BME-C513
# Course Name: Solid Mechanics

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 4** |

| | |
|---|---|
| **Prerequisites :** | Basics of Mechanical Engineering & Strength of Materials. |
| **Objectives:** | 1. The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids. |
| **Course Coordinator** | Dr. Jasbir Singh |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction to Cartesian tensors, Strains** Concept of strain, derivation of small strain tensor and compatibility, Stress Derivation of Cauchy relations and equilibrium and symmetry equations,<br>principal stresses and directions. | **08** |
| UNIT-2 | *Module-2* | **Constitutive equations:** Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition. | **04** |
| | *Module-3* | **Deflection of beam:** Relation between slope deflection and radius of curvature, solution of beam deflection, problem by Macaulay's method, Direct integration method, Method of super position, Moment Area Method. | **04** |
| UNIT-3 | *Module-4* | **Columns & Struts:** Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Eulers formulae for the elastic buckling load, Eulers, Rankine, Gordom's formulae<br>Johnson's empirical formula for axial loading columns and their applications. | **08** |
| UNIT-4 | *Module-5* | Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems, application to thick cylinders, rotating discs. | **05** |
| | *Module-6* | Deformation in circular shaft due to torsion, Basic assumption, Torsion equation, Torsion of non- circular cross-sections. | **03** |
| UNIT-5 | *Module-7* | **Springs:** Stresses in open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs. | **08** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | Upon completion of this course, students will be able to:<br>CO1: Explain the concept of strain, strain tensor, principal stresses and directions.<br>CO2: How to determine the deflection of beam and solve the boundary value problems.<br>CO3: Compare the critical load obtained by using Eulers, Rankine, Gordom's formulae and Johnson's empirical formula for axial loading columns.<br>CO4: Classify the plane stress and plane strain problems |

| | |
|---|---|
| | CO5: Solve The deformation in circular and non-circular cross-sections due to torsion.<br>CO6: Analyze the stresses in open coiled helical spring and leaf spring. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press. | 2004 |
| 2. | Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International. | 1965 |
| 3. | Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international. | 1969 |
| 4. | Bedi, D. S., Strength of Materials, Khanna Publishing, Delhi | 2002 |

# Course Code: BME-M001

# Course Name: Universal Human Values

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 0** |
| **Prerequisites:** | Moral Education |
| **Objectives:** | The objective of the course is four fold:<br>1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.<br>2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.<br>3. Strengthening of self-reflection.<br>4. Development of commitment and courage to act. |
| **Course Coordinator** | Mr. Rishi Kumar Prajapati |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.**<br>Purpose and motivation for the course, recapitulation from Universal Human Values-I Self-Exploration– what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Priority Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. | **5** |

| | | | |
|---|---|---|---|
| | *Module-2* | **Include practice sessions** to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking disliking. | **3** |
| **UNIT-2** | *Module-3* | **Understanding Harmony in the Human Being - Harmony in Myself!**<br>Understanding human being as a co-existence of the sentient 'I'& the Material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Health.Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease. | **8** |
| **UNIT-3** | *Module-4* | **Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship** Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention & competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. | **5** |
| | *Module-5* | Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives. | **3** |
| UNIT-4 | *Module-6* | Understanding Harmony in the Nature and Existence - Whole existence as Coexistence. Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all- | **5** |

| | | | |
|---|---|---|---|
| | | pervasive space. Holistic perception of harmony at all levels of existence | |
| | *Module-7* | Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc. | **3** |
| **UNIT-5** | *Module-8* | Implications of the above Holistic Understanding of Harmony on Professional Ethics.Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers. At the level of society: as mutually enriching institutions and organizations. Sum up Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc | **8** |
| **Total No. of Hours** | | | **40** |

| **Course Name: Universal Human Value**<br>**Course Code: BME-M001** | |
|---|---|
| **CO1** | **Understand and analyze the essentials of human values and skills, self-exploration, happiness and prosperity.** |
| **CO2** | **Evaluate coexistence of the "I" with the body.** |
| **CO3** | **Identify and evaluate the role of harmony in family, society and universal order.** |
| **CO4** | **Understand and associate the holistic perception of harmony at all levels of existence.** |
| **CO5** | **Develop appropriate technologies and management patterns to create harmony in professional and personal lives.** |

**Suggested Books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| **1** | Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, | 2010 |
| **2** | Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, | 1999 |
| **3** | Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, | 2004 |

# Course Code: BME-C561

# Course Name: Heat Transfer Lab

| | |
|---|---|
| **MM: 50**<br>**Time: 2 Hr.**<br>**L T P**<br>**0 0 2** | **Sessional: 15**<br>**ESE: 30**<br>**Credit : 1** |

| | |
|---|---|
| **Prerequisites:** | Fundamental knowledge of Thermodynamics. |
| **Objectives:** | 1. To impart practical knowledge on heat transfer, mass transfer in engineering systems.<br>2. To do the experiments related to their subjects like thermodynamics, thermal engineering, heat and mass transfer concepts. |
| **Course Coordinator** | Mr. Mayank Pokhriyal |

| Module | Course Content | No. of Hours |
|---|---|---|
| *Experiment-1* | Conduction - Composite wall experiment | **02** |
| *Experiment-2* | Conduction - Composite cylinder experiment | **02** |
| *Experiment-3* | Convection - Pool boiling experiment | **02** |
| *Experiment-4* | Convection - Experiment on heat transfer from tube-natural convection. | **02** |
| *Experiment-5* | Convection - Heat Pipe experiment. | **02** |
| *Experiment-6* | Convection - Heat transfer through fin-natural convection. | **02** |
| *Experiment-7* | Convection - Heat transfer through tube/fin-forced convection. | **02** |
| *Experiment-8* | Any experiment - Such as on Stefen's Law, on radiation determination of emissivity, etc. | **02** |
| *Experiment-9* | Any experiment - Such as on solar collector, etc. on radiation | **02** |
| *Experiment-10* | Heat Exchanger - Parallel flow experiment | **02** |
| *Experiment-11* | Heat Exchanger - Counter flow experiment | **02** |
| *Experiment-12* | Any other suitable experiment such as on critical insulation thickness. | **02** |
| *Experiment-13* | Conduction - Determination of thermal conductivity of fluids. | **02** |
| *Experiment-14* | Conduction - Thermal Contact Resistance Effect. | **02** |
| **Total** | | |

| | |
|---|---|
| CO1 | Experiment with-Composite wall, Composite Cylinder Experiment. |
| CO2 | Explain-on heat transfer from tube- natural convection |
| CO3 | Illustrate-Heat Transfer through fin-natural convection |
| CO4 | Compare-on heat transfer through tube/fin –forced convection |
| CO5 | Determine-Determination of thermal conductivity of fluid. |
| CO6 | Identify-parallel flow and counter flow. |
| CO7 | Select- such as on solar collector o radiation, Stefen´s laws on radiation. |

| NOTE: | ➢ Apart from the above practical listed any eight practical can be conducted by each student.<br>➢ Each student shall be required to perform one experiment in the practical examination.<br>➢ A Teacher shall be assigned 20 students for daily practical work in laboratory.<br>➢ No batch for practical class shall consist of more than 20 students.<br>➢ The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students.<br>➢ Every student shall have to perform minimum eight experiments |
|---|---|

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Fundamentals of Momentum, Heat and Mass Transfer by James R.Welty; John Wiley & Sons(Pvt).Ltd. ISBN: 978-1-119-49541-3 | 2019 |
| 2. | Heat Transfer, by Vijay Gupta, New Age International (P) Ltd. Publishers ISBN10 8122408001 | 2016 |
| 3. | Heat Transfer, by Y.V.C. Rao, University Press., ISBN-8173713847 | 2001 |

# Course Code: BME-C562

# Course Name: Measurement & Metrology Lab

| | |
|---|---|
| **MM: 50**<br>**Time: 2 Hr.**<br>**L T P**<br>**0 0 2** | **Sessional: 15**<br>**ESE: 30**<br>**Credit : 1** |

| | |
|---|---|
| **Prerequisites:** | Study of Measurement by different tools. |
| **Objectives:** | 1 Measurement of linear and angular dimensions<br>2. To perform various alignment tests on machine tools<br>3. Estimation of surface roughness<br>4. Measurement of pressure, flow, speed, displacement and temperature. |
| **Course Coordinator** | Mr. Mayank Pokhriyal |

| Module | Course Content | No. of Hours |
|---|---|---|
| *Experiment-1* | Study & working of simple measuring instruments. Like Vernier calipers, micrometer, tachometer etc. | **02** |
| *Experiment-2* | Measurement of effective diameter of a screw thread using 3-wire method. | **02** |
| *Experiment-3* | Measurement of angle using sine bar & slip gauges. | **02** |
| *Experiment-4* | Study of angular measurement using level protector | **02** |
| *Experiment-5* | Pressure measuring experiment | **02** |
| *Experiment-6* | Temperature measurement experiment | **02** |
| *Experiment-7* | Measurement of the surface roughness. | **02** |

| | | |
|---|---|---|
| *Experiment-8* | Force measuring experiment. | **02** |
| **Total No. of Hours** | | |

| | |
|---|---|
| **Learning Outcomes:** | At the end of the course students are able to:<br>1 .Demonstrate the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness.<br>2. Perform alignment tests on various machine tools.<br>3. Demonstrate the use of instruments for measuring pressure, flow, speed, displacement and temperature. |

**Suggested books:**

| S.No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications. | 2005 |
| 2. | Jain R.K. "Engineering Metrology", Khanna Publishers. | 2009 |
| 3. | Doeblein E.O., "Measurement Systems, Application Design", McGraw Hill. | 1990 |
| 4. | Kumar D.S., "Mechanical Measurements and Control", Metropolitan, N. Delhi. | 2005 |

# Course Code: BME-C570

# Course Name: Project (Summer Training)

| | |
|---|---|
| **MM: 50**<br>**Time: 2Hr.**<br>**L T P**<br>**0 0 2** | **Sessional:15**<br>**ESE: 35**<br>**Credit : 1** |

| | |
|---|---|
| **Prerequisites:** | Fundamental Knowledge of Different Machines. |
| **Objectives:** | 1. The objective of the summer training and internship program on recent/ latest technologies is to make students acquire knowledge of latest technologies and also to work under the guidance of industry professionals.<br>2. Students will develop presentation, listening and communication skills<br>3. Students will develop Argumentative Skills and Critical Thinking. Course Outcomes:<br>4. Students will gain knowledge of the current and upcoming technologies.<br>5. Students will be able to look into the working environment in the industry. |
| **Course Coordinator** | Dr. Sanjeev Kumar Lambha |

Students will develop better communication skills and critical thinking. The presentation will be held for the Summer Training and Internship program done in summer break on recent/ latest technologies after IV semester examination, a certificate of completion to be submitted along with the presentation in the department. In case, any student is unable to do an internship in some company, he is allowed to do any one extra online skill enhancement course, for which the course completion certificate along with the presentation has to be submitted in the department.

| | |
|---|---|
| **Learning Outcomes:** | 1. Students will gain knowledge of the current and upcoming technologies.<br>2. Students will be able to look into the working environment in the industry<br>3. Students will develop better communication skills and critical thinking. |

# Program Elective -I (Fifth semester)

## Course Code: BME-P521
## Course Name: Manufacturing System Design

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | |
| **Objectives:** | The objective is to introduce students to the basics of manufacturing system modelling and design. |
| **Course Coordinator** | Mr. Praveen Kumar Pandey |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | Introduction to the course and overview of manufacturing systems | **04** |
| | *Module-2* | Manufacturing strategy, Manufacturing flexibility, Manufacturing complexity | **04** |
| UNIT-2 | *Module-3* | Basic decision making models, Investment decisions under uncertainty using lifecycle costing models | **04** |
| UNIT-3 | *Module-4* | System reliability and maintenance models, Economic design of quality control plans. | **08** |
| UNIT-4 | *Module-5* | Single and mixed model assembly lines, Shop floor scheduling algorithms, Economic lot sizing, Inventory control models | **10** |
| UNIT-5 | *Module-6* | Performance modelling of production lines, Production control mechanisms like Kanban, CONWIP and PLOCA, Futuristic approaches for manufacturing system control | **10** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | On completing the course, students should be able to<br><br>**CO1:** Understand the various strategies involved to overcome the complexities of a manufacturing system.<br><br>**CO2:** Apply decision models to build an efficient manufacturing system.<br><br>**CO3:** Sketch the projections of solids and development of surfaces.<br><br>**CO4:** Demonstrate the shop floor scheduled algorithm with single and mixed modelled assembly lines.<br><br>**CO5:** Make use of control mechanisms like Kanban, CONWIP, PLOCA and other futuristic approaches to generate a flexible manufacturing system. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Miltenburg J., "***Manufacturing Strategy: How to formulate and Implement a winning plan",*** 2nd Ed, Taylor & Francis, ISBN 9781138084001 | 2005 |
| 2. | James L. Riggs J. L., Bedworth D. D., Randhawa S. U., "***Engineering Economics",*** 4th Ed, Tata McGraw Hill, ISBN-0079122485 | 2004 |
| 3. | Ebileng C. E., "***An Introduction to Reliability and Maintainability Engineering",*** McGraw Hill India, ISBN-9780070421387 | 2000 |
| 4. | Askin R. G., Goldberg J.B., "***Design and Analysis of Lean Production Systems",*** John Wiley & Sons(Asia), ISBN- 978-0-471-11593-9 | 2003 |

# Course Code: BME-P522

# Course Name: Soft Computing Techniques

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Programming Skills in C , C + , Matlab and mathematics |
| **Objectives:** | 1. Understand Soft Computing concepts, technologies, and applications<br>2. Understand the underlying principle of soft computing with its usage in various application. .<br>3. Understand different soft computing tools to solve real life problems. |
| **Course Coordinator** | Dr. Jasbir Singh, Mr. Mayank Pokhriyal |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Introduction to soft computing, Introduction to biological and artificial neural networks, Introduction to fuzzy sets and fuzzy logic systems | **05** |
| UNIT-2 | *Module-2* | **Artificial neural networks and applications:** Different artificial neural network models, learning in artificial neural networks, neural network applications in control systems | **08** |
| UNIT-3 | *Module-3* | **Fuzzy systems and applications:** Fuzzy sets, fuzzy reasoning, fuzzy interference systems, fuzzy control, fuzzy clustering, application of fuzzy systems. | **10** |
| UNIT-4 | *Module-4* | **Neuro-fuzzy systems:** Neuro-fuzzy modelling, Neuro-fuzzy control | **04** |
| | *Module-5* | **Genetic Algorithms:** Simple GA, Crossover and mutation, genetic algorithms, in search and optimization. | **05** |
| UNIT-5 | *Module-6* | **Applications:** Pattern Recognitions, Image processing, Biological sequence alignment and drug design, Robotics and sensors, Information retrieval systems, Share market analysis, Natural language processing | **08** |

| Total No. of Hours | | 40 |
|---|---|---|
| **Learning Outcomes:** | Upon successful completion of this course students should be able to:<br>1. Develop application on different soft computing techniques like Fuzzy, GA and Neural network<br>2. Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system. | |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Konar, "***A computational intelligence [i.e. intelligence]: principles, techniques and applications", I st*** Ed, Springer, ISBN- 3-540-20898-4 | 2005 |
| 2. | Friedman M. & Kandel A., "***Introduction to pattern recognition: statistical, structural, neural and fuzzy logic approaches",*** 2 nd vol., World Scientific, ISBN-978-981-02-3312-9 | 1999 |
| 3. | Jang J. S. R., Sun C. T. & Mizutani E., "***Neuro-fuzzy and soft computing: a computational approach to learning and machine intelligence",*** Prantice Hall, ISBN-0-13-261066-3 | 1997 |
| 4. | Mitchell M., "***An introduction to genetic algorithm", 2 nd*** Ed, MIT Press, ISBN-9780262631853 | 1998 |
| 5. | Ross T. J., "***Fuzzy logic with engineering applications", 2 nd*** Ed, John Wiley & Sons, ISBN- 0-470-86075-8 | 2004 |

# Course Code: BME-P523

# Course Name: Advanced Engineering Thermodynamics

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Fundamental Knowledge of Basic Thermodynamics Engineering. |
| **Objectives:** | This course deals with the advance level of Thermodynamics. In this student will learn about entropy generation. Reactive system and its application in Thermodynamics. |
| **Course Coordinator** | Dr. Shobhit Srivastava |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Review of laws of thermodynamics:** Energy concepts for closed and open systems. | **06** |
| UNIT-2 | *Module-2* | **Entropy considerations:** Minimization of entropy generation principle and thermodynamic optimization. | **08** |
| UNIT-3 | *Module-3* | **Energy:** Energy analysis of thermal systems and plants, Thermo-economic applications. | **08** |
| UNIT-4 | *Module-4* | **Phase transition:** Equations of state, Multi- component and multi-phase system, Reactive systems. | **08** |
| UNIT-5 | *Module-5* | Kinetic theory of gases, Distribution of molecular velocities and energy, transport properties of gases | **06** |

| | | | |
|---|---|---|---|
| | *Module-6* | Principles of irreversible thermodynamics and applications. | **04** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | After the completion of this course, student will have a good understanding of entropy, entropy generation systems, reactive system, kinetic theory of gases and applications. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Bejan A., "***Advanced engineering thermodynamics", 3rd*** Ed, John Wiley & Sons, ISBN-978-0-471-67763-5 | 2006 |
| 2. | Bejan A., "***Entropy generation minimization: the method of thermodynamic optimization of finite-size systems and finite time processes",*** 1st Ed, CRC Press, ISBN-9781498782920 | 1995 |
| 3. | Annamalai K. & Puri I.K., "***Advanced thermodynamics engineering",*** 2nd Ed, CRC Press, ISBN- 9781498768412 | 2011 |
| 4. | Wark K., "***Advanced thermodynamics for engineers",*** 1st Ed, Mc-Graw Hill, ISBN-9780070682924 | 1994 |
| 5. | Winterbone D. E., "***Advanced thermodynamics for engineers",2nd*** Ed, Arnold, ISBN- 9780080999838 | 2015 |

# Course Code: BME-P524

# Course Name: Machine Tool Design

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Fundamental Knowledge of Manufacturing Science. |
| **Objectives:** | 1. To gain the knowledge of different drives and mechanisms used in machine tools.<br>2. To gain the knowledge of design of gear boxes & feed boxes used in machine tools.<br>3. To gain the knowledge of design of structures, guide ways, spindles of machine tools.<br>4. To gain the knowledge of various control systems used in machine tools. |
| **Course Coordinator** | Dr. Sanjeev Kumar Lambha |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Developments is machine tools, types of machine tools surface, profits and paths Produced by machine tools. Features of construction and operations of basic machine tools e.g. lathe, drill, milling shapes and planers, grinding machine etc. | **05** |
| | *Module-2* | General requirement of machine tool design. Machine tool design process. Tool wear, force Analysis. | **05** |

| | | | |
|---|---|---|---|
| UNIT-2 | *Module-3* | **Machine Tools Drives:** Classification of machine tool drives, group Vs individual drives, Selection of electric motor, A brief review of the elements of mechanical transmission e.g. gear, belt and chain drives, slider-crank mechanism, cam mechanism, nut & Screw transmission, Devices for intermittent motion, reversing & differential mechanisms | **03** |
| | *Module-4* | Couplings and clutches Elements of hydraulic transmission system. e.g. pumps, cylinder, directional control valves, pressure valves etc. Fundamentals of Kinematics structure of machine tools. | **06** |
| UNIT-3 | *Module-5* | **Regulation of Speed and Feed Rates:** Laws of stepped regulation, selection of range ratio, standard progression ratio, selection of best possible structural diagram, speed chart, Design of feed box. | **03** |
| | *Module-6* | Developing gearing diagrams. Stepless regulation of speed and feed in machine tool, speed and feed control. | **04** |
| UNIT-4 | *Module-7* | **Design of Machine Tool Structure:** Requirements and design criteria for machine tool structures, selection of material Basic design procedure for machine tool structures, design of bed, column and housing, Model technique in design. Design of guideways and power screws. | **03** |
| | *Module-8* | Basic guideway profiles, Designing guideway for stiffness a wear resistance, hydrostatic and antifriction grandways. Design of sliding friction power Screws. Design of spindlier & spindle supports. Layout of bearings, selection of bearings for machine tools | **06** |
| UNIT-5 | *Module-9* | **Dynamics of Machine Tools:** General procedure for assessing the dynamic stability of cutting process, closed loop system, chatter in machine tools. Control $S_y$ stems: Functions, requirements &types of machine tool controls, controls for speed & feed change. Automatic and manual Controls. Basics of numerical controls. Machine tool testing. | **05** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | **CO1:** Understand the basics motion involved in a machine tool with tool geometry of different operations.<br>**CO2:** Understand the different types of machine tool drives and mechanisms used in machine tools.<br>**CO3:** Design different types of speed and feed drives.<br>**CO4:** Design the machine tool structures.<br><br>**CO5:** Apply different control strategies as per the requirements of machine tool operations. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | N.K. Mehta, Machine Tools Design & Numerical Controls, T.M.H. New Delhi. ISBN-10-9781259004575 | 2012 |
| 2. | S.K. Basu, Design of Machine Tools ,Allied Publishers. ISBN-10-8120417771 | 2014 |

| | | |
|---|---|---|
| 3. | Bhattacharya A and Sen.G.C, Principles of Machine Tools, New Central Book Agency. ISBN-10-8173811555 | 2009 |

# Open Elective -I (Fifth semester)

## Course Code: BME-O531
## Course Name: Engineering Economy

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Analysis of Market demand and Survey. |
| **Objectives:** | 1. Emphasizes the systematic evaluation of the costs and benefits associated with proposed technical projects.<br>2. The student will be exposed to the concepts of the "time value of money" and the methods of discounted cash flow.<br>3. Students are prepared to make decisions regarding money as capital within a technological or engineering environment |
| **Course Coordinator** | Mr. Rishi Kumar Prajapati |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | Nature and Purpose of Engineering Economics, Economic Decisions, Role of engineers in Business, Large Scale Engineering Projects, Types of Strategic Engineering. Understanding financial statements: The balance sheet, the income statement, the cash flow statement, The fund flow statement using ratios to make business decisions. | **08** |
| UNIT-2 | *Module-2* | **Demand Analysis:** Meaning of Demand, Types of demand, and Determinants of demand. | **04** |
| | *Module-3* | Elasticity of Demand, Demand Forecasting. | **04** |
| UNIT-3 | *Module-4* | **Production Function:** Input output relationship, Production Function, Least cost combination of Inputs, Returns to scale, Managerial uses of production functions, Economies of scale. | **08** |
| UNIT-4 | *Module-5* | **Cost Analysis and Market Structure:** General cost terms, Classification of costs, Cost concepts Relevant to decision making, Break Even analysis, Cost Volume Profit Analysis. | **05** |
| | *Module-6* | Introduction of different market structures- Perfect competition, Monopoly, Monotheistic competition, Price discrimination, Oligopoly. | **03** |

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|---|---|---|---|
| UNIT-5 | *Module-7* | **Depreciation:** Introduction, Straight line method of depreciation, declining balance method of depreciation-sum of the years digits method of depreciation, sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives - introduction, Examples, Inflation adjusted decisions -procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset. | **08** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | 1. Describe the role of economics in the decision making process and perform calculations in regard to interest formulas<br>2. Estimate the Present, annual and future worth comparisons for cash flows<br>3. Calculate the rate of return, depreciation charges and income taxes<br>4. Enumerate different cost entities in estimation and costing<br>5. Explain the importance of finance functions, financial ratios and solve related problems<br>6. Explain the elements of budgeting and bench marking<br>• |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Chan S. Park, Contemporary Engineering Economics, Prentice Hall (3/e) 2002. ISBN 978- 0-13-277542-7 | 2002 |
| 2. | Mote VL and Paul Samuel, Managerial Economics Concepts and Cases. ISBN-10- 0070965188 | 2017 |
| 3. | K.K. Dewett, "Modern Economics Theory, 1997, S. Chand & Co., New Delhi. ISBN-10- 8121924634 | 1997 |

# Course Code: BME-O532
# Course Name: Cloud Computing

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | |
| **Objectives:** | The course has following objectives:<br>1 To understand the concepts of Cloud Computing.<br>2 To learn Taxonomy of Virtualization Techniques.<br>3 To learn Cloud Computing Architecture.<br>4 To acquire knowledge on Aneka Cloud Application Platform.<br>5 To learn Industry Cloud Platforms. |
| **Course Coordinator** | Dr. Mayank Agarwal, Dr. Nishant Kumar |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Overview of cloud computing:** What is a cloud, Definition of cloud, Characteristics of cloud, why use clouds, how clouds are changing, driving factors towards cloud, Comparing grid with cloud, Public clouds (commercial) | **7** |
| UNIT-2 | *Module-2* | **Cloud computing concepts:** Concepts of cloud computing, Cloud computing leverages the Internet, Positioning cloud to a grid infrastructure, Elasticity and scalability, Virtualization, Characteristics of virtualization, Benefits of virtualization, Virtualization in cloud computing, Hypervisors, Multitenancy, Types of tenancy, Application programming interfaces (API), Billing and metering of services, Management, tooling, and automation in cloud computing. | **7** |
| UNIT-3 | *Module-3* | **Cloud service delivery:**Cloud service, Cloud service model architectures, Infrastructure as a service (IaaS) architecture, Infrastructure as a service (IaaS) details, Platform as a service (PaaS) architecture, Platform as a service (PaaS) details, Platform as a service (PaaS), Examples of PaaS software, Software as a service (SaaS) architecture, Software as a service (SaaS) details, Examples of SaaS applications, Trade-off in cost to install versus, Common cloud management platform reference architecture: Architecture overview diagram, Common cloud management platform, Database as a Service - Monitoring as a Service – Communication as services. | **7** |
| UNIT-4 | *Module-4* | **Cloud deployment scenarios:** Cloud deployment models, Public clouds, Hybrid clouds, Community, Virtual private clouds, Vertical and special purpose, Migration paths for cloud, Selection criteria for cloud deployment, Case study example: AWS Platform. Virtualization for Cloud Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization –System Vm, Process VM, Virtual Machine monitor – Virtual machine properties - Interpretation and binary translation, HLL VM - Hypervisors – Xen, KVM, VMWare, Virtual Box, Hyper-V | **6** |
| UNIT-5 | *Module-5* | **Security in cloud computing:** Cloud security reference model, how security gets integrated, Cloud security, understanding security risks, Principal security dangers to cloud computing, Data corruption or loss, User account and service hijacking, Steps to reduce cloud security breaches. | **6** |
| | *Module-6* | **Classification of Cloud Implementations**: Amazon Web Services, The Elastic Compute Cloud (EC2). The Simple Storage Service (S3), The Simple Queuing Services (SQS), Google AppEngine - PaaS, Windows Azure; Aneka, Hadoop, A Comparison of Cloud Computing Platforms | **7** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | At the end of this course student will be able to:<br>1 Understand the concept of virtualization and how this has enabled the development of<br>2 Cloud Computing<br>3 Know the fundamentals of cloud, cloud Architectures and types of services in cloud<br>4 Understand scaling, cloud security and disaster management<br>5 Design different Applications in cloud<br>6 Ability to use AWS/IBM Cloud/Google cloud |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Buyya Rajkumar, "***Practices and paradigms in cloud computing",*** **1st** Ed, Wiley, ISBN- 978-8126541256 | 2013 |
| 2. | Miller Michael, "***Cloud Computing",*** 1st Ed, Que Publishing, ISBN-978-0789738035 | 2008 |
| 3. | Jasm Kris, "***Cloud computing",*** **1st** Ed, Jones and Barret India, ISBN-978-1449647391 | 2012 |
| 4. | Velte Anthony, Velte Toby and Elsenpeter Robert, "***Cloud Computing: A practical approach",*** 1st Ed, Tata McGraw Hill, ISBN-978-0070683518 | 2009 |
| 5. | Hurwitz Judith, Bllor Robin, Kaufman Marcia and Halper F, "***Cloud computing for dummies",*** 1st Ed, Wiley, ISBN-978-8126524877 | 2009 |

# Course Code: BME-O533

# Course Name: Automatic Control System

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | |
| **Objectives:** | The course has following objectives:<br>1. To introduce the fundamentals of modeling, analysis and response of control systems in continuous and discrete data systems.<br>2. To familiarize students with classical and modern control systems including non-linear systems. |
| **Course Coordinator** | Mr. Gajendra Singh Rawat |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Control System:** Open loop & closed control; servomechanism, Physical examples. Transfer Functions, Block diagram algebra, Signal flow graph, Mason's gain formula Reduction of parameter variation and effects of disturbance by using negative feedback. | **7** |
| UNIT-2 | *Module-2* | **Time Response Analysis:** Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants Design specifications of second order systems: Derivative error, derivative output, integral error and PID compensations, design considerations for higher order systems, performance indices | **7** |
| UNIT-3 | *Module-3* | **Control System Components:** Constructional and working concept of ac servomotor, synchros and stepper motor.<br>**Stability and Algebraic Criteria:** Concept of stability and necessary conditions, Routh- Hurwitz criteria and limitations.<br>**Root Locus Technique:** The root locus concepts, construction of root loci. | **7** |

| | | | |
|---|---|---|---|
| UNIT-4 | *Module-4* | **Frequency Response Analysis:** Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots.<br>**Stability in Frequency Domain:** Nyquist stability criterion, assessment of relative stability: gain margin and phase margin, constant M&N circles. | **6** |
| UNIT-5 | *Module-5* | **Introduction to Design:** The design problem and preliminary considerations lead, lag and lead-lag networks, design of closed loop systems using compensation techniques in time domain and frequency domain | **6** |
| | *Module-6* | **Review of State Variable Technique:** Review of state variable technique, conversion of state- variable model to transfer function model and vice- versa, diagonalization, Controllability and observability and their testing | **7** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | At the end of this course student will be able to:<br>Understand the general concept of a system and classify systems into different types and represent a system using different techniques like block diagram, signal flow graph.<br>2. Develop transfer function model of mechanical, electrical, thermal, fluid system and different control system components like servomotors, synchronous, potentiometer, Tacho-generators etc.<br>3. Analyze system response and evaluate error dynamics in time domain.<br>4. Determine system stability using Routh-Hurtwitz (RH) criteria, root locus techniques in time domain and Bode plot and Nyquist technique in frequency domain.<br>5. Design different control law or algorithms like proportional control, proportional plus derivative(PD) control, proportional plus integration(PI) control, and proportional plus integration plus derivative (PID) control and different compensators like lag, lead, lag- lead. |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Nagrath & Gopal, Control System Engineering, 4th Edition, New age International ISBN-10-9789386070111 | 2008 |
| 2. | K. Ogata, Modern Control Engineering, Prentice Hall of India, ISBN-10-0136156738 | 2009 |
| 3. | Norman S. Mise, Control System Engineering 4th edition, Wiley Publishing Co | 2006 |
| 4. | M.Gopal, Control System; Principle and design, Tata McGraw Hill ISBN-9780070482890 | 2002 |
| 5. | D.Roy Choudhary, Modern Control Engineering, Prentice Hall of India. ISBN: 9788120321960, | 2005 |

# Course Code: BME-O534

# Course Name: Composite Materials

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| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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| **Prerequisites:** | Strength of material, Material Science. |
| **Objectives:** | 1. To understand the mechanical behaviour of composite materials<br>2. To get an overview of the methods of manufacturing composite materials |

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| **Course Coordinator** | Mr. Mayank Pokhriyal |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. | **03** |
| | *Module-2* | Lamina-assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, and transformed stiffness. | **04** |
| UNIT-2 | *Module-3* | Manufacturing of composite materials, hand layup processes – spray up process | **03** |
| | | compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding | **05** |
| UNIT-3 | *Module-4* | Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties | **03** |
| | *Module-5* | Determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates. | **06** |
| UNIT-4 | *Module-6* | Characteristics of MMC, various types of metal matrix composites, alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. | **03** |
| | *Module-7* | Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries | **05** |
| UNIT-5 | *Module-8* | Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies. Testing of composites: | **04** |
| | *Module-9* | Physical, Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties | **04** |
| **Total No. of Hours** | | | **40** |

CO1 Define-Definition and applications of composite materials,Fibers-glass, carbon, ceramic and aramid fibers;Matrices-polymer, graphite, ceramic and metal matrices

CO2 Determine-Determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials,generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates

CO3 Make use of-Manufacturing of composite materials ,hand layup processes– spray up process

CO4 Classify-orthotropic stiffness matrix, commercial material properties,rule of mixtures, transformation matrix, and transformed stiffness

CO5 Identify- Lamina-assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limitcase,

CO6 ExplainTsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates

CO7 Illustrate- Basic assumptions of laminated anisotropic plates,symmetric laminates, angle ply laminates, crossply laminates, laminate structural moduli, evaluation of lamina properties

CO8 Choose- Characteristics of MMC, various types of metal matrix composites, alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements particles– fibres. Effect of reinforcement–volume fraction – rule of mixtures

CO9 Compare- Processing of MMC – powder metallurgy process –diffusion bonding–stir casting– squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties.

CO10 Develop-Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill | 1994 |
| 2. | Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill. | 1998 |
| 3. | Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England. | 1994 |
| 4. | Chawla K. K., "Composite materials", Second Edition, Springer – Verlag. | 1998 |

# Course Code: BME-O535
# Course Name: Machine Learning

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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| **Prerequisites:** | Understanding of Basic Programming Concept and Mathematics (probability and statistics). |
| **Objectives:** | The course has following objectives<br>To learn the fundamentals of Machine Learning.<br>To understand basic component of an intelligence system. To explore applications of machine learning.<br>To understand different types of machine learning algorithms and tools. To learn how to use machine learning model to solve real world problem. |
| **Course Coordinator** | Dr. Suyash Bhardwaj |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | Introduction to Machine Learning, Difference between Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL), Applications of Machine Learning, Limitations or need for applying ML algorithms, Types of Machine Learning and their use cases, Types of problem – Regression and Classification, Types of data – Structured Data and Unstructured Data. Batch and online learning. | **03** |
| UNIT-2 | *Module-2* | Tools required for machine learning- Python Libraries (Numpy, Pandas, Matplotlib etc), Framework for machine learning algorithm (Scikit- learn, TensorFlow, Keras, Anaconda, Google Colab etc), Popular ML Datasets (MNIST Dataset, IRIS Dataset, Wine quality dataset, ImageNet, IMDB reviews, Recommender Systems Dataset etc), Data repositories sources for machine learning practices (UCI Machine learning repository, Kaggle, Wikipedia, CMU, Google Dataset Search, The Big Bad NLP Database etc). | **12** |
| UNIT-3 | *Module-3* | Basic concept of Probability theory and Linear Algebra, Bias, Variance, Bias-Variance tradeoff, overfitting and underfitting. Pre-processing of data - Data cleaning, wrangling and filtering, Handling missing and categorical data, Data scaling, Feature extraction and selection, covariance matrix, Dimensionality Reduction, Train-Test splitting strategy, Training Set, Validation Set, Test Set, Importance of cross validation – Holdout Method and K-fold cross validation. | **05** |
| UNIT-4 | *Module-4* | Introduction to performance metrics for Machine Learning Algorithm – Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Confusion Matrix, Classification Accuracy, Classification Report (Precision, Recall/Sensitivity, Specificity, F1-Score, Area Under ROC curve). Fine tuning of model – Grid Search, Randomized Search, Ensemble Method. Concept of Bagging. | **15** |
| UNIT-5 | *Module-5* | Introduction to regression problems, Types of regression – Linear Regression, Logistic Regression, Polynomial Regression. Introduction to classification problems and Types of classification - Binary Classification, Multi-Class Classification, Multi-Label Classification, Imbalanced Classification. Introduction to reinforcement learning and types - Model-Free and Model-Based RL.. | **05** |
| **Total No. of Hours** | | | **40** |

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| **Learning Outcomes:** | understand a wide variety of **learning** algorithms. Understand how to evaluate models generated from data. Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Introduction to Machine Learning, Alpaydin, E., MIT Press, 2004 | 2004 |
| 2. | Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller and Sarah Guido, O'Reilly, 2016 | 2016 |

**GURUKULA KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR**
**Faculty of Engineering & Technology**
**Mechanical Engineering**
**B. Tech. Fourth Year**
**Syllabus in accordance with AICTE Model Curriculum**

## B.Tech. IV Year
## Semester – VII

| S. NO. | COURSE CODE | COURSE OPTED | COURSE NAME | Period per week | | | EVALUATION SCHEME | | | | Credit | Subject TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SESSIONAL EXAM. | | | EXAM. ESE | | |
| | | | | L | T | P | CT | TA | TOTAL | | | |
| **THEORY SUBJECTS** | | | | | | | | | | | | |
| 1 | BME-C711 | PCC | Refrigeration & Air Conditioning | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 2 | BME-C712 | PCC | Maintenance Management | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 3 | BME-P72X | PEC | Program Elective-IV | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 4 | BME-P72X | PEC | Program Elective-V | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| 5 | BME-O73X | OEC | Open Elective-III | 3 | 0 | 0 | 20 | 10 | 30 | 70 | 3 | 100 |
| **PRACTICAL / TRAINING / PROJECT** | | | | | | | | | | | | |
| 6 | BME-C761 | PCC | Refrigeration & Air ConditioningLab | 0 | 0 | 2 | 10 | 05 | 15 | 35 | 1 | 50 |
| 8 | BME-C770 | PCC | Project-III | 0 | 0 | 8 | 40 | 20 | 60 | 140 | 4 | 200 |
| | | | **TOTAL** | **15** | **0** | **10** | **150** | **75** | **225** | **525** | **20** | **750** |

**NOTE:** *Electives will be offered depending upon the availability of teaching staff and minimum thirty students should opt for a particular elective.*

**L**-Lecture; **T**-Tutorial; **P**-Practical; **CT**-Cumulative Test; **TA**- Teacher Assessment; **ESE** End Semester Examination; **BSC-**Basic Science Course; **ESC-** Engineering Science Courses; **PEC-**Program Elective Course; **SEC-** Skill Enhancement Course; **AECC-** Ability Enhancement Compulsory Course; **HSMC-**Humanities, Social Science & Management Course

**Grading & Grade Points: O(**Outstanding**)= 10; A$^{+}$(**Excellent**)= 9; A(**Very Good**)= 8; B$^{+}$(**Good**)= 7; B(**Above Average**)= 6; C(**Average**)= 5; P(**Pass**)= 4; F(**Fail**)= 0; Ab(**Absent**)= 0**

## Program Elective -IV & V (Seventh semester)

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|---|---|
| BME-P721 | Computer Aided Design |
| BME-P722 | Advanced Machining Processes |
| BME-P723 | Advanced Welding Processes |
| BME-P724 | Non-Traditional & Computer Aided Manufacturing |
| BME-P725 | Power Plant Engineering |
| BME-P726 | Simulation of Mechanical Systems |
| BME-P727 | Additive Manufacturing |
| BME-P728 | Finite Element Methods |
| BME-P729 | Automobile Engineering |

## Open Elective -III (Seventh semester)

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|---|---|
| BME-O731 | Nanotechnology and Nano computing |
| BME-O732 | Artificial Intelligence and Robotics |
| BME-O733 | Energy Resources and Management |
| BME-O734 | Engineering System Design Optimization |

# Course Code: BME-C711

## Course Name: Refrigeration & Air Conditioning

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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|---|---|
| **Prerequisites:** | Fundamental Knowledge of Thermodynamics. |
| **Objectives:** | ● To familiarize with the terminology associated with refrigeration systems and air conditioning.<br>● To understand basic refrigeration processes.<br>● To understand the basics of psychrometry and practice of applied psychometrics.<br>● To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components. |
| **Course Coordinator** | Mr. Yogesh Kumar |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Refrigeration:** Introduction to refrigeration system, Methodsof refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P. | **02** |
| | *Module-2* | **Air Refrigeration Cycle:** Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART). | **06** |
| UNIT-2 | *Module-3* | **Vapour Compression System:** Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Advanced vapour compression cycles, Different configuration of multistage system, Cascade system | **08** |
| UNIT-3 | *Module-4* | **Vapour Absorption System:** Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram, Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison. | **06** |

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|---|---|---|---|
| | *Module-5* | **Refrigerants:** Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone depletion and global warming issues | **02** |
| UNIT-4 | *Module-6* | **Air Conditioning:** Introduction to air conditioning, Psychometric properties, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). | **08** |
| UNIT-5 | *Module-7* | **Refrigeration Equipment & Application:** Elementary knowledge of refrigeration & air conditioning equipments eg compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning | **08** |
| **Total No. of Hours** | | | **40** |

**Course Outcomes:** At the end of the course, the student will be able to

**CO1:** Define the concept of refrigeration and its unit, COP, Dry air rated temperature (DART), Refrigerant, Sensible heat factor (SHF), Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).
**CO2:** Explain working Principal of vapour absorption refrigeration system, Carnot refrigeration cycle Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, air conditioning cycle, properties of refrigerants.
**CO3:** Compare between absorption & compression systems, Ammonia-Water and Lithium-Bromide water vapour absorption system, Single stage and multi-stage vapour compression cycle, comfort and industrial air conditioning.
**CO4:** Classify methods of refrigeration, methods of air conditioning, classification of refrigerants, psychometric processes, Vapour absorption system, Vapour compression system.
**CO5:** Determine COP of refrigerator and air conditioner, capacity of the refrigerator, cooling performance, heat rejection capacity, power required to refrigerator and air conditioning system, Effect of refrigerant, intercooling, cascade system, sub cooling, and superheating.

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Manohar Prasad, ***"Refrigeration and Air conditioning",*** 3rd edition, New Age International (P) Ltd. Publication ISBN- 978-8122436945 | 20<br>20 |
| 2. | C P Arora**,** ***"Refrigeration and Air conditioning",*** 3rd edition, McGraw Hill Education,<br>ISBN- 978-9351340164 | 20<br>17 |
| 3. | W. F. Stoecker, J. W. Jones, ***"Refrigeration and Air conditioning",*** McGraw Hill India, Publisher, ISBN- 9789332902954 | 20<br>14 |
| 4. | P.L. Ballaney**,** ***"Refrigeration and Air conditioning",***16th edition, Khanna Publishers<br>,<br>ISBN- 978-8174091369 | 19<br>72 |

# Course Code: BME-C712

# Course Name: Maintenance Management

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 1 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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|---|---|
| **Prerequisites:** | English language |
| **Objectives:** | • To ensure that equipment and infrastructure are always in good condition.<br>• To carry out prompt emergency repair of equipment and infrastructure so as to secure the best possible availability for production.<br>• To ensure the operation of equipment for production and for the distribution of energy and fluids. |
| **Course Coordinator** | Dr. Sunil Kumar |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Introduction, operating life cycle, reliability, Failure analysis, failure rate curve, elements in series, parallel, logic diagrams, improving reliability, maintainability, availability, reliability and maintainability. | **08** |
| UNIT-2 | *Module-2* | **Maintenance Strategies**: Break down maintenance, planned maintenance, strategies, preventive maintenance, design out maintenance, planned lubrication, total productive maintenance, and zero break down. | **08** |
| UNIT-3 | *Module-3* | Replacement planning maintain or replace decision, replacement of items that deteriorate identical equipment, replacement of items that fail without deterioration individual, group replacement, replacement in anticipation of failure. | **08** |
| UNIT-4 | *Module-4* | Break down maintenance planning, assignment model, minimum cost service rate. | **08** |
| UNIT-5 | *Module-5* | Maintenance Management, production maintenance system, objectives and functions, forms, policy, planning, organization, economics of maintenance, manpower planning, materials planning, spare parts planning and control, evaluation of maintenance management. | **08** |
| **Total No. of Hours** | | | **40** |

| CO No. | Course Outcomes |
|---|---|
| CO-1 | Explain maintenance objectives and functions, need for maintenance plan and organization, Functions of maintenance control and determine Failure probability. |

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|---|---|
| CO-2 | Gain the necessary knowledge about the types of maintenance and know how to use them when design maintenance systems. |
| CO-3 | Explain different maintenance systems and the steps involved in establishing a maintenance. |
| CO-4 | Explain different maintenance management objective and economics point of view. |
| CO-5 | Different type equipment and tool used in maintenance and management. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Nauhria & Prakash, ***Management of systems***, Wheeler publishing, ISBN-9788185814520 | 1998 |
| 2. | V. Venkataraman , ***Maintenance engineering and management,*** *Prentice Hall India Learning Private Limited,* ISBN- 978-8120331303 | 2007 |
| 3 | H P Garg, ***Industrial Maintenance,*** S. Chand Publishing, ISBN- 9788121901680 | 2010 |
| 4. | R.C Mishra, ***Maintenance Engineering and Management,*** Prentice Hall India Learning Private Limited; 2nd edition, ISBN- 978-8120345737 | 2012 |

# Course Code: BME-C761

# Course Name: Refrigeration & Air Conditioning Lab

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|---|---|
| **MM: 50**<br>**Time: 2 Hr.**<br>**L T P**<br>**0 0 2** | **Sessional: 15**<br>**ESE: 35**<br>**Credit : 1** |

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|---|---|
| **Prerequisites:** | Fundamental Knowledge of Refrigeration cycle and air conditioning equipment. |
| **Objectives:** | ● To understand the practical knowledge of vapour compression cycle.<br>● To understand the practical knowledge of air conditioning test rig.<br>● To understand the practical knowledge of ice plant test rig.<br>● To understand the practical knowledge of different devices used in industry. |
| **Course Coordinator** | Mr. Kapil Dev Sharma |

| Module | Course Content | No. of Hours |
|---|---|---|
| *Experiment-1* | Experiment on refrigeration test rig and calculation of various performance parameters | **02** |
| *Experiment-2* | Experiment on air-conditioning test rig & calculation of various performance parameters. | **02** |
| *Experiment-3* | Experiment on Ice-plant test rig & calculation of various performance parameters. | **02** |
| *Experiment-4* | To study different types of expansion devices used in refrigeration system. | **02** |
| *Experiment-5* | To study different types of evaporators used in refrigeration systems. | **02** |
| *Experiment-6* | To study basic components of air-conditioning system. | **02** |

| | | |
|---|---|---|
| *Experiment-7* | To study air washer system and processes. | **02** |
| *Experiment-8* | To study the window air conditioner | **02** |
| **Total No. of Hours** | | **16** |

**Course Outcomes:** At the end of the course, the student will be able to

**CO1:** Understand the working of refrigeration system and air conditioning system.
**CO2:** Demonstrate the operation of refrigeration and air conditioning system.
**CO3:** Define the importance of various important components of refrigeration and air conditioning system.
**CO4:** Compare various processes of the vapour compression cycle of psychometric chart.
**CO5**: What is the fundamental principles of vapour compression cycle used in refrigeration and air conditioning cycle.

**NOTE**

1. In practical examination the student shall be required to perform one experiment.
2. A teacher shall be assigned 20 students for daily practical work in laboratory.
3. No batch for practical class shall consist of more than 20 students.
4. The number of students in a batch allotted to an examiner for practical examination shall not exceed 20 students.
5. Addition/deletion in above list may be made in accordance with the facilities available with the approval of H.O.D./Dean.

## Course Code: BME-C770
## Course Name: Project-III

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|---|---|
| **MM: 200** | **Sessional: 60** |
| **Time: 2 Hr.** | **ESE: 140** |
| **L T P** | **Credit : 4** |
| **0 0 8** | |

**COURSE OBJECTIVE:**

- To enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor.
- To provide a good initiation for the student(s) in R&D work.
- Survey and study of published literature on the assigned topic.
- Working out a preliminary Approach to the Problem relating to the assigned topic
- Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
- Preparing a Written Report on the Study conducted for presentation to the Department.
- Preparing a Written Report on the Study conducted for presentation to the Department.
- Improve upon the communication and presentation skills.

Each student shall be assigned a Minor Project by Departmental committee. The student is required to perform his project work under the supervision of the supervisor(s). There shall be a presentation on the project work of the student to be evaluated by a departmental committee chaired by H.O.D. The student is required to submit his project report along with a research paper in the form of Dissertation 15 days before the end of VII semester. The student is required to submit three copies of the project work with a certificate from the supervisor(s) that the work is an authentic record of the work performed by him. The report shall be forwarded by H.O.D. The report of the project work shall be evaluated by the external examiner(s). The same external examiner(s) shall hold the viva-voce examination.

**COURSE OUTCOME:**

- Students will get knowledge of problem identification and use their skills for teambuilding and project development.
- Develop a solution for any real world problem.
- Students will get equipped with knowledge of latest/upcoming problems and solutions.
- Students will also be able to improve skills for project planning, implementation and communication.

**NOTE:**

- Marks for the project work shall be awarded jointly by the external and internal examiners after viva-voce examination.
- There shall be a seminar on the project work of the student to be evaluated by the Departmental committee chaired by H.O.D.

**TEXTBOOKS:**

1. Ford, Neal, Matthew McCullough and Nathaniel Schutta, Presentation patterns: Techniques for crafting better presentations (1 ed.), Addison- Wesley, 2012. ISBN 978- 0321820808.

# Course Code: BME-P721

# Course Name: Computer Aided Design

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Programming in C and Basic Algebra |
| **Objectives:** | The primary objective of the course is to introduce the student to working with discretised geometry in design of mechanical components and representations of shapes. It is intended to be a first course on Finite Element Techniques and CAD tools like surface and solid<br>modelling. They will also practice on AUTOCAD and CREO. |
| **Course Coordinator** | Dr. Sanjeev Kumar Lambha |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction and Review of Computer Programming:** Introduction to CAD/CAE, Element of CAD, Concepts of integrated CAD/CAM, CAD Engineering applications, its importance & necessity. Review of C, C++, statements such as if else for while & switch, functions, pointer notations, structure & class, concept of OOP. | **04** |
| | *Module-2* | **Computer Graphics I -** Computer systems, Graphics input devices- cursor control devices, Digitizers, Scanners, speech oriented devices and touch panels, Graphics display devices CRT, colour CRT monitors, DVST, Flat- panel display, Graphics output Devices. | **04** |

| | | | |
|---|---|---|---|
| UNIT-2 | *Module-3* | **Computer Graphics-II:** Graphics software, Graphics functions, output primitives- Bresenhams line drawing and Mid-point circle algorithms. | **03** |
| | *Module-4* | **Geometric Transformations -** Word/device co- ordinate representations, 2D and 3D geometric transformations, Matrix representation-translation, scaling, shearing, rotation and reflection, composite transformations, concatenation, rotation about arbitrary axis. Exercise and programs. | **05** |
| UNIT-3 | *Module-5* | **Plane Curves:** Curve representation, Interpolations Vs approximation, Parametric Continuity conditions, Spline Curves- Hermit spline, Bezier spline and B- spline Curves and its Properties. | **05** |
| | *Module-6* | **3-D Graphics:** Polygon surfaces Polygon mesh representations, Quadric and Super quadric surfaces and Blobby objects, Fractals. Solid modelling- wire mesh and sweep representation, constructive solid geometry, Boolean operations, Boundary representations. Colour models. | **05** |
| UNIT-4 | *Module-7* | **Computer Aided Design of Machine Elements and other Systems:** CAD of machine elements such as shaft, springs, bearings and problems from other systems such as heat exchanger, inventory control etc. Writing Computer program in C, Drafting/Design of software such as Auto-CAD and Pro-E. | **06** |
| UNIT-5 | *Module-8* | **Numerical Methods:** Introduction, Errors in numbers, Binary, octal and Hexadecimal number representation. Root-finding & Optimisation. Interactive methods- Bisection method, Regula- Falsi method, Newton Raphson method, Interpolation- Lagrange and Newton s interpolation, Curve fitting-Least Square method, Numerical differentiation-interpolation methods, Numerical integration- Trapezoidal and Simpson Method. | **05** |
| | *Module-9* | **Finite Element Methods -** Introduction and Application of FEM, Stiffness Matrix/ Displacement Matrix, One/Two Dimensional bar & beam element (as spring system) analysis. | **03** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | **CO1:** Understand the basics of computer graphics for developments of CAD models.<br><br>**CO2:** Apply Geometric transformations to create solid models using CAD tools.<br><br>**CO3:** Illustrate and draw various curves used in CAD drawings.<br><br>**CO4:** Design the basic drawing of mechanical components such as shafts, springs, bearings, heat exchangers using CAD software i.e. AUTOCAD.<br><br>**CO5:** Apply numerical methods for the modelling of CAD models. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | McConnell, J. J., "***Computer graphics theory into practice****", Illustrated edition,* Jonesand Bartlett Publishers, ISBN- 978-0763722500 | 2005 |

| | | |
|---|---|---|
| 2. | Davis, M. J., "***Computer Graphics****",* UK Ed., Nova Science Pub Inc, ISBN- 978-1617618116 | 2011 |
| 3. | Rogers, D. F., Earnshaw, R. A., Graphics, B. C. S. C., Group, D., & Society, C. G. "***Computer graphics techniques theory and practice****", 1990 Ed.* Springer-Verlag, ISBN- 978-0387972374 | 1990 |
| 4. | Salomon, D., "***Transformations and projections in computer graphics****"* Springer, ISBN- 978-1846283925 | 2006 |
| 5. | Bethune, J. D., "***Engineering Design and Graphics with SolidWorks****"* Prentice Hall, ISBN- 978-0135024294 | 2009 |
| 6. | Zeid, I., "***Mastering CAD/CAM (Engineering Series)****",* 2nd Ed., McGraw-Hill Higher Education, ISBN- 978-0070634343 | 2006 |
| 7. | NPTEL courses *http//nptel.iitm.ac.in/courses.php*- web and video resources on *Computer Aided Design and Manufacturing.* | |


# Course Code: BME-P722

# Course Name: Advanced Machining Processes

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Conventional Machining Processes. |
| **Objectives:** | • To identify the classification of unconventional machining processes.<br>• To understand the principle, mechanism of metal removal of various unconventional machining processes.<br>• To understand the applications of different processes.<br>• To study the various process parameters and their effect on the component machined on various unconventional machining processes |
| **Course Coordinator** | Mr. Rishi Kumar Prajapati |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Limitations of conventional manufacturing processes, need of unconventional manufacturing processes and its classification. | **08** |
| | *Module-2* | **Unconventional Machining Process**: Principle and working and applications of unconventional machining process such as Electro-Discharge machining, Electro-chemical machining, ultrasonic machining, Abrasive jet machining etc. | |
| UNIT-2 | *Module-3* | **Principle and working and application of unconventional machining processes** such as laser beam machining, Electron beam machining, Ultrasonic machining etc. | **08** |
| UNIT-3 | *Module-4* | **Unconventional Welding Processes:** Explosive welding, Cladding etc. Under water welding, Metallizing, Plasma arc welding/cutting etc. | **08** |

| | | | |
|---|---|---|---|
| UNIT-4 | *Module-5* | **Unconventional Forming Processes**: Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro-Discharge forming, water hammer forming, explosive compaction etc. | **08** |
| UNIT-5 | *Module-6* | **Introduction to the Basic Principles of Additive Manufacturing/ digital Manufacturing**: Advantages and limitations of AM technologies AS | **08** |
| | | developing new engineering systems, identifying emerging opportunities in developing products for mass customization. Additive Manufacturing Processes | |
| **Total No. of Hours** | | | **40** |

| CO No. | Course Outcomes |
|---|---|
| CO-1 | Understand the needs and classification of unconventional machining process. |
| CO-2 | Understand the principle of working, mechanism of metal removal in the various unconventional machining process. |
| CO-3 | Understand the basic techniques of machining processes |
| CO-4 | The student is able to identify the process parameters, their effect and applications of different processes. |
| CO-5 | Estimate the material removal rate and cutting force, in an industrially useful manner, for practical machining processes. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | P.C. Pandey***, Modern Machining Processes,*** McGraw Hill Education, ISBN- 978-0070965539 | 1980 |
| 2. | V.K Jain, ***Unconventional Machining,*** Allied Publishers Pvt. Ltd.; 1st Ed., ISBN-978-8177642940 | 2019 |
| 3. | Ian Gibson, David W. Rosen, Brent Stucker, "***Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing***", 1st Ed., Springer Publ., ISBN- 978-1-4419-1119-3 | 2010 |

# Course Code: BME- P723

# Course Name: Advanced Welding Processes

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Conventional welding and Weld Design |

| | |
|---|---|
| **Objectives:** | • Able to get the knowledge of various conventional and advanced welding techniques which make them interested to choose a career in the field of welding.<br>• To impart knowledge on various advanced welding processes so that the students can apply them in engineering industry applications.<br>• To develop the knowledge on the design of welded joints and the quality control of weldments. |
| **Course Coordinator** | Mr. Yogesh Kumar |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction:** Importance and application of welding, classification of welding process. Selection of welding process. | **03** |
| | *Module-2* | **Review of conventional welding process:** Gas welding, Arc welding, MIG, TIG welding. Resistance welding. Electro slag welding, Friction welding etc. Welding of MS.CI, Al, Stainless Steel & Maurer/Schacfflar Diagram. Soldering & Brazing | **05** |
| UNIT-2 | *Module-3* | **Advanced welding Techniques:** Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc. | **07** |
| UNIT-3 | *Module-4* | **Advanced welding Techniques (continued):** Principle and working and application of advanced welding techniques such as explosive welding/ cladding, | **03** |
| | *Module-5* | Underwater welding, Spray-welding /Metallizing, Hard facing. | **06** |
| UNIT-4 | *Module-6* | **Weld Design:** Welding machines/equipments and its characteristics. Weld defects and distortion and its remedies, Inspection/testing of welds | **05** |
| | *Module-7* | Macrostructure & microstructure of welds, HAZ, Weld Design, Welding of pipe-lines and pressure vessels. Life predication. | **04** |
| UNIT-5 | *Module-8* | **Thermal and Metallurgical Consideration:** Thermal considerations for welding, temperature Distribution, Analytical analysis, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties. | **08** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | At the end of the course students are able to:<br>● Apply the knowledge of solid state welding process for engineering applications.<br>● Understand the principles of radiant energy metal joining process<br>● Understand the fundamental principles of special arc welding process.<br>● Understand the knowledge of plasma arc in metal joining and cutting process.<br>● Understand the knowledge of design principles in weld joints. Apply the concept of quality control and testing of weldments in industrial environment. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Bruce Stirling **,** ***Text Book Of Welding Technology,*** Dhanpat Rai Publications, ISBN- 978-8189928360 | 2013 |
| 2. | Richard L. Little,***Welding and Welding Technology,*** McGraw-Hill Inc., ISBN- 978-0070380950 | 1973 |
| 3 | Parmer R. S., ***'Welding Engineering and Technology'***, Khanna Publishers, 2nd Ed., ISBN- 978-8174091260 | 1996 |
| 4 | Bowditch, William A., Bowditch, Kevin E., Bowditch, Mark A, ***Welding Technology Fundamentals,*** **4th Ed.,** Goodheart-Willcox Co., ISBN- 978-1605252568 | 2009 |

# Course Code: BME-P724

# Course Name: Non-Traditional and Computer Aided Manufacturing

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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|---|---|
| **Prerequisites:** | The student should have completed 2 semesters of UG Engg. |
| **Objectives:** | ● To acquaint and equip with the Computer Aided Design and manufacturing of farm machinery with the help of CAD |
| **Course Coordinator** | Mr. Kapil Dev Sharma |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | ***Non-Traditional Manufacturing***<br>**Introduction**: Classifications of material removal processes. Characteristics of conventional material removal (machining) processes. Need for non-conventional or non-traditional processes. | **8** |

| | | | |
|---|---|---|---|
| UNIT-2 | *Module-2* | ***Non-Traditional Manufacturing***<br>**Process Description, Modelling, Application and Product Quality Related Issues**: Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, Abrasive Water Jet Machining, Electro-Discharge Machining, Chemical & Photo Chemical Machining, Electro-Chemical Machining, Electron Beam Machining, Laser Beam Machining. | **8** |
| UNIT-3 | *Module-3* | ***Non-Traditional Manufacturing***<br>**Advanced Topics:** Basic introduction to Chemical, physical vapour deposition processes, Thermal spraying processes, Hybrid processes like electro-jet drilling, electro chemical grinding, electro-chemical discharge machining. Rapid prototyping. | **8** |
| UNIT-4 | *Module-4* | ***Computer Aided Manufacturing***<br>**Introduction**: Relation between production volume and flexibility. Various manufacturing systems – batch, mass, group, cellular and flexible manufacturing systems; Type of automation and benefits of soft or flexible automation. | **6** |
| | *Module-5* | Automation in Material Handling and Assembly | **2** |
| UNIT-5 | *Module-6* | ***Computer Aided Manufacturing***<br>**CNC Machines**: Introduction, classification, design and control features including interpolations. | **3** |
| | *Module-7* | NC Part-Programming | **2** |
| | *Module-8* | **Introduction to Robotics**: Definitions, motivation, historical development. Basic structure, classification, workspace, drives, controls, sensors, grippers, specifications. | **3** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course<br>● Understanding the implementation of automation in production system and ability to know the role of computer in the area of manufacturing.<br>● Ability to design and develop various parts of CNC Machines for improving their effectiveness and implementation of adaptive control.<br>● Ability to develop manual part program and computer assisted part program for the production of components.<br>● Ability to understand the various modules of FMS and apply the concept of group technology and computer assisted process planning. |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Mishra P. K., "***Non-Conventional Machining***", Narosa Publishing House, ISBN-9788173191381 | 1997 |
| 2. | Pandey and Shan, "***Modern Machining Processes***", McGraw Hill, ISBN-0070965536 | 1980 |
| 3. | Bhattacharya A., "***New Technology***", Institution of Engineers (I), ISBN-10: 0521735882 | 2010 |
| 4. | Jain S. K. and Schmid S. R., "***Manufacturing Engg. & Technology***", Addison Wesley Ltd., ISBN-10:8177581708 | 2002 |
| 5. | NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112 web and video resources on Manufacturing Processes & Advanced manufacturing processes. | |

# Course Code: BME-P725

# Course Name: Power Plant Engineering

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Engineering Thermodynamics, Fluid Mechanics, Heat Transfer |
| **Objectives:** | To introduce students to different aspects of power plant engineering<br>● To familiarize the students to the working of power plants based on different fuels.<br>● To expose the students to the principles of safety and environmental issues. |
| **Course Coordinator** | Mr. Praveen Kumar Pandey |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction**: Analysis of steam cycles, optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power. Fuels and their properties, stoichiometric and actual air requirements, flue gas analysis. | **08** |
| UNIT-2 | *Module-2* | **Boilers**: Different types of boilers, boiler mountings, feed water treatment, boiler loading and manner of operation. Boiler energy balance, draft system. Different types of furnaces for burning coal, fuel oil and gas. Circulation theory, down-comers and risers, economizers and super-heaters, air pre-heater, drum and its internals. | **08** |
| UNIT-3 | *Module-3* | **Steam Turbines**: Convergent and convergent- divergent nozzles - theory and design. Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing. | **08** |
| UNIT-4 | *Module-4* | **Plant Components**: Theory and design of condensers, air ejector and cooling towers. Types and applications. | **08** |
| UNIT-5 | *Module-5* | **Power Plant Economics & Environmental Considerations**: Plant energy studies: concepts and resources, procedures and implementation. Energy accounting. Various thermal systems and energy management. Electrical load management. | **08** |
| | | Economic analysis. Waste heat recovery. Multi objective energy management- conservation, pollution control and evaluation of alternative energy sources. Cost of energy management and payback. | |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | After learning the course the students should be able to:<br>• Understand the different power generation methods, its economics and global energy situation<br>• Apply the basic thermodynamics and fluid flow principles to different power generation methods<br>• Analyze thermodynamic cycles of steam power plant and understand construction, working and significance of its various systems<br>• Analyze thermodynamic cycles of gas turbine power plant, nuclear power plant and jet propulsion systems |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Nag P.K., "***Power plant engineering***", 3rd Ed., Tata McGraw-Hill., ISBN-978-0070648159 | 2007 |
| 2. | Arora S. C., & Domkundwar S., "***A course in power plant engineering***",8th Ed., Dhanpat Rai, ISBN- 978-8177001952 | 2016 |
| 3. | Elanchezhian C., "***Power Plant Engineering***", I.K. International Pub. House, ISBN-978-8189866303 | 2013 |
| 4. | Sharma P. C., "***Power Plant Engineering***", S. K. Kataria & Sons, ISBN- 978-9350143841 | 2013 |
| 5. | Drbal L. F., Boston P. G., Westra K. L., Black, & Veatch, "***Power plant engineering***",<br>Chapman & Hall, ISBN- 978-0412064012 | 1995 |
| 6. | Skrotzki B. G. A., & Vopat W. A., "***Power station engineering and economy****",* 2nd Ed., McGraw- Hill, ISBN- 978-0070579408 | 1960 |

# Course Code: BME-P726

# Course Name: Simulation of Mechanical Systems

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Mathematics |
| **Objectives:** | The objective of this course is that students will learn to model and solve mechanical design problems. |
| **Course Coordinator** | Dr. Jasbir Singh |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction**: A review of basic probability and statistics, random variables and their properties,<br>Estimation of means variances and correlation. | **06** |
| UNIT-2 | *Module-2* | **Physical Modeling**: Concept of System and environment, Continuous and discrete systems, Linear and nonlinear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation. | **08** |

| | | | |
|---|---|---|---|
| UNIT-3 | *Module-3* | **System Simulation and Approach**: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages. System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers. | **09** |
| UNIT-4 | *Module-4* | Variance reduction techniques, Determination of length of simulation runs. Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems. | **09** |
| UNIT-5 | *Module-5* | Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Case studies. | **08** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | The students are expected to have :<br>● Practical and simulation exposure to understand the complexity in design and manufacturing systems.<br>● Key simulation techniques that are going to be useful while solving complex problems. |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Geoffrey Gordon, "***System Simulation***", Prentice Hall, ISBN-9780138817978 | 1978 |
| 2. | Robert E. Shannon, "***System Simulation: The Art and Science****",* Prentice Hall, ISBN- 9780138818395 | 1975 |
| 3. | J. Schwarzenbach and K.F. Gill, Edward Arnold, "***System Modelling and Control",*** Edward Arnold, ISBN-9780713135183 | 1984 |
| 4. | M Close and Dean K. Frederick, "***Modeling and Analysis of Dynamic Systems",*** Houghton Mifflin, ISBN-9780395551141 | 1993 |
| 5. | P. D. Cha, J. J. Rosenberg and C. L. Dym - ***'Fundamentals of Modeling and Analyzing Engineering Systems***, Cambridge University, ISBN-9780521594431 | 2000 |

# Course Code: BME-P727

# Course Name: Additive Manufacturing

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | The student should have completed 2 semesters of UG Engg. |
| **Objectives:** | ● In this course students will learn the importance of additive manufacturing (3D Printing/ Rapid Prototyping/ Green Manufacturing) and its huge role in global product development and innovation.<br>● The students will learn the latest trends and opportunities in 3D printing, including ―personal‖ 3D printing, localized services, production parts, mass customization, and how to commercialize your ideas. |
| **Course Coordinator** | Mr. Rishi Kumar Prajapati, Mr. Mayank Pokhriyal |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | Introduction to the Basic Principles of Additive Manufacturing/ digital Manufacturing: advantages and limitations of AM technologies AS developing new engineering systems, identifying emerging opportunities in developing products for mass customization. | **04** |
| | *Module-2* | Additive Manufacturing Processes | **02** |
| UNIT-2 | *Module-3* | **AM Technology:** Extrusion, Beam Deposition, Jetting, Sheet Lamination, Direct-Write, Photo polymerization, Metal Technology & Processes, Sintering, and Powder Bed Fusion. | **06** |
| UNIT-3 | *Module-4* | **Design/Fabrication Processes**: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, design practices for additive manufacturing. | **05** |
| | *Module-5* | **Designing for Additive Manufacturing**: Scaffolds, bio printing, tissue and organ engineering | **04** |
| UNIT-4 | *Module-6* | Multiple Materials, Metals, polymers, ceramics, Hybrids, Composite Materials, current and material Selection & future directions, Process & Material Selection. | **05** |
| | *Module-7* | Direct Digital Manufacturing and Distributed Manufacturing, Related Technologies: 3D | **06** |
| | | scanning, sintering, Mold making, Casting, Scanning, rapid tooling (RT), rapid manufacturing (RM). | |
| UNIT-5 | *Module-8* | **Applications of AM**: Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewelry, Toys, Packaging, Architecture, Design and Entertainment and many more. | **02** |
| | *Module-9* | **Biomedical Applications of AM**: Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others. | **02** |
| | *Module-10* | Future Trends and Directions in Additive Manufacturing, Business Opportunities, Standards and standardization in 3D Printing and the Future of Manufacturing, Intellectual Property, Product Development, Commercialization | **04** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | ● Understanding the evolution and need of AM processes. It will develop the ability of select the process for particular application.<br>● Understanding the basic principle of curing type, extrusion and layer deposition type AM processes. The students will learn the pros & cons of these processes and their applications.<br>● The students will understand the use of pre requirement of AM process. Basic knowledge about the software requirement and processing of drawing.<br>● The students will learn about the post processing requirements of different AM processes<br>● Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering.<br>● Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio manufacturing. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Ian Gibson, David W. Rosen, Brent Stucker, "***Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing***", 1st Ed., Springer Publ., ISBN-978-1-4419-1119-3 | 2010 |
| 2. | Hopkinson, N, Haque, R., and Dickens, P., "***Rapid Manufacturing: An Industrial Revolution for a Digital Age: An Industrial Revolution for the Digital Age***", Wiley, ISBN- 978-0470016138 | 2005 |
| 3. | Bartolo P J (editor), "***Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping***", 1st Ed , Taylor and Francis, ISBN- 9780203931875 | 2007 |
| 4. | Chua C. K., Leong K. F., Lim C. S., "***Rapid Prototyping***", World Scientific, ISBN-978-981-3106-04-8 | 2003 |
| 5. | Pique A., Chrisey D. B., "***Direct Write Technologies for RP Applications: Sensors, Electronics and Integrated Power Sources***", 1st Ed, Academic Press, ISBN-9780121742317 | 2001 |
| 6. | Venuvinod P. K., Ma W., "***Rapid Prototyping – Laser Based and Other Technologies***", Kluwer, ISBN- 978-1-4757-6361-4 | 2004 |
| 7. | Andreas Gebhardt, "***Understanding Additive Manufacturing***", Hanser Publ., ISBN-978-1569905074 | 2012 |
| 8. | Gibson, "***Advanced Manufacturing Technologies for Medical Applications"***, Wiley, ISBN- 978-0-470-01688-6 | 2005 |

# Course Code: BME-P728

# Course Name: Finite Element Methods

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Matrix Algebra & Basic Mathematics courses. |
| **Objectives:** | ● The objective of the course is to apprise the students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in solid mechanics.<br>● Different application areas will be dealt with after introducing the basic aspects of the method. |
| **Course Coordinator** | Dr. Sanjeev Kumar Lambha |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Basic concepts**: The standard discrete system, Finite elements of an elastic continuum displacement approach, Generalization of the finite element concepts- weighted residual and variational approaches. | **08** |
| UNIT-2 | *Module-2* | **Element Types**: Triangular, rectangular, quadrilateral, sector, curved, iso-parametric elements and numerical integration. Automatic mesh generation schemes. | **12** |
| UNIT-3 | *Module-3* | **Application to structural mechanics problems**: Plane stress and plane strains, Axisymmetric stress analysis, three dimensional stress analyses, bending of plates. | **06** |
| UNIT-4 | *Module-4* | **FEM in Steady State Field Problems**: Introduction, heat conduction, fluid flow and nonlinear material problems, plasticity, creep etc. | **08** |
| UNIT-5 | *Module-5* | Computer procedures for Finite element analysis. | **06** |
| **Total No. of Hours** | | | **40** |

| | |
|---|---|
| **Learning Outcomes:** | **CO1:** Understand the basic concepts of finite element methods, concepts behind variational approaches and weighted residual methods in FEM.<br><br>**CO2:** Implement the formulation techniques to solve problems using triangular, rectangular, quadrilateral, curved and isoparametric elements.<br><br>**CO3:** Apply analytical concepts to solve for stress and strain analysis involved in problems related to structural mechanics.<br><br>**CO4:** Identify the finite element methods for problems involving dynamics, heat transfer and fluid flow.<br><br>**CO5:** Explain the computer procedures involved in finite element analysis. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | Chandrupatla T. R., and Belegundu A. D., "***Introduction to Finite Elements in Engineering***", 4th Ed, Pearson Education, 978-0132162746 ISBN- | 2011 |
| 2. | David V Hutton, "***Fundamentals of Finite Element Analysis****",* International Ed. McGraw-Hill Int., ISBN- 978-0071218573 | 2003 |
| 3. | Rao S.S., "***The Finite Element Method in Engineering***", 5th Ed, Pergammon Press, ISBN- 978-1856176613 | 2010 |
| 4. | Logan D.L., "***A First course in the Finite Element Method***, 5th Ed., Thomson Learning, ISBN- 978-0495668251 | 2010 |

| | | |
|---|---|---|
| 5. | Robert D. Cook., David. S, Malkucs Michael E Plesha, "***Concepts and Applications of Finite Element Analysis***", 4th Ed., Wiley, ISBN- 978-0471356059 | 2001 |
| 6. | Reddy J.N, "***An Introduction to Finite Element Method***", 3rd Ed, McGraw-Hill International Student Edition, ISBN- 978-0072466850 | 2005 |
| 7. | O. C. Zienkiewicz and R. L. Taylor, "***The Finite Element Methods, The basic formulation and linear problems Vol.1***", Ed, McGraw-Hill College;, ISBN- 978-0070841741 | 1987 |


## Course Code: BME-P729

## Course Name: AUTOMOBILE ENGINEERING

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | Rigid Body Dynamics (done in 1st year B.Tech.), Thermodynamics, Fluid Mechanics |
| **Objectives:** | The anatomy of the automobile in general.<br>2. The location and importance of each part.<br>3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.<br>4. Suspension, frame, springs and other connections.<br>5. Emissions, ignition, controls, electrical systems and ventilation. |
| **Course Coordinator** | Mr. Kapil Dev Sharma |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Power Unit**: Principles of Design of main components. Valve mechanism. Power and Torque characteristics. Rolling, air and gradient Resistance. Tractive effort. | **04** |
| | *Module-2* | **Gear Box** Gear ratio determination. Design of Gear box. | **03** |
| UNIT-2 | *Module-3* | **Transmission System:** Requirements. Clutches. Toque converters. Over drive and free wheel, Universal joint. Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Fron t Axle. | **06** |
| | *Module-4* | Castor Angle, wheel camber & Toe in Toe out etc. Steering geometry. Ackerman mechanism, Understeer and Over steer. | **03** |
| UNIT-3 | *Module-5* | **Braking System:** General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vaccum and air brakes. Thermal aspects. | **05** |

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|---|---|---|---|
| | *Module-6* | Chassis and Suspension System: Loads on the frame. Strength and stiffness. Various suspension systems | **03** |
| UNIT-4 | *Module-7* | **Electrical System:** Types of starting motors, | **04** |
| | | generator & regulators, lighting system, Ignition system Horn, Battery etc. BS4 and BS6. | |
| | *Module-8* | Performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of fuel cells. | **04** |
| UNIT-5 | *Module-9* | **Automobile Air Conditioning:** Requirements, Cooling & heating systems Cooling & Lubrication System: Different type of cooling system and lubrication system. | **04** |
| | *Module-10* | Maintenance System: Preventive maintenance, break down maintenance, and over hauling system | **04** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | At the end of the course students are able to:<br>● Identify the different parts of the automobile.<br>● Explain the working of various parts like engine, transmission, clutch, brakes.<br>● Describe how the steering and the suspension systems operate.<br>● Understand the environmental implications of automobile emissions.<br>● Develop a strong base for understanding future developments in the automobile industry |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year |
|---|---|---|
| 1. | Hietner, ***Automotive Mechanics Principles And Practices,*** 2 Ed., ISBN- 978-8123908915 | 2004 |
| 2. | Kripal Singh, ***Automobile Engineering Vol-1,*** ISBN- 978-8180141966 | 2020 |
| 3. | Narang***, Automobile Engineering,*** Khanna Publishers - ISBN- 9387394255 | 1995 |
| 4. | K.K. Ramalingam, ***"Automobile Engineering",*** Scitech Publication, Chennai, ISBN- 978-8188429486 | 2011 |

# Course Code: BME-O731

# Course Name: Nanotechnology and Nano computing

| | |
|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | First two years of undergraduate course of Engineering (Introductory, undergraduate level<br>Physics, Chemistry and Mathematics) |

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|---|---|
| **Objectives:** | • To foundational knowledge of the Nanocomputing and related fields.<br>• To make the students acquire an understanding the Nanocomputing and Applications<br>• To help them understand in broad outline of Nanocomputing and Nanotechnology |
| **Course Coordinator** | Dr. Jasbir Singh |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Nanotechnology:** Nano systems, Molecular machinery and manufacturing, quantum mechanics, mechanosynthesis, Ideas of Richard Feynman | **04** |
| | *Module-2* | **Nanocomputing:** Introduction, Nanocomputing Technologies, Carbon nanotubes, Nano Information processing, Silicon Nano electronics, prospects and Challenges. | 04 |
| UNIT-2 | *Module-3* | **Carbon Nanotubes:** Properties, Molecular structure, Chiral Vector, carbon nanotube Electronics, Carbon Nanotube Field effect Transistors | **08** |
| UNIT-3 | *Module-4* | **Nanocomputing with Imperfections:** Nanocomputing in presence of defects and faults, redundancy, Error control coding, reconfiguration, Fault Simulation, Defect Tolerance, Reconfigurable Hardware, Overcoming Manufacturing defects | **05** |
| | *Module-5* | **Reliability of Nanocomputing:** Markov Random Fields, examples, reliability Evaluation strategies, Law of large Numbers, Nano prism. | **03** |
| UNIT-4 | *Module-6* | **Nanoscale Quantum Computing** Quantum Computers, Challenges to Physical Realization, Quantum-dot Cellular Automata | **08** |
| | | (QCA), QCA Clocking, Design Rules, Placement, Basic QCA Circuits using QCA Designer Software and their implementation | |
| UNIT-5 | *Module-7* | **Molecular Computing:** Background of molecular electronics, Alderman's Experiment, DNA Computation, Bacteriorhodopsin, challenges before molecular computing. Optical Computing: Introduction, use of Optics for Computing, Optical Computing Paradigms, Ultrafast Pulse Shaping, Photonic Switches | **08** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | After completing this course students will be able to:<br>● Learn about the background on Nanocomputing<br>● Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment<br>● Apply their learned knowledge to develop Nanomaterial's. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | G. Schmidt , ***Nanoparticles: From theory to applications*** , Wiley Weinheim, ISBN-978-3-527-60404-3 | 2006 |
| 2. | S K Shukla and R I Bahar , ***Nano, Quantum and Molecular Computing- Implications to High level design and Validation***, Illustrated Ed., Kluwer Academic Publishers, ISBN- 978-1402080678 | 2004 |
| 3. | V Sahni and D Goswami, ***Nanocomputing – an Introduction***, Tata McGraw Hill, ISBN- 978-0070248922 | 2008 |
| 4. | Leon L. Shaw***, "Processing & properties of structural naonmaterials",*** Wiley , ISBN- 978-0873395588 | 2003 |

# Course Code: BME-O732

# Course Name: Artificial Intelligence and Robotics

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

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|---|---|
| **Prerequisites:** | : Knowledge of "Kinematics of Machine" & Passion to learn the Subject |
| **Objectives:** | ● To present a problem oriented in depth knowledge of Artificial Intelligence and Robotics.<br>● To address the underlying concepts, methods and application of different Artificial Intelligence and Robotics. |
| **Course Coordinator** | Mr. Sanjeev Kumar Lambha |

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| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Scope of AI**: Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction. | **04** |
| UNIT-2 | *Module-2* | **Problem solving**: State space search; Production systems, search space control: depth first, breadth- first search, heuristic search - Hill climbing, best- first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means- End Analysis. | **08** |

| | | | |
|---|---|---|---|
| UNIT-3 | *Module-3* | **Knowledge Representation**: Predicate Logic: Unification, modus pones, resolution, dependency directed backtracking. Rule based Systems: Forward reasoning: conflict resolution, backward reasoning: use of no backtrack. Structured Knowledge Representation: Semantic Nets: slots, exceptions and default frames, conceptual dependency, scripts. | **10** |
| UNIT-4 | *Module-4* | **Handling uncertainty and learning**: Non- Monotonic Reasoning, Probabilistic reasoning, use of certainty factors, fuzzy logic. Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets. | **08** |
| UNIT-5 | *Module-5* | **Robotics**: Robot Classification, Robot Specification, notation; Direct and Inverse Kinematics: Co-ordinates Frames, Rotations, | **10** |
| | | Homogeneous Coordinates, Arm Equation of four Axis SCARA Robot, TCV, Inverse Kinematics of Four Axis SCARA Robot. | |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | • The student can identify different areas of Artificial Intelligence and Robotics.<br>• Can find the applications of all the areas in industry. |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | E. Rich and K. Knight, "***Artificial intelligence***", 2nd Ed., TMH, ISBN- 978-0070522633 | 1991 |
| 2. | N.J. Nilsson, "***Principles of AI***", Reprint Ed, Narosa Publ. House, 978-0934613101 | 1993 |
| 3. | Robin R Murphy, "***Introduction to AI Robotics***", 1st Ed., PHI Publication, ISBN-978-0262133838 | 2001 |
| 4. | D.W. Patterson, "***Introduction to AI and Expert Systems***", PHI, ISBN- 978 0134771007 | 1990 |
| 5. | R. J. Schalkoff, "***Artificial Intelligence - an Engineering Approach***", Int. Ed., McGraw Hill, Singapore, ISBN- 978-0071009324 | 1992 |
| 6. | George Lugar, "***Al-Structures and Strategies for and Strategies for Complex Problem solving***", 6th Ed., Pearson Educations, ISBN- 978-0321545893 | 2008 |

## Course Code: BME-O733

## Course Name: ENERGY RESOURCES AND MANAGEMENT

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|---|---|
| **MM: 100**<br>**Time: 3 Hr.**<br>**L T P**<br>**3 0 0** | **Sessional: 30**<br>**ESE: 70**<br>**Credit : 3** |

| | |
|---|---|
| **Prerequisites:** | First two years of undergraduate course of Engineering (Introductory, undergraduate level<br>Physics and Chemistry ) |
| **Objectives:** | ● To provide students with a general awareness on the importance of energy and its conservation, its impact on society, various energy sources, energy conversion processes, energy management. |
| **Course Coordinator** | Mr. Praveen Pandey |

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|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Energy Resources and Their Utilization:** Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation. | **02** |
| | *Module-2* | **Solar Radiations:** Extra-terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, Flux on a plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, Solar radiation data for India. | **03** |
| UNIT-2 | *Module-3* | **Solar Energy:** Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal | **03** |

| | | | |
|---|---|---|---|
| | | analysis of solar collectors, Tracking CPC and solar swing Solar thermal energy storage, Different systems, Solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants. | |
| | *Module-4* | **Solar Photovoltaic System:** Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system. | **04** |
| UNIT-3 | *Module-5* | **Biogas:** Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, Biomass resource development in India. | **04** |
| | *Module-6* | **Wind Energy:** Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis windmills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development. | **04** |
| UNIT-4 | *Module-7* | **Electrochemical Effects and Fuel Cells:** Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells . | **04** |
| | *Module-8* | **Tidal power:** Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy, limitations of tidal energy conversion systems. **Hydrogen Energy:** Properties of hydrogen in respect of its use as source of renewable energy, | **04** |
| | | Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel, Development of hydrogen cartridge, Economics of hydrogen fuel and its use. | |
| UNIT-5 | *Module-9* | **Thermoelectric Systems:** Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators. | **04** |

| | | | |
|---|---|---|---|
| | *Module-10* | **Geothermal Energy:** Structure of earth's interior, Geothermal sites, earthquakes & volcanoes, Geothermal resources, Hot springs,Steam ejection, Principal of working, Types of geothermal station<br>With schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion. | **04** |
| | *Module-11* | **Ocean Energy:** Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion Systems, Thermoelectric OTEC, Developments of OTEC, Economics. Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity production from different energy Sources, Energy options for Indian economy. | **04** |
| **Total No. of Hours** | | | **40** |

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|---|---|
| CO1 | Understand of renewable and non -renewable sources of energy. |
| CO2 | Gain knowledge about working principle of various solar energy systems. |
| CO3 | Understand the applications of wind energy and wind energy conversion system. |
| CO4 | Develop capability to do basic design of bio gas plant. |
| CO5 | Understand the applications of different renewable energy sources like ocean, thermal, hydro, geothermal energy etc. |

**Suggested books:**

| **S. No.** | **Name of Authors /Books /Publisher** | **Year of Publication** |
|---|---|---|
| 1. | Bansal Keemann, Meliss***," Renewable energy sources and conversion technology"***, Tata Mc Graw Hill, Publisher, ISBN- 978-0074600238 | 1989 |
| 2. | Kothari D.P., ***"Renewable energy resources and emerging technologies", 2nd Ed., Prentice Hall of India Pvt. Ltd***., ISBN- 978-8120344709 | 2011 |
| 3. | Rai G.D, ***"Non-Conventional energy Sources",*** Khanna Publishers., ISBN- 978-8174090737 | 1988 |
| 4. | Ashok V. Desai, ***"Nonconventional Energy",*** New Age International Publishers Ltd., ISBN- 978-8122402070 | 1990 |

## Course Code: BME-O734

## Course Name: Engineering System Design Optimization

| | |
|---|---|
| **MM: 100** | **Sessional: 30** |
| **Time: 3 Hr.** | **ESE: 70** |
| **L T P** | **Credit : 3** |
| **3 0 0** | |

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|---|---|
| **Prerequisites:** | Mathematics |
| **Objectives:** | • The primary objective of this course is for students to gain knowledge to translate practical engineering design problems into mathematical optimization problems<br>that can be solved using numerical methods for optimization. |
| **Course Coordinator** | Dr. Jasbir Singh, Dr. Lokesh Joshi |

| | |
|---|---|
| **NOTE:** | The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus |

| UNIT | Module | Course Content | No. of Hours |
|---|---|---|---|
| UNIT-1 | *Module-1* | **Introduction**: Optimization problem formulation, optimization algorithms, applications and examples, different optimization methods<br>available. | **07** |
| UNIT-2 | *Module-2* | **Single Variable Optimization**: Optimization criteria, bracketing methods – Exhaustive search method, bound phase method; Region Elimination methods – Fibonacci search method, Golden search method; Gradient based methods – Newton<br>Raphson method, Bisection method; Root finding using optimization technique. | **09** |
| UNIT-3 | *Module-3* | **Multi objective optimization**: Optimization criteria, Different search methods, Unidirectional search, Direct search method – Evolutionary optimization method, Powell's conjugate direction<br>method; Gradient based methods – Newton's method and Variable metric method. | **09** |
| UNIT-4 | *Module-4* | **Specialized Methods**: Integer programming, Geometric programming, simulated annealing, Global optimization using - steep descent method, simulated annealing. | **06** |
| UNIT-5 | *Module-5* | **Genetic algorithms and evolutionary Approaches**: Differences and similarities between Genetic algorithms and traditional techniques, operators of GA"s, Computer program for simulated annealing, Newton Raphson method, Evolutionary optimization method. | **09** |
| | | | |
| **Total No. of Hours** | | | **40** |

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|---|---|
| **Learning Outcomes:** | At the end of this course, students will be able to<br>● Demonstrate an understanding of how design optimization fits into the overall engineering design process.<br>● To formulate practical engineering design problems as well-posed optimization problems.<br>● To determine the advantages and disadvantages of applying different optimization techniques for a specific problem.<br>● To model and analyze multiobjective and multidisciplinary optimization problems. |

**Suggested books:**

| S. No. | Name of Authors /Books /Publisher | Year of Publication |
|---|---|---|
| 1. | P. Y. Papalambros and D. J. Wilde, ***Principles of Optimal Design: Modeling and Computation***, 2nd edition, Cambridge University Press, ISBN: 0521627273. | 2000 |
| 2. | S. S. Rao**,** ***Engineering Optimization: Theory and Practice***, 4th edition, John Wiley & Sons, ISBN: 0470183527. | 2009 |
| 3. | K. Deb***, Optimization for Engineering Design,*** 2nd edition, PHI Learning Pvt. Ltd., ISBN: 8120346785. | 2009 |
| 4. | K. Deb, ***Multi objective optimization using Evolutionary algorithms***", John Wiley, ISBN: 9780471873396 | 2001 |
| 5. | H. A. Taha, ***Operations Research-An Introduction***, Prentice Hall, ISBN: 9780134480176 | 2017 |