# Indian Institute of Information Technology Bhagalpur

# Mechatronics Engineering (MEA)

### B.Tech. Curricula and Syllabus

*Semester-III*

## Curricula:

| Course Code | Course name | L | T | P | C |
|---|---|---|---|---|---|
| **MA201** | **Engineering Mathematics III** | **3** | **1** | **0** | **4** |
| **CS203** | **Object Oriented Programming** | **3** | **0** | **0** | **3** |
| ME201 | Solid Mechanics | 3 | 0 | 2 | 4 |
| ME202 | Thermodynamics | 3 | 0 | 0 | 3 |
| ME203 | Electrical Machine | 3 | 0 | 2 | 4 |
| **HS201** | **Management Concepts and Technology** | **2** | **0** | **0** | **2** |
| CS211 | Object Oriented Programming LAB | 0 | 0 | 3 | 2 |
| ME211 | Mechanical Workshop | 0 | 0 | 3 | 2 |
| **SAI** | **Society Internship Program** | **0** | **0** | **0** | **1** |

## Syllabus:

| **Course Code** | **Course name** | **L** | **T** | **P** | **C** | **Year** | **Semester** |
|---|---|---|---|---|---|---|---|
| MA201 | Engineering Mathematics III | 3 | 1 | 0 | 4 | 2nd | 3rd |
| **Topic** | **Contents** | | | | | | **No. of Lectures** |
| Module-I | Complex numbers and elementary properties. Complex functions - limits, continuity and differentiation. Cauchy-Riemann equations. Analytic and harmonic functions. | | | | | | **08** |
| Module-II | Elementary functions. Anti-derivatives and path (contour) integrals. Cauchy-Goursat Theorem. Cauchy's integral formula, Morera's Theorem. Liouville's Theorem, Fundamental Theorem of Algebra and Maximum Modulus Principle. Taylor series. Power series. Singularities and Laurent series. | | | | | | **09** |
| Module-III | Cauchy's Residue Theorem and applications. Mobius transformations; Partial Differential Equations: First order PDEs; solutions of linear and nonlinear first order PDEs; classification of second-order PDEs. | | | | | | **08** |
| Module-IV | Method of characteristics Iin PDE; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, heat conduction equation, Laplace's equations and solutions by method of separation of variables; initial boundary value problems. | | | | | | **08** |
| Module-V | Solution of PDE by Laplace transform; Fourier series, Fourier integrals; Fourier transforms, sine and cosine transforms; solution of PDE by Fourier transform. | | | | | | **10** |

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| | **Total** | **43** |
| **Text** | 1. B S Grewal, J S Grewal, J K Dhanoa, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017.<br>2. E. Kreyszig, H. Kreyszig, E. J. Norminton*, Advanced Engineering Mathematics,* 10th*,* Wiley India Pvt. Ltd., 2017 | |
| **Reference** | 1. Ian N Sneddon, *Elements of Partial Differential Equations*, Dover Publications; 2006.<br>2. John H Mathews, Russell W Howell, *Complex Ananlysis for Mathematics and Engineering*, Jones and Bartlett India Pvt.Ltd, 6th edition, 2011.<br>3. James Ward Brown, Ruel V Churchill, *Complex Variables and Applications,* Tata McGraw Hill Education*, 8th edition, 2016.* | |

| **Course Code** | **Course Name** | **L** | **T** | **P** | **C** | **Year** | **Semester** |
|---|---|---|---|---|---|---|---|
| CS203 | Object oriented Programming | 3 | 0 | 0 | 3 | 2nd | 3rd |
| Course Objective: The course is designed to provide students with complete knowledge of Object Oriented. Programming through C++ and to enhance the programming skills of the students by giving practical assignments to be done in labs. The course also aims to provide students with requisite knowledge about Object Oriented Programming through C++ so that they make their own Applications/Projects using C++. | | | | | | | |
| Topic | | | | | | | Hour |
| Module I | Principles of OOPs, Basics of C++, Functions in c++ : Basic Concepts of OOP, Benefits of OOP, OOP Languages, Applications of OOP. C++ program basics, data types, operators in c++, scope resolution, type cast operators, operator overloading, operator precedence. Main function, function prototyping, call by reference, inline functions, default arguments, constant arguments, function overloading, friend and virtual functions, maths library functions. | | | | | | 6 |
| Module II | Classes, objects, constructors and destructors – C structures revisited, specifying a class, defining a member function, private member functions, memory allocation for objects, static data members and member functions, array of objects, objects as function arguments, friendly functions, returning objects, pointers to members, constructors, Parametrized constructors, Multiple constructors, Copy constructor, Destructors. | | | | | | 6 |
| Module III | Operator overloading, inheritance, virtual functions and polymorphism – Overloading unary operators, overloading binary operators, rules for overloading operators, type conversions. Derived classes, single inheritance, multilevel inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance, virtual base classes, abstract classes, nesting of classes. Pointers, pointer to objects, this pointer, pointer to derived classes, virtual functions, pure virtual functions. | | | | | | 8 |
| Module IV | Console I/O operations, working with files and templates – C++ streams and stream classes, unformatted I/O operations, formatted console I/O operations, managing output with manipulators. Classes for file stream | | | | | | 8 |

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| | operations, opening/closing of file, file pointers and their manipulation, error handling during file operation, command line arguments. Class templates, class template with multiple parameters, function templates, overloading template functions, member function templates, non-type template arguments. | |
| Module V | Exception handling and Standard template library – Basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, rethrowing exception, specifying exception. Components of STL, Containers, Algorithms, Iterators, Application of Container classes, Functions objects. | 6 |
| | Total | 34 |
| Text | 1. Object Oriented Programming with C; E Balagurusamy, ; 7th, McGraw Hill Education (India) Pvt. Limited; 2018.<br>2. The Complete Reference C++ (Indian Edition); Herbert Schildt, ; 4th, McGraw Hill Education (India) Pvt. Limited; 2017. | |
| Reference | 1. The C++ Programming Language; Bjarne Stroustrup, ; 3rd, Pearson India Education Services Pvt.Ltd; 2017. | |

| **Course Code** | **Course name** | **L** | **T** | **P** | **C** | **Year** | **Semester** |
|---|---|---|---|---|---|---|---|
| ME201 | Solid Mechanics | 3 | 0 | 2 | 4 | 2nd | 3 |

**Course objective:**

1) To understand the basic concepts of the stresses and strains for different materials and strength of structural elements.
2) To know the development of internal forces and resistance mechanism for one dimensional and two dimensional structural elements.
3) To analyse and understand different internal forces and stresses induced due to representative loads on structural elements.
4) To analyse and understand principal stresses due to the combination of two dimensional stresses on an element and failure mechanisms in materials.
5) To evaluate the behavior of torsional members, columns and struts.

| **Topic** | **Contents** | **No. of Lectures** |
|---|---|---|
| **Module 1** | | |
| | Introduction, Definition and concept and of stress and strain. Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self-weight.Compound bars, Temperature stresses, Compound section subjected to temperature stresses, state of simple shear, Elastic constants and their relationship | **8** |
| **Module 2** | | |
| | Stress at a point, analysis of deformation and definition of strain components, principal stresses and strains, Mohr's circle representation. Constitutive relations. | **8** |

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| **Module 3** | | |
| Material properties for isotropic materials and their relations, 3d stress – strain, Theories of failures for isotropic materials. | | **8** |
| **Module 4** | | |
| Shear Force and Bending Moment diagrams. Axially loaded members. Stresses due to bending: pure Bending, transverse shear. | | **8** |
| **Module 5** | | |
| Torsion of circular shafts, Combined stresses due to bending, torsion and axially loading.Deflections due to bending, Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorems. Thin cylinders and spherical vessels, columns. | | **8** |
| | **Total** | **40** |
| | | |
| **Text** | 1) E. P. Popov, "Engineering Mechanics of Solids", Prentice Hall, 1998.<br>2) F. P. Beer, E. R. Johnston (Jr.) and J.T. DeWolf, "Mechanics of Materials", Tata McGraw Hill, 2005. | |
| **Reference** | 1) S. H. Crandall, N. C. Dahl, and T. J. Lardner, "An Introduction to The Mechanics of Solids", 2nd Ed., Tata McGraw Hill, 2008.<br>2) S. P. Timoshenko, "Strength of Materials, Vols. 1 & 2", CBS Publishers, 1986. | |

| **Course Code** | **Course name** | **L** | **T** | **P** | **C** | **Year** | **Semester** |
|---|---|---|---|---|---|---|---|
| ME202 | Thermodynamics | 3 | 0 | 0 | 3 | 2nd | 3rd |

**Course objective:**

1. To make familiar with thermodynamic systems and different process.
2. To know the basic laws of thermodynamics, zeroth law, first law, second law
3. Identify different types of properties ex. extensive and intensive property.
4. To develop understanding of entropy

| **Contents** | **No. of Lectures** |
|---|---|
| **Module : 1** | |
| Thermodynamic systems, States, processes, Zeroth law, work and heat, | **6** |
| **Module : 2** | |

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| Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation(SFEE), important applications.limitations of first law of thermodynamics, Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. | **8** |
| **Module : 3** | |
| Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes; factors that make a process irreversible, reversible heat engines. Unresisted expansion, remarks on Carnot's engine, internal and external reversibility, Clasius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy | **8** |
| **Module : 4** | |
| Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility, second law efficiency | **8** |
| **Module : 5** | |
| P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Properties of mixtures of ideal gases, Thermodynamic cycles - Otto, Diesel, dual and Joule | **8** |
| **Total** | **38** |
| | |
| **Text** | 1. R. E. Sonntag, C. Borgnakke and G. J. V. Wylen, "Fundamentals of Thermodynamics", 6th Ed., John Wiley, 2003.<br>2. P. K. Nag, "Engineering Thermodynamics", 5th Ed., Tata McGraw Hill Pub. 2013. |
| **Reference** | 1. Y. A. Cengel and M. A. Boles, "Thermodynamics, An Engineering Approach", 4th Ed., Tata McGraw Hill, 2003.<br>2. G. F. C. Rogers and Y. R. Mayhew, "Engineering Thermodynamics Work and Heat Transfer", 4th Ed., Pearson 2003. |

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| Course Code | Course name | L | T | P | C | Year | Semester |
|---|---|---|---|---|---|---|---|
| ME203 | Electrical Machine | 3 | 0 | 2 | 4 | 2nd | 3 |

**Course objective:**
The aim is to deep exposition of the theory of electromechanical devices with specific emphasis on the theory of electric machines. The students would be able to understand and implement fundamentals of rotating electrical machines.

| Contents | No. of Lectures |
|---|---|
| **Module : 1** | |
| Gauss's law for electric fields and magnetic fields, Faraday's law, The Ampere–Maxwell law, Magnetic Circuits, Magnetic Materials and their properties, Magnetically induced EMF and Force, AC Operation of Magnetic Circuits, Hysteresis and Eddy-Current Losses, Permanent Magnets, Application of Permanent Magnet Materials, Energy in Magnetic System, Field Energy and Mechanical Electromechanical Systems Force, Multiply-Excited Magnetic Field Systems, Forces/Torques in Systems with Permanent Magnets, Energy Conversion via Electric Field, Dynamical Equations of | **9** |
| **Module : 2** | |
| Introduction, Transformation Construction and Practical Considerations, Transformer on No-Load, Ideal Transformer, Real Transformer and Equivalent Circuit, Transformer Losses, Transformer testing, The per unit system, Efficiency and voltage regulation, Three phase transformers, Phase Conversion, Voltage and Current Transformers, Transformer as a Magnetically Coupled Circuit | **8** |
| **Module : 3** | |
| Elementary Machines, Generated EMF, MMF of distributed Winding, Rotating Magnetic Field, Torque in round rotor machine, Operation of basic machine types, Magnetic Leakage in Rotating Machines, Losses and Efficiency, Matching Characteristics of Electric Machine and Load, AC Winding, DC winding, Fractional kilowatt motors. | **8** |
| **Module : 4** | |
| DC Machines: Introduction, EMF and Torque, Circuit Model, Armature reaction, Commutation, Methods of Excitation, Magnetisation Characteristics, Self-Excitation, Characteristics of DC Motor/Generator, Starting of DC motors, Speed control of DC motor, DC Machine dynamics, Permanent Magnet DC motors | **8** |
| **Module : 5** | |
| Induction Machine: Introduction, Flux and MMF Waves in Induction Motor – Principle of Operation, Development of Circuit Model, Power across air gap, Torque and Power | **8** |

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| Output, Tests to determine circuit model parameters, Starting, Cogging and Crawling, Classes of squirrel cage motors, | |
| **Total** | **41** |
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| **Text** | 1)A Fitzgerald," Electric Machinery", , McGrawHill, 2017.<br>2)D. P. Kothari and I. J. Nagrath, "Electric Machines", McGrawHill, 2013. |
| **Reference** | 1) S. Chapman, " Electric Machinery Fundamentals", McGrawHill, 2017.<br>2) D. Fleish, "A Student's Guide to Maxwell's Equations", 2008. |

| **Course Code** | **Course name** | **L** | **T** | **P** | **C** | **Year** | **Semester** |
|---|---|---|---|---|---|---|---|
| HS201 | Management Concepts and Technology | 2 | 0 | 0 | 2 | 2nd | 3rd |
| **Topic** | **Contents** | | | | | | **No. of Lectures** |
| Module-I | Principles of Management: Concept of Management, Functions of Management, Planning and its Nature &Organising, Designing organizational Structure, Authority relationships, | | | | | | **04** |
| Module-II | Delegation of Authority. Staffing: Motivation and its Theory, Leadership Communication. Directing, Controlling & its techniques. Coordinating; Principles of Economic: Microeconomics: Concept of consumption, production, exchange, distribution. | | | | | | **05** |
| Module-III | Demand analysis: Concept, kind of demand, change in demand, law of demand; Utility analysis: Marginal, total, consumer surplus, consumer equilibrium; Production analysis: Law of supply, different factors of production, law of returns, economies of scale. | | | | | | **06** |
| Module-IV | Cost analysis: Cost concept, importance of cost behaviour, cost classification; Pricing analysis: Different kinds of markets, pricing & equilibrium in different markets - perfect, imperfect, monopoly. | | | | | | **05** |
| Module-V | Income distribution: Briefing them about rent, wages, interest and profit. The international economics: Changing scenario, globalization, structural adjustment programme, stabilization policy, the multinational corporation. IBRD, IMF, GATT, WTO, ITO, IDA, IFC, MIGA. | | | | | | **05** |
| | **Total** | | | | | | **25** |
| **Text** | 1. Business Organisation& Management - C.R Basu.<br>2. Essentials of Management - Harold Koontz, HeingWerhrich.<br>3. An introduction to Positive Economics; Lipsey.<br>4. Modern Microeconomics; A. Koutsoyiannis.<br>5. Managerial Economics - Analysis, Problems and Cases; P.L. Mehta.<br>6. Business Economics; ManabAdhikary. | | | | | | |