

## UG SCHEME 2022: Department of Mechanical Engineering

### Malaviya National Institute of Technology Jaipur

#### DETAILS OF THE COURSE

| Course Code | Course Title                       | Credits | Lecture | Tutorial | Practical | Studio |
|-------------|------------------------------------|---------|---------|----------|-----------|--------|
| 22MET101    | Introduction to Mechanical Systems | 2       | 2       | 0        | 0         | 0      |

PREREQUISITE :None.

#### COURSE OUTCOMES

|     |  |
|-----|--|
| CO1 | To understand the construction and working of a mobility system.               |
| CO2 | To ascertain the manufacturing processes appropriate for hardware development. |
| CO3 | To select favorable engineering material(s) for the given application.         |
| CO4 | To analyze the efficiency of different thermal systems.                        |
| CO5 | To select appropriate power transmission drive(s) for the given application.   |

#### COURSE CONTENTS

**Mobility Systems:** various modes of transportation – rail, road, air and water; main components of an automobile; conventional and alternative fuels; electric vehicles

**Manufacturing Processes:** Machining operations and machine tools: lathe, drilling, shaper, milling; Joining methods: shielded metal arc welding, oxy-acetylene gas welding, basic welded joints, soldering, brazing; foundry tools and sand casting; additive manufacturing processes and their mechanisms.

**Engineering Materials:** Introduction, classification and mechanical properties of engineering materials, criteria for engineering material selection

**Power Generation Systems:** Steam generation, properties of steam, steam power plant – components, working and their thermodynamic cycle, steam tables, Mollier diagram; internal combustion engines, petrol and diesel engine and their thermodynamic cycles, engine cooling systems.

**Refrigeration and Air Conditioning:** Refrigerator, heat pump, heat engine, coefficient of performance, unit of Refrigeration, thermodynamic cycles; domestic refrigerator, desert cooler, unitary air conditioner, ice plant.

**Power Transmission Devices:** Introduction, belt drive, rope drive, chain drive, gear drive

#### TEXT BOOKS/ REFERENCE BOOKS (Title, Authors, Publisher & Year):-

1. Basics of Mechanical Engineering by Pravin Kumar, Pearson publishing co.
2. Elements of Mechanical Engineering by D. S. Kumar, Kataria & Sons, New Delhi.
3. Engineering Thermodynamics by P. K. Nag, McGraw-Hill Publishing Co., New Delhi.
4. Workshop Technology by S. K. Garg, Laxmi Publications, New Delhi.

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|-------------|---|---------|---------|----------|-----------|--------|
| 22MEP102    | Product Realization through Manufacturing | 1       | 0       | 0        | 2         | 0      |

PREREQUISITE : Nil

#### COURSE OUTCOMES:

|     |  |
|-----|--|
| CO1 | To select suitable tools and equipment to prepare jobs related to welding, fitting, machining, foundry processes and 3D printing techniques. |
| CO2 | To prepare the equipment/machine tool for the production of the job.   |
| CO3 | To produce job using materials of specific shape and size by a suitable set of operations.   |
| CO4 | To measure the accuracy of job using different measuring instruments.  |

#### COURSE CONTENTS

| S. No | Shop / Lab                       | Topics  |
|-------|----------------------------------|---|
| 1     | All Shops                        | Introduction to Product Realization through 3D Printing, Welding, Foundry, Machining, and Assembly.   |
| 2     | Machine Shop                     | Introduction/Classification of Machine tools (Lathe, Shaper, Drilling, Grinder, Milling machines), Single and Multi-point Cutting tools, Safety/Precautions during machine shop. Demo and hands on practice on preparation of Job on Lathe Machine Tool —Simple Turning, Step turning, facing, Knurling, etc. |
| 3     | Welding Shop                     | Introduction/Classification/Advantages and Disadvantages of welding processes (i.e. Arc, Gas and Resistance Welding), Safety/Precautions during welding shop. Demo and hands on practice on preparation of Butt/Lap/Corner/T-Joint on Arc welding machine.  |
| 4     | Foundry Shop                     | Introduction to Oil/Electric Furnace/Foundry tools/ Moulding Sand, Types of patterns, Types of Allowances, Safety/Precautions during foundry shop. Demo and hands on practice on preparation of Mould cavity and Casting Job(s).  |
| 5     | Fitting Shop                     | Introduction to various Fitting tools/Measuring tools/ Marking tools, Safety/Precautions during foundry shop. Demo and hands on practice on preparation of fitting job using following operations (Filing, Drilling, Tapping, Assembly etc.)  |
| 6     | Product Design & Development Lab | Introduction to FDM based 3D Printing Steps. Demo and hands on practice on FDM based 3D Printing including Pre and Post Processing.   |

#### TEXT BOOKS/ REFERENCE BOOKS (Title, Authors, Publisher & Year)

- 1.The Elements of Workshop Technology - Vol I & II, S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, latest edition, Media Promoters and Publishers, Mumbai.
- 2.Lab Manuals

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| Course Code | Course Title                       | Credits | Lecture | Tutorial | Practical | Studio |
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| 22MET103    | Applied Probability and Statistics | 3       | 2       | 1        | 0         | 0      |

**PREREQUISITE** : Basic fundamentals of mathematics

#### COURSE OUTCOMES

|     |  |
|-----|--|
| CO1 | Acquiring a basic knowledge about application of probability theory, useful for modeling uncertain phenomena in engineering                |
| CO2 | Learning the general methods of estimating statistical parameters using data and thereby establishing their values with hypothesis testing |
| CO3 | Learning standard statistical methods useful for everyday routine elementary applications  |
| CO4 | Implementing Applied Probability and Statistics theory knowledge in real world decision making.  |

#### COURSE CONTENTS

**Introduction to the role of probability and statistics in engineering:** Why study statistics, role of science and engineer in quality improvement, a case study: Visually inspecting data to improve product quality, concept of population and sample.

**Descriptive statistics and treatment of data:** Measures of central tendency, Pareto diagram, frequency distribution, box plots, pair plots, scatter plots.

**Probability concepts:** Conditional probability, Bayes' theorem, random variables, types of probability distribution, binomial distribution, mean and variance of probability distribution, Chebyshev's theorem, Poisson distribution, normal distribution, uniform distribution, sampling distribution of mean and variance.

**Inferential statistics:** Point estimation, interval estimation, inferences concerning means, variance and proportions with hypothesis testing.

**Curve fitting:** Correlation, Method of least squares, linear regression, residual analysis, auto-correlation.

#### TEXT BOOKS/ REFERENCE BOOKS:-

- 1) Probability and Statistics for Engineers, Richard A. J., Miller, I. and Freund J., 8th ed., Pearson, 2015.
- 2) Data Analysis and Decision Making, Albright, S.C., Winston, W.L. and Zappe, C.J Cengage, 2015.

#### ONLINE/E RESOURCES

- 1) <https://www.youtube.com/c/joshstarmarmer>
- 2) <https://statquest.org>

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| Course Code | Course Title                 | Credits | Lecture | Tutorial | Practical | Studio |
|-------------|------------------------------|---------|---------|----------|-----------|--------|
| 22MET104    | Casting, Welding and Forming | 3       | 3       | 0        | 0         | 0      |

PREREQUISITE : None

#### COURSE OUTCOMES:

|     |  |
|-----|--|
| CO1 | To provide detailed information about the moulding processes   |
| CO2 | Illustrate casting problem (melting, refining & pouring and production of a mould) and explain process capabilities and application of casting processes. Design a “mould ready to pour” solution for a given casting. |
| CO3 | Illustrate capabilities of welding processes and select an appropriate welding process for a given application   |
| CO4 | Illustrate capabilities of forming process and hence application of bulk metal forming processes and sheet metal work.   |

#### COURSE CONTENTS

**Casting Processes:** Casting, molding methods and processes-materials, equipment, molding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making. Design considerations in casting, gating and risering, directional solidification in castings. Heat transfer & fluid mechanics aspects in casting, Sand castings-pressure die casting-permanent mould casting-centrifugal casting precision investment casting, shell moulding, CO2 moulding, continuous casting-squeeze casting-electro slag casting, Thixo Molding, Moulding for Magnesium alloys. Gas injection moulding. Fettling, finishing, defects in Castings. Foundry melting furnaces: selection of furnace-crucibles oil fired furnaces, electric furnaces-cupola, hot blast etc

**Welding Processes:** Classification of welding processes, gas welding-arc welding-shielded metal arc welding, TAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc, thermit welding soldering, brazing and braze welding. Electron beam and Laser beam welding-plasma arc welding-stud welding-friction welding-explosive welding ultrasonic welding-underwater welding-roll bonding-diffusion bonding-cold welding-welding of plastics, dissimilar metal. Gas welding equipment's-welding power sources and characteristics-safety aspects in welding-automation of welding, seam tracking, vision and arc sensing-welding robots. Defects in welding-causes and remedies-destructive testing methods - NDT of weldments - testing of pipe, plate, boiler, drum, tank-case studies-weld thermal cycle-residual stresses-distortion-relieving of stresses, weld ability of cast iron, steel, stainless steel, aluminium alloys effect of gases in welding, fatigue failure in weldments.

**Metal Forming Processes-** Principle, solid mechanics aspects of forming, classification and equipment for forging, rolling and extrusion processes, Defects and analysis: Rod/wire drawing-tool, equipment and principle of processes defects, Tube drawing and sinking processes. Mannesmann processes of seamless pipe manufacturing. Classification conventional and HERF processes, Presses-types and selection of presses, formability of sheet metals, Principle, process parameters, equipment and application of the following processes. Deep drawing, spinning, stretch forming, plate bending, press brake forming, Explosive forming, electro hydraulic forming, magnetic pulse forming. Super plastic forming, electro forming-fine blanking, P/M forging-Isothermal forging-high speed, hot forging high velocity extrusion.

#### TEXT BOOKS/ REFERENCE BOOKS:-

1. Taylor H F, Flemings M C and Wulff J, Foundry Engineering, Wiley Eastern Limited, 1993.
2. Lindberg R.A, Processes and Materials of Manufacture, Prentice Hall of India (P) Limited, 1996.
3. Lancaster J.F., Metallurgy of welding, George Allen and Unwin, 1991.
4. S. K. Hazra Choudhury, A. K. Hajra Choudhury, Nirjhar Roy. Elements of workshop technology Vol I- Manufacturing Processes, MPP.
5. Kalpakjian Serope, Manufacturing engineering and Technology, Wesley Publishing Co., 1995.
6. William F. Hosford & Caddel Robert M., Metal forming (Mechanics & Metallurgy), Prentice Hall Publishing Co., 1990.
7. P. N. Rao, Manufacturing Technology, Volume 1, Tata McGraw-Hill Education, 2013
8. Amitabh Ghosh and Ashok Kumar Mallik, Manufacturing science, East west press private limited 1985.

#### ONLINE/E RESOURCES

1. SWAYM / NPTEL Portal

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|-------------|----------------------------------|---------|---------|----------|-----------|--------|
| 22MEP105    | Casting, Welding and Forming Lab | 2       | 0       | 0        | 2         | 0      |

PREREQUISITE : None

#### COURSE OUTCOMES:

|     |  |
|-----|--|
| CO1 | To provide detailed information about the moulding processes   |
| CO2 | Illustrate casting problem (melting, refining & pouring and production of a mould) and explain process capabilities and application of casting processes. Design a "mould ready to pour" solution for a given casting. |
| CO3 | Illustrate capabilities of welding processes and select an appropriate welding process for a given application   |
| CO4 | Illustrate capabilities of forming process and hence application of bulk metal forming processes and sheet metal work.   |

#### COURSE CONTENTS

- To perform various testing of green sand properties. i.e. (a) Clay content (b) Moisture content test (c) Grain fineness number test
- To perform various testing of green sand properties. i.e. (d) Permeability Test (e) Strength test (f) Hardness test
- Design of greensand mould with complete gating system for a product and testing it through a software
- Study of various castings defects and testing by NDT. i.e. UT
- Performing a parametric study of casting of MMC on stir casting machine
- Performing a butt joint and lap joint using TIG/MIG
- Mechanical testing of butt/lap joint welded by arc welding process
- To study the effect of process parameters in gas welding / arc welding / resistance welding (any one)
- Study of various weld defects and testing by NDT. i.e. UT/DP
- Design of die and punch and performing a forming operation
- To study the different types of dies and producing the washer

#### TEXT BOOKS/ REFERENCE BOOKS

1. Lab Manuals

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| 22MET106    | Engineering Thermodynamics | 4       | 3       | 1        | 0         | 0      |

PREREQUISITE Nil

#### COURSE OUTCOMES:

|     |  |
|-----|--|
| CO1 | To understand the basic concepts of thermodynamic such as temperature, pressure, system, properties, process, state, cycles and equilibrium.                 |
| CO2 | To solve common engineering problems in the thermal sciences field, including problems involving application of the first and second laws of thermodynamics. |
| CO3 | To relate science of thermodynamics to the commonly available thermal systems.   |
| CO4 | To apply learned knowledge and skills of this course in order to understand, analyze, and design different thermal components, processes and systems.        |

#### COURSE CONTENTS

**Introduction and Basic Concepts:** Thermodynamics and Energy, Application Areas of Thermodynamics, Systems and Control Volumes, Properties of a System, Density and Specific Gravity, State and Equilibrium, Processes and Cycles, The Steady-Flow Process, Temperature and the Zeroth Law of Thermodynamics.

**Energy Conversion and General Energy Analysis:** Introduction, Forms of Energy, Some Physical Insight to Internal Energy, Mechanical Energy, Energy Transfer by Heat, Energy Transfer by Work, Electrical Work, Mechanical Forms of Work, Shaft Work, The First Law of Thermodynamics, Energy Balance, Energy Change of a System, Corollaries of 1st law, Application of first law to closed systems and open systems under steady and unsteady flow condition.

**Properties of Pure Substances:** Pure Substance, Phases of a Pure Substance, Phase-Change Processes of Pure Substances, Compressed Liquid and Saturated Liquid, Saturated Vapor and Superheated Vapor, Saturation Temperature and Saturation Pressure, Property Diagrams for Phase-Change, Processes, The T-v Diagram, The P-v Diagram, Extending the Diagrams to Include the Solid Phase, The P-T Diagram, The P-v-T Surface, Property Tables, Enthalpy, Superheated Vapor, The Ideal-Gas Equation of State

**Energy Analysis of Closed Systems:** Moving Boundary Work, Polytropic Process, Energy Balance for Closed Systems, Specific Heats, Internal Energy, Enthalpy, and Specific Heats of Ideal Gases, Specific Heat Relations of Ideal Gases, Internal Energy, Enthalpy, and Specific Heat of Solids and Liquids, Internal Energy Changes, Enthalpy Changes.

**The Second Law of Thermodynamics:** Introduction to the Second Law, Thermal Energy Reservoirs, Heat Engines, Thermal Efficiency, Kelvin-Planck Statement, Refrigerators and Heat Pumps, Coefficient of Performance, Heat Pumps, Statement, Equivalence of the Two Statements, Perpetual-Motion Machines, Reversible and Irreversible Processes, Irreversibility, Internally and Externally Reversible Processes, The Carnot Cycle, The Reversed Carnot Cycle, The Carnot Principles.

**Entropy: Entropy,** Statistical definition of entropy, Reversible and irreversible processes in terms of Entropy, Application Second Law of Thermodynamics to closed systems and open systems under steady and unsteady flow condition.

**Miscellaneous:** Exergy, Second law efficiency, Maxwell Equations, Zeroth Law of Thermodynamics, Third Law of Thermodynamics, Clapeyron equation, Joule-Thomson effect, P-v-T surfaces for ideal and real gases.

#### TEXT BOOKS/ REFERENCE BOOKS: -

1. Y. A. Cengel & M. A. Boles; Thermodynamics-An Engineering Approach; McGraw-Hill Inc.
2. P. K. Nag; Engineering Thermodynamics; Tata McGraw-Hill, New Delhi.
3. G. Van Wylen, R. Sounting & C Borgnakke; Fundamentals of Classical Thermodynamics; John Wiley & Sons/New Age International, Delhi
4. J. P. Holman; Thermodynamics; McGraw-Hill Book Co. New Delhi.

#### ONLINE/E RESOURCES

1. <https://nptel.ac.in/courses/101104063>

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#### Details of the Course

| Course Code | Course Title          | Credits | L | T | P | Studio |
|-------------|-----------------------|---------|---|---|---|--------|
| 22MET107    | Engineering Mechanics | 3       | 2 | 1 | 0 | 0      |

**Prerequisite:** None

#### Course Outcomes:

|     |  |
|-----|--|
| CO1 | Understand the basic principles of engineering mechanics with emphasis on their analysis and application to practical engineering problems |
| CO2 | Analyze planar and spatial systems to determine the forces in members of trusses, frames   |
| CO3 | Understand the concept of moment of inertia and apply them to engineering problems   |
| CO4 | Apply fundamental ideas of kinematics and dynamics to the analysis of simple practical problems  |

#### Course Contents:

**Introduction to Mechanics and Laws of Mechanics. Statics of Particles:** Forces in a Plane- Force on a Particle, Resultant of Two Forces, Resultant of Several Concurrent Forces, Resolution of a Force into Components Rectangular Components of a Force. Equilibrium of a Particle, Free-Body Diagrams. Forces in Space – Rectangular Components of a Force in Space, Force Defined by Its Magnitude and Two Points on Its Line of Action. Addition of Concurrent Forces in Space, Equilibrium of a Particle in Space.2

**Rigid Bodies: Equivalent Systems of Forces:** Principle of Transmissibility. Equivalent Forces, Moment of a Force about a Point, Varignon's Theorem, Moment of a Force about a Given Axis, Moment of a Couple, Equivalent Couples, Resolution of a Given Force into a Force and a Couple, Reduction of a System of Forces to One Force and one Couple Equivalent Systems of Forces, Reduction of a System of Forces to a Wrench.

**Equilibrium of Rigid Bodies:** Introduction, Free-Body Diagram, Equilibrium in Two Dimensions, Reactions at Supports and Connections for a Two-Dimensional Structure, Equilibrium of a Rigid Body in Two Dimensions, Statically Indeterminate Reactions. Partial, Constraints, Equilibrium of a Two-Force Body, Equilibrium of a Three-Force Body, Equilibrium in Three Dimensions, Equilibrium of a Rigid Body in Three Dimensions, Reactions at Supports and Connections for a Three-Dimensional Structure.

**Force Analysis of Rigid bodies Structures:** Plane Trusses, Methods of Joints, Method of Section, Space Trusses, Frames and Machines, Internal Forces Developed in various Structural Members (such as rod, beam, shaft), Shear and Moment Equations and Diagrams (SFD and BMD), Relations between Distributed Load, Shear, and Moment.

**Distributed Forces:** Centroids and Center of Gravity: Moments of Inertia of Areas, Second Moment, or Moment of Inertia, of an Area, Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Product of Inertia, Principal Axes and Principal Moments of Inertia, Mohr's Circle for Moments and Products of Inertia, Moments of Inertia of a Mass Moment of Inertia of a Mass, Parallel-Axis Theorem, Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration, Moments of Inertia of Composite Bodies, Moment of Inertia of a Body with Respect to an Arbitrary Axis through O, Mass Products of Inertia.

**Methods of Virtual Work and Total Potential Energy:** Work- Work of a Force and Couple, Virtual Work- Principle of Virtual Work for a Particle and Rigid Bodies, Potential Energy and Stability- Elastic Kinematics and Dynamics of Rigid Bodies: General plane motion.

#### Text Books/ Reference Books

1. Vector Mechanics for Engineers, Beer, F.P and Johnson Jr. E.R. Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 2019.
2. Engineering Mechanics, Hibbeler, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2017.
3. Engineering Mechanics – Statics and Dynamics, Irving H. Shames, IV Edition – Pearson Education Asia Pvt. Ltd., 2005.
4. Engineering Mechanics, Merian J.L. and Kraige L.G., Vol. 1 Statics and Vol. 2 Dynamics, Wiley-India, 5 Edition, 2017.