DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET251	**Dynamics of Machines**	**4**	**3**	**1**	**0**	**0**

PREREQUISITE : Engineering Mechanics; Kinematics of Machines

COURSE OUTCOMES:

CO1	Derivations Equations of Motions, computation of static and dynamic forces of mechanisms.
CO2	Dynamic Force analysis for linkages
CO3	Calculate the balancing masses and their locations for parallel and linkage
CO4	Compute the frequency of free vibration, forced vibration and damping coefficient.
CO5	Calculate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.

COURSE CONTENTS

Dynamics Fundamentals: Three-dimensional Dynamics of rigid bodies: translations, Fixed-axis rotation, parallel-plane motion, rotation about a fixed axis, General motion, Angular momentum, Moments and products of Inertia, Equations of Motion.

Dynamic Force Analysis: Force analysis of fourbar linkages, Shaking force and shaking moment, Controlling input torque-flywheel

Balancing: Static and dynamic balancing, balancing conditions, balancing for parallel plane motions, balancing of linkages. Engine dynamics: Equivalent dynamic models, Shaking force and shaking moments, Balancing of single-cylinder engine, multi-cylinder engines

Control Mechanisms: Governors, types, centrifugal governors, gravity controlled and spring controlled centrifugal governors characteristics – stability- sensitiveness-hunting, isochronisms-effect of friction-controlling force; Gyroscopes, gyroscopic forces and torques, gyroscopic stabilization, gyroscopic effects in automobiles, ships and airplanes

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

TEXT BOOKS/ REFERENCE BOOKS

1. Kinematics and Dynamics of Machinery, First Edition in SI, R.L. Norton, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2016
2. Theory of Machines, 4 Edition, S. S. Rattan, Tata McGraw-Hill, 2014.
3. Theory of Mechanisms & Machines by Amitabha Ghosh, Asok Kumar Mallik, Affiliated East-West Press Pvt Ltd, 2000
4. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press, 2014
5. Kinematics, Dynamics and Design of Machinery by by Kenneth J. Waldron , Gary L. Kinzel, Wiley India Pvt Ltd, 2016
6. Engineering Mechanics – Dynamics, vol. 2, J.L. Meriam, L.G. Kraige, Wiley India Pvt. Ltd, New Delhi
7. Dynamics and Balancing of Multibody Systems, Himanshu Chaudhary, S.K. Saha, Springer

ONLINE/E RESOURCES

1. NPTEL: Theory of Mechanisms by Prof. Sujatha Srinivasan, IIT Madras
2. NPTEL: Kinematics of Mechanisms and Machines by, Prof. A. Dasgupta, IIT Kharagpur

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET252	**Heat Transfer**	**4**	**3**	**1**	**0**	**0**

PREREQUISITE: Calculus, Physics, Engineering Thermodynamics, Fluid Mechanics, Material Science

COURSE OUTCOMES

After attending the course, the student will be able to demonstrate following skills which would be evaluated though various assessments

CO1	Understand different modes of heat transfer and the governing laws
CO2	Model the governing equations and boundary conditions applicable to one dimensional steady state conduction with and without heat generation
CO3	Solve engineering problems involving forced convection
CO4	Solve engineering problems involving free convection
CO5	Solve elementary problems involving rating and sizing of heat exchanger(s)
CO6	Solve engineering problems involving radiation heat exchange

COURSE CONTENTS

- Basic modes of heat transfer; mechanisms of heat transfer; governing laws; thermal conductivity of matter in different states.
- General conduction equations; boundary and initial conditions; variable thermal conductivity; one dimensional steady state conduction with and without heat generation; conduction in composite medium; critical thickness of insulation; extended surfaces, efficiency, effectiveness; unsteady conduction.
- Convective boundary layers; local and average heat transfer coefficients; governing equations for forced convection, dimensionless groups, laminar and turbulent flow convection; external and internal flow convection; empirical correlations for forced convection.
- Free convection boundary layers, governing equations, dimensionless groups; laminar and turbulent free convection, integral solution; empirical correlations; mixed convection; phase-change convection.
- Types of heat exchangers; arithmetic and log mean temperature difference for parallel and counter flow arrangement; overall heat transfer coefficient, effect of fouling; analysis of multi-pass heat exchangers; effectiveness of heat exchangers; considerations for heat exchanger selection.
- Thermal radiation and governing laws; radiation properties; emissive power and intensity of radiation; diffused radiation; Gray body radiation; solar radiation; radiation exchange between surfaces, shape factor; radiation shields.

References-

Text Books/ Reference books

1. Introduction to Heat Transfer, Bergman TL, Lavine AS, Incropera FP, Dewitt DP, Wiley, 2011.
2. Heat Transfer, Holman JP, McGraw Hill, 2004.
3. Heat and Mass Transfer, Cengel YA, Ghajar AJ, McGraw Hill, 2017.
4. Heat & Mass Transfer, Arora and Domkundwar, Dhanpat Rai and Company, 2006.

Online/E resources

1. NPTEL, Heat and Mass Transfer, IISc Bangalore, Prof. Pradip Dutta (https://nptel.ac.in/courses/112108149

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET253	**IC engines**	**3**	**3**	**0**	**0**	**0**

PREREQUISITE : Engineering Thermodynamics and fundamental knowledge of Fluid Mechanics.

COURSE OUTCOMES:

CO1	Perform calculations for efficiency and M.E.P. for ideal air standard cycles and actual cycles of operation. Explain the combustion process in SI and CI engines. Understand factors influencing combustion chamber design
CO2	Illustrate the working principal of basic engine components such as fuel supply systems and ignition system
CO3	Lubricating systems and cooling systems. Get familiarized with the terms supercharging, turbocharging and scavenging.
CO4	Understand I.C. engine emission and emission reduction techniques,
CO5	Recognize special engines; gain some knowledge of various sensors, ECU etc. Understand basic I.C. engine simulation models

COURSE CONTENTS

Components, classification and application of IC engine, working of four/ two stroke engine, valve timing diagram, scavenging, fuel, qualities of fuel, rating of fuel, stoichiometric air fuel ratio, Ideal and actual cycles of operation, air standard cycles, combustion and abnormal combustion in SI and CI engines, factors affecting knocking, control of knocking, combustion chambers

Mixture requirement for different loads and speeds, carburetor and its working, types of injection systems in SI and CI engine, ignition system for SI engine

Lubrication: Need, function and classification of lubrication system-wet sump and dry sump, crankcase ventilation. Cooling: Types of cooling systems-liquid and air cooled, comparison of liquid and air-cooled systems, working of supercharger, working of turbocharger, control of turbocharger

Air pollution due to IC engines, emission norms, formation and control of PM, HC, CO and NOx emission for SI and CI engine

Measurement and testing of IC engines, introduction to special engines, sensors used to IC engine, electronic control unit, computer simulation of two stroke & four stroke engines

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

1. Stone, R., Introduction to Internal Combustion Engines, The Macmillan Press Limited, London,
2. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw Hill Book Co., NY
3. Obert, E.F., Internal Combustion Engines and Air Pollution, Harper & Row, NY
4. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill, New Delhi
5. Mathur, M.L. and Sharma, R.P., A Course in Internal Combustion Engines, DhanpatRai & Sons, New Delhi
6. Taylor, C.F., The Internal Combustion in Theory and Practice Vol. I & II, The M.I.T. Press.

ONLINE/E RESOURCES

1. https://nptel.ac.in/courses/112103262
2. https://nptel.ac.in/courses/112104033

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET254	**Operations Planning and Control**	**3**	**2**	**1**	**0**	**0**

PREREQUSITE- None

COURSE OUTCOMES:

CO1	To understand the importance and basic concepts of the operation planning and control
CO2	Analyze and evaluate various facility locations alternatives and their decisions
CO3	Apply qualitative and quantitative models for forecasting of product demand
CO4	Develop aggregate production and capacity plans for operations
CO5	Apply inventory models to decide appropriate inventory policy
CO6	Develop sequence of jobs in production environment

COURSE CONTENTS

Introduction to production and operations management, Service v/s production operations, Characteristics of MTS, MTO, ETO, and ATO. Plant location and layout, factors affecting plant location, Types of layouts, Line Balancing

Forecasting: Qualitative and quantitative forecasting, Simple and moving averages, Exponential smoothing, Time series decomposition: trend and seasonality, Quantitative evaluation of forecasting models

Aggregate production plans, Master Production Schedule, Capacity planning.

Inventory Control: Basic EOQ model and its extension to finite production rate and quantity discounts, Single period probabilistic models, Inventory policies, MRP, MRP-II.

Operations scheduling, Sequencing and scheduling, Job shop and flow shop, Sequencing using FCFS, SPT, EDD, Johnson's rule.

JIT and Lean manufacturing

References-

Text Books/ Reference books:

1. Everett E. Adam, Ronald J. Ebert, Production and Operations Management. 5th Edition, PHI.
2. Steven Nahmias, Production and Operations Analysis. 5th Edition, Mc Graw Hill.
3. Joseph S. Martinich, Production and Operations Management. 5th Edition, Wiley India.
4. Seetharama L. Narasimhan, Dennis W. McLeavey, Peter J. Billington. Production planning and Inventory Control. 2th Edition, PHI.

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical
22MET255	**Science of Machining**	**4**	**3**	**1**	**0**

Pre-requisite course: Product Realization through Manufacturing

Course Outcomes

CO1	To understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
CO2	To identify different forces acting during machining with the help of merchant circle force diagram and Cutting force measuring techniques.
CO3	To understand the thermal Aspects In Machining and how to control that temperature with the help of Cutting fluid.
CO4	To understand the fundamental knowledge on the relation of tool with machinability and tool life.
CO5	To understand the fundamental knowledge of jig and fixtures during machining.

COURSE CONTENTS

MATERIALS AND GEOMETRY OF CUTTING TOOLS: Introduction, Desirable Properties of Tool Materials, Characteristics of Cutting Tool Materials, Cutting tool geometry, Chip flow direction, Tool angles specification systems, Cutting parameters and Tool geometry, Index able inserts, chip breakers, Tools of unusual geometry.

MECHANICS OF METAL CUTTING: Merchant's circle diagram- determination of cutting and thrust forces; Coefficient of friction; shear plane angle, Velocity and force relationship, shear stress and strain and strain rate in orthogonal cutting, stress distribution along rake face, theories of Lee and Shaffer's, Oxley's, etc. Cutting force measuring techniques i.e dynamometer.

THERMAL ASPECTS IN MACHINING AND CUTTING FLUID: Regions of heat generation; Heat In the Primary Shear Zone, Heat at the Tool/work Interface, Heat Flow at the Tool Clearance Face, Average shear plane temperature; Average chip-tool interface temperature; method of tool temperature measurement, temperature distribution in tool, Cutting Fluid: Types and composition of cutting fluids, selection of cutting fluid.

TOOL WEAR, TOOL LIFE AND MACHINABILITY: Tool wear mechanisms, Types of tool damage during cutting, Wear and chipping characteristics of different tool materials, Tool wear equations, tool failure criteria, Tool life equations, Effect of process parameters on Tool life, Tool life testing, Machinability, Surface finish and surface integrity.

INTRODUCTION TO JIGS & FIXTURES: Introduction, Important Considerations while Designing Jigs and Fixtures, Meaning of Location, Principles of Locations, Different Methods Used for Locations, Different Types of Jigs and fixtures, Advantages of Jigs and Fixtures.

Text Books / Reference Books:

1. Manufacturing Engineering and Technology Kalpakjain
2. Metal cutting theory and practice by Bhattacharya
3. Manufacturing Engineering and Technology Groover
4. Metal Cutting Principles Milton C Saw, Oxford
5. Machining Sciences Amitabh Ghosh
6. Jigs and fixtures, 3rd edition Prakash Hiralal Joshi

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP256	**Heat Transfer Lab.**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE: Calculus, Physics, Engineering Thermodynamics, Fluid Mechanics, Material Science

COURSE OUTCOMES

After attending the course, the student will be able to demonstrate following skills which would be evaluated though various assessments

CO1	Ability to apply theory to analyze different modes of Heat Transfer.
CO2	Ability to distinguish between heat transfer at steady and Unsteady states.
CO3	Ability to rate the thermal performance of extended surfaces.
CO4	Ability to rate the thermal performance of a heat exchanger.

COURSE CONTENTS

- Measurement of thermal conductivity of fluids.
- Measurement of thermal conductivity of solids.
- Study of Heat conduction through a solid composite medium.
- Study of unsteady Heat Transfer.
- Study of free convection over an extended surface.
- Study of forced convection over an extended surface.
- Study of convection in internal flows.
- Study of natural convection in external flows.
- Study of parallel flow heat exchanger.
- Study of counter flow Heat Exchanger.
- Measurement of radiative emissivity of a test surface.
- Measurement of Stefan-Boltzmann Constant.

REFERENCES-

TEXT BOOKS/ REFERENCE BOOKS

1. Introduction to Heat Transfer, Bergman TL, Lavine AS, Incropera FP, Dewitt DP, Wiley, 2011.
2. Heat Transfer, Holman JP, McGraw Hill, 2004.
3. Heat and Mass Transfer, Cengel YA, Ghajar AJ, McGraw Hill, 2017.
4. Heat & Mass Transfer, Arora and Domkundwar, Dhanpat Rai and Company, 2006.

ONLINE/E RESOURCES

1. NPTEL, Heat and Mass Transfer, IISc Bangalore, Prof. Pradip Dutta (https://nptel.ac.in/courses/112108149)

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP257	**IC engines Laboratory**	**2**	**0**	**0**	**2**	**0**

PREREQUISITE : Engineering Thermodynamics and fundamental knowledge of Fluid Mechanics.

COURSE OUTCOMES:

CO1	Understand the practical operation of 2 stroke and 4 stroke I.C engines using valve timing diagram and experimentally draw valve timing diagram for a four stroke single cylinder Ruston diesel engine
CO2	Analyze the performance of single and multi-cylinder engines with the variation of Various performances like load and speed.
CO3	Discuss the importance of engine testing and demonstrate and experiment with dynamometer
CO4	Explain the effect of various exhaust gases on the environment and demonstrate how to minimize them by using different techniques
CO5	To understand types of dynamometers and Dartturbo-prop engine.

COURSE CONTENTS

- To draw the valve timing diagram for a four-stroke single cylinder Ruston diesel engine.
- Study of construction, working and various types of dynamometers.
- To draw the volumetric efficiency and performance characteristics for four stroke four stroke single cylinder water cooled diesel engine (Kirloskar).
- To calculate and draw heat balance sheet of four stroke four stroke single cylinder water cooled diesel engine (Kirloskar).
- To draw the volumetric efficiency and performance characteristics for four stroke single cylinder air cooled diesel engine (Kirloskar).
- To draw the volumetric efficiency and performance characteristics for four stroke single cylinder air cooled engine (Kirloskar) fueled with diesel blends.
- To draw the volumetric efficiency and performance characteristics for four stroke single cylinder four stroke gasoline Honda Genset engine.
- To draw the volumetric efficiency and performance characteristics of Mahindra multi-cylinder diesel engine at fixed load and varying engine rpm.
- To draw the volumetric efficiency and performance characteristics of Mahindra multi-cylinder diesel engine at fixed rpm and varying engine load.
- To draw performance and emission characteristics of four stroke single cylinder water cooled four stroke VCR C.I engine coupled with eddy current dynamometer.
- Study of Dartturbo-prop engine.
- Study of IC engine generated emissions, effects measurement and control.

REFERENCES-

1. Lab Manuals

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP258	**Kinematics and Dynamics of Machines lab**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE : Engineering Mechanics, Kinematics of Machines

COURSE OUTCOMES

CO1	Explain gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipments.
CO2	Determine mass moment of inertia of mechanical element, governor effort and range sensitivity, natural frequency and damping coefficient, torsional frequency, critical speeds of shafts, balancing mass of rotating and reciprocating masses, and transmissibility ratio.
CO3	Understanding of balancing mass of rotating and reciprocating masses, and transmissibility ratio.
CO4	Understanding of Coriolis forces and centrifugal forces through experiments
CO5	Modeling of linkages through software

COURSE CONTENTS

- Four Bar linkage mechanism including Accessories
- Cam analysis mechanism
- Slider Crank/ Quick return mechanism
- Scotch Yoke Mechanism
- Geneva mechanism
- Universal Joint
- Mechanical Power Transmission training system including accessories
- Balance of Reciprocating Masses Simulator
- Vibration Fundamental Training System
- Portable Stand-alone Vibration Analyzer
- Coriolis and centrifugal forces
- Modeling and analysis of linkages on motion solve of Hyper works
- Modeling and analysis of linkages on motion solve of Hyper works

REFERENCES-

1. Lab Manuals

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP259	**Science of Machining Lab**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE: Product Realization through Manufacturing

COURSE OUTCOMES:

CO1	Students will able to understand the cutting tool geometry and cutting tool materials of single point.
CO2	Students will able to understand the different forces acting during machining through merchant circle diagram. Force analysis through dynamometer.
CO3	Students will able to understand thermal aspects in machining and different cutting fluid to control the temperature and method of applying cutting fluid.
CO4	Students will able to understand tool wear mechanism and tool life equation.
CO5	Students will able to understand about jig and fixtures.

COURSE CONTENT:

- Measurements of Tool angles of the given single point cutting tool in orthogonal rake system (ORS) and Machine Tool Reference system (MTR).
- Make a job as per drawing using lathe machine.
- To study the Constructional features of a Milling Machine and Indexing on Horizontal Milling Machine and **m**ake a job using Gear Cutting Machine (Horizontal Milling machine
- To Study the constructional features of a Capstan and Turret lathe machine and make a rivet job using the same out of an Aluminum rod on Capstan and Turret Lathe machine.
- To study the constructional features of a Copying Lathe Machine and make a job for a standard component using Copying Lathe machine
- To study the Constructional features of a shaper machine and make a job as per drawing using shaper machine.
- Experiments for jig and fixtures
- Experimentations on Dies for Press Tools.
- Experiments for tool wear mechanism and tool life equation.
- Study of universal dynamometer and determine cutting and feed force.

REFERENCES-

1. Lab Manuals