Velagapudi Ramakrishna Siddhartha Engineering College: Vijayawada - 7

Scheme of Instruction and Examination – VR14

Department of Mechanical Engineering

Semester V

S.No	Sub. Code	Subject Title	L	T	P	C	CE	SE	T
1	14ME 3501	Hydraulic Machines	3	1		2	30	70	100
2	14ME 3502	Design of Machine Elements	4	1		4	30	70	100
3	14ME 3503	Machine Dynamics	4	1		4	30	70	100
4	14ME 3504	Internal Combustion Engines	4	1		4	30	70	100
5	14ME 2505	Institutional Elective *	4			4	30	70	100
6	14ME 5506	Independent Learning				2	30	70	100
7	14ME 3507	Metal Cutting and Machine Tools	3	1		3	30	70	100
8	14ME 3551	Geometrical Modeling Lab			3	2	30	70	100
9	14ME 3552	SM & FM Lab			3	2	30	70	100
		Total	**22**	**5**	**6**	**27**	**270**	**630**	**900**

L – Lecture, T – Tutorial, P – Practical, C – Credits, CE - Continuous Evaluation,

SE - Semester- End Evaluation ,T – Total Marks

Institutional Elective* (offered to other departments)

14ME 2505A: Robotics and Automation

14ME 2505B: Automobile Engineering

14ME 2505C: Manufacturing Processes

14ME 2505D: Work Study

Independent Learning

14ME 5506A: Unconventional Machining Processes

14ME 5506B: Work Study

Velagapudi Ramakrishna Siddhartha Engineering College: Vijayawada - 7

Scheme of Instruction and Examination – VR14

Department of Mechanical Engineering

Semester VI

S.No	Sub. Code	Subject Title	L	T	P	C	CE	SE	T
1	14ME 3601	Heat Transfer	4	1		4	30	70	100
2	14ME 3602	Design of Transmission Elements	4	1		4	30	70	100
3	14ME 3603	Operations Research	4	1		4	30	70	100
4	14HS 1604	Engineering Economics and Finance	3			3	30	70	100
5	14ME 3605	Engineering Metrology and Measurements	3	1		3	30	70	100
6	14ME 3651	Fuels and IC Engines Lab			3	2	30	70	100
7	14ME 3652	Machine Tools Lab			3	2	30	70	100
8	14ME 5653	Term Paper			1	2	30	70	100
		Total	**18**	**4**	**7**	**24**	**240**	**560**	**800**

L – Lecture, T – Tutorial, P – Practical, C – Credits, CE - Continuous Evaluation,

SE - Semester End Evaluation, T – Total Marks

14ME 3501 - HYDRAULIC MACHINES

Course Category:	**Program Core**	**Credits:**	2
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	3 - 1 - 0
Prerequisites:	14ME 3403 Fluid Mechanics	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	30 70 100

Course outcomes		After successful completion of this course, the student will be able to											
	CO1	Apply the momentum principles for analysis of impact of jets.											
	CO2	Analyze the performance of hydraulic turbines.											
	CO3	Understand the working and factors influencing the performance of hydraulic pumps.											
	CO4	Familiarize with different hydraulic devices and systems needed for various applications.											
Contribution of Course Outcomes towards achievement of Program Outcomes (L–Low, M-Medium, H-High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M				H							
	CO2	M				H							
	CO3	M				H							
	CO4	H									M		
Course Content	**UNIT I:** **Introduction:** Classification of fluid machines, impulse action, linear impulse momentum and angular momentum principles. **Impact of jets:** Introduction, Force exerted by a fluid jet on stationary and moving flat plate and curved vanes, flow over radial curved vanes. **UNIT II:** **Hydraulic Turbines:** Elements of hydroelectric power plants, Heads and efficiencies of a turbine, Classification- Pelton, Francis and Kaplan turbines, working proportions of turbines. **Performance of Turbines:** Unit quantities, Specific speed, Comparison and selection of turbines, Numerical problems, Draft tube, Oil pressure Governing, Performance characteristics. **UNIT III:** **Centrifugal Pumps:** Types, Working, Reciprocating vs. Centrifugal pump, Work done by impeller, Head of a pump, losses and efficiencies, Minimum starting speed, Specific speed, Multistage pumps, Pumps in parallel, Performance characteristic curves, limitation of suction lift, NPSH, Cavitation.												

	UNIT IV: **Reciprocating Pumps:** Introduction, main components, working, types work done by Reciprocating pump, coefficient of discharge, slip, percentage slip, and negative slip. **Hydraulic Systems:** Hydraulic-press, accumulator, lift, intensifier. **Pumping devices**: Hydraulic ram, Airlift pump and jet pump
Text Books and Reference Books	**Text Books:** 1. Hydraulics and Fluid Mechanics --P.N.Modi & S.M. Seth., Standard Book House, 2nd Edition, 2005. 2. Fluid Mechanics & Hydraulic Machines - by R.K.Bansal, Laxmi Publications, 9th Edition, 2009. **Reference Books:** 1. Fluid Mechanics & Hydraulic Machines – by R.K.Rajput,4th Edition, 2008 S.Chand & Company Limited 2. Fluid Mechanics & Fluid Power Engineering - by D.S.Kumar, SK.Kataria& Sons
E-resources	1. http://www.efluids.com/ 2. http://fluid.power.net/ 3. www.hydraulicspneumatics.com/ 4. www.waterengr.com/ 5. www.pumps.org/

14ME 3502 - DESIGN OF MACHINE ELEMENTS

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 1 - 0
Prerequisites:	14ME 1107- Mechanics for Engineers 14ME 3302 - Mechanics of Materials 14ME 3306 - Kinematics of Machines	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Acquire knowledge about the design fundamentals and design procedure of machine elements.
	CO2	Design power screws and apply fatigue failure criteria for machine components under various loading conditions.
	CO3	Design permanent fasteners such as the riveted, welded joints under various loading conditions.
	CO4	Design temporary joints such as bolted joints and suspension systems such as coil and leaf springs.

Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M		H		H							
	CO2	M		H		H							
	CO3	M		H		H							
	CO4	M		H		H							

Course Content

UNIT I:

Basics: Phases of design, Types of designs, standardization in design, preferred numbers and significance.

Design for Static Strength: Simple Stresses - Combined stresses - Torsion and bending stresses - stress strain relation, various theories of failure - Factor of safety and its importance in design.

UNIT II:

Design for Fatigue Strength: Stress concentration - Theoretical stress concentration factor - Fatigue stress concentrations factor, Design for fluctuating stresses, Fatigue strength and endurance limit, Goodman diagram, Soderberg line

Power Screws: Types - Mechanics of power screws, efficiency, self locking of screw and stresses in screw.

	UNIT III: **Fasteners:** **Riveted joints:** Terminology, Design of Boiler Joints, Lozenge joint, Design of joints under eccentric loading. **Welded joints:** Eccentrically loaded welded joints. **UNIT – IV:** **Bolted joints:** Design of bolted joints under eccentric loading **Springs:** Introduction; Materials; Types of springs, Helical springs under axial load, Fatigue loading, leaf springs.
Textbooks and Reference books	**Text Book:** 1. Design of machine elements by Bhandari, Tata McGraw Hill book Co. 2. Machine Design by P.C. Sharma & D.K. Agarwal. **Reference books:** 1. Design of Machine Elements by Sharma & Purohit ,PHI 2. Machine Design by Robert L.Norton. 3. Design of Machine Elements by Kannaiah **DATA BOOKS TO BE ALLOWED IN EXAMINATION:** 1. Design data book, Mahadevan & Balaveera Reddy - CBS Publishers 2. Design data book, V.B.Bhandari - Tata McGraw Hill book Co 3. Design data book, P.S.G. College of Technology, Coimbatore **Web Resources:** 1. http://nptel.ac.in/downloads/112105125/ 2. http://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mechanical-design-spring-2009/lecture-notes/

14ME 3503 - MACHINE DYNAMICS

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture-Tutorial-Practice:**	4-1-0
Prerequisites:	14ME 1107 Mechanics for Engineers 14ME 3306 Kinematics of Machines	**Continuous Evaluation:**	30
		Semester end Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Balance rotating and reciprocating masses.
	CO2	Analyze speed regulations in governors and gyroscopic effects on vehicles.
	CO3	Understand the concepts of energy fluctuations control using fly wheels.
	CO4	Evaluate natural frequency for longitudinal and transverse and torsional vibrations.

Contribution of Course Outcomes towards achievement of Program Outcomes (H-Highly Mapped,M-Moderately Mapped,L-Low)

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
CO1	M		L		H							
CO2	M		L		H							
CO3	M		H		H							
CO4	M		L		H							

Course Content

UNIT – I

TURNING MOMENT DIAGRAMS: Introduction, Single - cylinder double – acting steam engine, Single - cylinder four stroke engine, Multi-cylinder engine, Fluctuation of energy, determination of maximum fluctuation of energy, coefficient of fluctuation of energy.

FLY WHEELS: Introduction, Coefficient of fluctuation of speed, energy stored in fly wheel.

UNIT – II

GOVERNORS: Introduction, Watt Governor, Porter Governor, Hartnell Governor, Sensitiveness of a Governor, Hunting, Isochronism, Stability.

GYROSCOPES: Angular Velocity, Angular Acceleration, Gyroscopic Torque, Gyroscopic Effect on Air-planes, Naval Ships, Four wheelers and Two wheelers.

UNIT – III

BALANCING OF ROTATING SYSTEMS:

Introduction, Static balancing, Dynamic balancing, Transferring of a Force from one plane to another, Balancing of Several Masses in Different planes

BALANCING OF RECIPROCATING SYSTEMS: Balancing of Reciprocating Mass, Balancing of locomotives, Effects of partial balancing in locomotives, Hammer blow, Variation of Tractive effort, and Swaying couple

	UNIT – IV **UNDAMPED FREE VIBRATIONS:** **LONGITUDINAL VIBRATION:** Introduction, Definitions, Types of vibrations, Basic features of vibrating systems, Degree of freedom, free longitudinal vibrations. **TRANSVERSE VIBRATION:** Single concreted load, shaft carrying several loads, whirling of shafts. **TORSIONAL VIBRATION:** Single two and rotor systems.
Text books and Reference books	**Text Books:** [1] S.S.Rattan, "Theory of Machines", Fourth edition, McGraw Hill Education (India) Private Limited, 2014 [2]Dr.R.K.Bansal & Dr.J.S.Brar," Theory of Machines", Fourth edition, , Laxmi Publications (P) Limited, 2009. **Reference books:** [1]R.S.Khurmi & J.K.Guptha," Theory of Machines", 14th Edition, S.Chand & Company, 2006. [2] V.P.Singh,"Mechanical vibrations", Second Edition, Dhanpat Rai & Co (P) Limited, 2009
E-resources and other digital material	[1] Video in web: http://nptel.ac.in/courses/112104114/ [2] Video in web: https://youtu.be/OlZXxPVpmBs [3] Notes in web: http://www.vssut.ac.in/lecture_notes/lecture1429901026.pdf

14ME 3504 - INTERNAL COMBUSTION ENGINES

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture-Tutorial-Practice:**	4-1-0
Prerequisites:	14ME 3303 Basic Thermodynamics 14ME 3404 Applied Thermodynamics	**Continuous Evaluation:**	30
		Semester end Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Analyze air standard & fuel air cycles and Understand the working of 2-stroke & 4-stroke, petrol & diesel engines.
	CO2	Analyze the performance of I.C. Engines, operating curves and their fuel supply systems.
	CO3	Understand the combustion phenomena in I.C. Engines and identify various alternative fuels and their applicability.
	CO4	Understand the formation of emissions in I.C. Engines, methods of emission control and familiarize with recent trends in I.C. Engines.

Contribution of Course Outcomes towards achievement of Program Outcomes (H-Highly Mapped, M-Moderately Mapped, L- Low)

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
CO1	M				H							
CO2	M											
CO3	H				H					M		
CO4	H							M				

Course Content

UNIT – I

Gas power cycles: Air standard Carnot cycle, Otto cycle, Diesel cycle, Dual Combustion cycle, Air standard efficiency and MEP, fuel air cycles and significance, effect of operating variables.

I.C.Engines: Engine nomenclature, Review and classification of I.C. Engines, working principles of S.I. and C.I. Engines - valve timing diagrams and port timing diagrams - Differences between S.I. & C. I. and 2 stroke & 4 stroke engines, principle and working Wankel engine

UNIT – II

Fuel supply systems: S.I. Engines - Air-fuel mixture requirements, principle of Carburetion, Simple carburetor, improvements in simple carburetor, C. I. Engines- Air fuel requirements, Fuel supply and injection systems, Bosch fuel pump and injector.

Combustion in IC Engines: S.I. Engines- Normal combustion, abnormal combustion, C.I. Engines- Ignition delay, Knock in C.I. engines, Knock rating of fuels- Octane number and Cetane number.

UNIT – III

Testing of I.C. Engines: Indicator diagram, evaluation of Indicated Power, Brake power, Fuel consumption, SFC, Mechanical & thermal efficiencies, mean effective pressure, air-fuel ratio, Heat balance, Engine performance curves, Variables affecting engine performance for both S.I. & C.I. Engines.

Alternate fuels: Liquid fuels – Alcohols - Methanol, Ethanol, Alcohols for SI and CI engines, Gaseous fuels – Hydrogen, Natural gas, CNG and LPG, other possible fuels.

	UNIT – IV **Engine emissions and control:** Exhaust emissions- HC, CO, NOx, Particulate and other emissions, Emission control methods- Thermal converter, catalytic converter, particulate traps, EGR, Euro and Bharat Norms. **Recent trends in IC Engines:** MPFI, GDI, CRDI and HCCI technologies
Text books and Reference books	**Text Books:** 1. V.Ganesan "I.C. Engines",4th Edition, 2012, T.M.H Publications 2. Gupta .H.N, "Fundamentals Of Internal Combustion Engines" 2nd edition 2013,Prentice-Hall Of India **Reference Books:** 1. P.W. Gill, J.H. Smith &Ziurys,"Fundamentals of I.C.Engines", 1972, IBH & Oxford and IBH Pub. 2. M.L. Mathur & R.P. Sharma, "A Course in I.C. Engines", 8th edition 1990, Dhanpat Rai & Sons 3. V.M. Domakundwar, "A Course in Internal Combustion Engines" 2nd edition 2010, Dhanapat RaiPublications 4. Willard W. Pulkrabek "Engineering Fundamentals of the Internal Combustion Engine" 2nd Edition 2004, Pearson Publications. 5. John Heywood "Internal Combustion Engine Fundamentals" 1st edition 2011, Tata McGraw-Hill Education Pvt. Ltd. 6. R.K.Rajput "Thermal Engineering", 6th Edition, 2010, Laxmi Publications.
E-resources and other digital material	1. http://www.howstuffworks.com/engine.html 2. http://www.animatedengines.com/ 3. www.vssut.ac.in/lecture_notes/lecture1429900545.pdf 4. http://freevideolectures.com/Course/88/Environmental-Air-Pollution/11 5. ftp://152.66.39.22/pub/bsc/Interan Combustion Engines-Temp.pdf

Institutional Elective

14ME 2505A - ROBOTICS AND AUTOMATION

Course Category:	**Institutional Elective**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 0 - 0
Prerequisites:	14ME 1106 Basics of Mechanical Engineering 14ME 1107/14ME 1207 Mechanics for Engineers	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO1	Understand the basic components & types of Robot with end effector-interfacing (**a**)
CO2	Understand the Machine vision functions (**a,d,k**)
CO3	Learn the working principles of Robot sensory devices (**a,d,k**)
CO4	Develop transformations and kinematics for robot manipulator **(a, e**)

Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
CO1	M											
CO2	L			H							H	
CO3	L			H							M	
CO4	H				M							

Course Content

<u>UNIT – I</u>

Introduction to Robotics, major component of a robot, robotic like devices, classification of robots – Classification by coordinate system and by control method, Precision of movement, Specifications of robots, fixed versus flexible automation, economic analysis, Overview of robot application.

<u>UNIT – II</u>

Robot end Effectors: Introduction, end effectors, types of end effectors, grippers, classification of grippers, Gripper mechanisms, Other types of grippers-Vacuum cups, Magnetic grippers, adhesive grippers and miscellaneous types. Tool as end effectors, Interfacing, considerations in gripper selection and design, remote centered devices.

Machine Vision: Introduction, Functions of machine vision, applications of machine vision.

	UNIT – III **Robotic Sensory Devices:** Objective, Non-optical position sensors – potentiometers, synchros, optical position sensors – opto interrupters, optical encoders (absolute & incremental). **Proximity sensors:** Contact type, non contact type – reflected light scanning laser sensors. **Touch & slip sensors :** Tactile sensors – proximity rod & photo detector sensors, slip sensors – Forced oscillation slip sensor, interrupted type slip sensors **UNIT – IV** **Transformations and Kinematics:** Objectives, homogenous coordinates, Transformations - translational & rotational with simple problems. Forward solution - establishing link co-ordinate frames, Denavit Hartenberg procedure. Simple problems involving planar manipulators.
Textbooks and Reference books	**Text books:** 1. Robotic Engineering by Richard D.Klafter, Prentice Hall, Tata Mc Graw-Hill, 1995. 3rd Edition. 2. Industrial Robotics by Mikell P.Groover, TMH **Reference Books:** 1. Introduction to Robotics – John J. Ceaig, Addison Wesley,3rd Edition 2. Robotics – K. S. Fu, Gonzalez & Hee, Tata Mc Graw-Hill, 1995. 3rd Edition. **3.** Robotics for Engineers by Yoram Koren. Tata Mc Graw-Hill, 1995. 3rd Edition.
E-resources and other digital material	**Web References:** 1. http://nptel.iitm.ac.in/courses.php?branch=Mechanical 2. http://academicearth.org/courses/introduction-to-robotics **Video references:-** http://nptel.iitm.ac.in/video.php?courseId=1052

Institutional Elective

14ME 2505B - AUTOMOBILE ENGINEERING

Course Category:	**Institutional Elective**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 0 – 0
Prerequisites:	14ME 1106 Basics of Mechanical Engineering	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	30 70 100

Course outcomes		Upon successful completion of the course, the student will be able to:											
	CO1	Understand the working of an I.C engine and fuel supply system (a)											
	CO2	Understand the working of cooling, lubrication and electrical systems. (a, d)											
	CO3	Understand the working of clutch and gear box. (a)											
	CO4	Understand the suspension system and control system (a)											
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M- Medium, H – High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M											
	CO2	M			M								
	CO3	M											
	CO4	M											
Course Content		**UNIT I:** **Engine:** Classification of Automobiles, layout of transmission system, engine classification, engine construction. **Fuel supply system** **Petrol Engine:** Introduction, types of fuel supply systems, simple carburetor- construction, working, advantages, disadvantages **Diesel Engine**: Introduction, types of fuel injection systems- construction, working, advantages, disadvantages. **UNIT II:** **Cooling system:** Introduction, types-air cooling and water cooling, working, advantages, disadvantages. **Lubricating system:** Functions, types- splash, petroil, Pressure lubrication - working, advantages and disadvantages. **Electrical system:** Introduction to Ignition system, basic types- battery and magneto, spark plug, starting motor (Bendix Drive Mechanism). **UNIT III:** **Transmission System:** **Clutch:** Introduction, types- single plate, multi plate and centrifugal, construction, working, advantages, disadvantages. **Gear Box:** Functions, types-sliding Mesh and constant mesh, construction, working, advantages, disadvantages.											

	UNIT – IV **Suspension system:** Introduction, types of springs-leaf springs, coil springs. Telescopic shock absorber, suspension system types-rigid axle and independent suspension. **Vehicle control:** Types of steering linkages, classification of brakes-Drum, disc and hydraulic.
Text books and Reference books	**Text Book:** [1] Automobile Engineering - G.B.S. Narang, 1989.5th Edition, Khanna Publishers. [2] Automobile Engineering -Vol I & II - Kirpal Singh, 1st edition, 2009. Standard publishers **Reference Books:** [1] Automotive Mechanics - Joseph Heitner 2nd Edition 1967, Van Nastrand Rehinhold [2] Automobile Engineering – R.B. Gupta 3rd edition 1982,satya prakashan
E-resources and other digital material	[1] nptel.ac.in/courses/IIT-MADRAS/Machine_Design_II/pdf/3_5.pd [2]https://www.svce.ac.in/departments/auto/.../AT2301/UNIT%20II.pdf [3] seminarprojects.com/s/nptel-automobile-engg-ppt-on-clutches [4] seminarprojects.com/s/nptel-automobile-ppt

Institutional Elective

14ME 2505C - MANUFACTURING PROCESSES

Course Category	**Institutional Elective**	**Credits:**	4
Course Type	**Theory**	**Lecture – Tutorial – Practice**	4 – 0 - 0
Prerequisites	14 PH 1102/14PH 1202 Engineering Physics 14 ME 1106 Basics of Mechanical Engineering	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO 1	Understand the basic principles of Metal Casting and special casting methods.
	CO 2	Understand the working principle and application of various welding methods.
	CO 3	Differentiate the various forming processes with application.
	CO 4	Understand the operation of Lathe, Milling and finishing operations.

Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- Highly Mapped, M-Moderately Mapped, L-Low)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	H											
	CO2	H											
	CO3	H											
	CO4	H											

Course Content	**Unit I: Metal Casting:** Introduction, General methods in Casting, Advantages and Applications of Casting, Patterns, types of patterns, Allowances, Elements of Gating systems, types of Cores, Casting defects. **Special Casting methods:** Die Casting, Centrifugal casting, Shell Moulding, Investment Casting.
	Unit II: Welding: Arc Welding **(**Principles of Arc Welding, Shielded metal Arc Welding, TIG Welding and MIG Welding), Gas Welding (Oxy- Acetylene Gas Welding, types of flames), Resistance Welding, Advantages and Applications, Welding Defects, Soldering and Brazing.
	Unit III: Metal Forming Processes: Introduction, Hot and Cold working of metals, Rolling (Hot rolling and Cold rolling), Forging and Extrusion (types), Wire Drawing. Sheet Metal Working Operations: Sheet metal Punching and Blanking operations and applications.

	Unit IV: Machine Tool Operations: Lathe: Description, specifications, Types, Operations (Turning, thread cutting, drilling, boring and knurling). **Milling machine**: Introduction, Working Principle, types of Milling machines, simple operations. **Finishing operations:** Grinding, Lapping, Honing, Shaving and Burnishing.
Text Books and Reference Books	**Text Books**: 1. P. N. Rao, "Manufacturing Technology", Vol. I, Edition 3, Tata Mc- Graw Hill Publishers, New Delhi, 2009. 2. V. S. Raghuvamshi, "A Course in Workshop Technology", Vol. I, Dhanpatrai & Sons, New Delhi, 2007. **Reference books:** 1. Hazra Chowdhury, "Workshop Technology", Vol. II, 11th Edition, 2002 2. George E. Dieter, "Mechanical Metallurgy", Mc-Graw Hill Publishers, S I Metric Edition, 2000.
E- resources and other digital material	**Web resources:** 1. http://nptel.iitm.ac.in 2. http://www.engr.sjsu.edu 3. http://web.iitd.ac.in

Institutional Elective
14ME 2505D - WORK STUDY

Course Category	**Institutional Elective**	**Credits:**	4
Course Type	**Theory**	**Lecture – Tutorial – Practice**	4 – 0 - 0
Prerequisites	14 ME 1106 Basics of Mechanical Engineering	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes:

- Understand the principles of method study.(a,d)
- Understand the principles of motion study.(a,d)
- Understand the methods of Work measurement.(a,d,e)
- Understand the concept of job evaluation and incentive Schemes.(a,d,e)

Contribution of Course Outcomes towards achievement of Program Outcomes (H- Highly Mapped, M- Moderately Mapped, L- Low)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	M			M								
	CO 2	M			M								
	CO 3	M			M	M							
	CO 4	M			M	M							

Unit I
Work study: Purpose of work study, its objectives, procedure and applications;
Method study: Definition and basic procedure, selection of job, various recording techniques like outline process charts, flow process charts, man machine charts, two handed process charts, string diagram, flow diagram, multiple activity chart, critical examination, development, installation and maintenance of improved method;

Unit II
Motion Study: Principles of motion economy and their application in, human body, Design of Tools and Equipment, Arrangement of workplace, micro motion study simo, cyclographs and chrono-cyclographs Methods Time Measurement (MTM)

UNIT III
Work measurement: Introduction & definition, objectives and basic procedure of work measurement; time study: basic procedure, equipments needed, breaking a job into elements; numbers of cycles to be timed; rating and methods of rating, allowances, calculation of standard time.
Work sampling: Basic procedure, design of work sampling study conducting work sampling study and establishment of standard-time.

Unit IV

Job evaluation and incentive schemes: Starlight line, Tailor, Merrick and Gantt incentive plans Standard data system; elemental and non-elemental predetermined motion systems, work factors system.

Text B**ook:**

1. ILO; work-study; International Labour Organization.

References:

1. Barrnes RM; Motion and Time Study; Wiley pub
2. Megaw ED; Contenmprory ergonomics; Taylor & fracis Currie RM; Work study; BIM publications

Independent Learning

14ME 5506A - UNCONVENTIONAL MACHINING PROCESSES

Course Category	**Independent Learning**	**Credits:**	2
Course Type	**Theory**	**Lecture – Tutorial – Practice**	0 – 0 - 0
Prerequisites	14 ME 1106 Basics of Mechanical Engineering	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1: Acquire the principles of operation and process parameters of Abrasive Jet Machining and characteristics of Unconventional manufacturing processes.
CO2: Acquire the principles of operation and process parameters of EDM, Wire cut EDM and USM.
CO3: Acquire the principles of operation and process parameters of CHM, ECM, and ECG.
CO4: Acquire the principles of operation and process parameters of LBM, PAM and EBM.

Contribution of Course Outcomes towards achievement of Program Outcomes (H- Highly Mapped, M- Moderately Mapped, L- Low)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M		M								H	
	CO2	M		M								H	
	CO3	M		M								H	
	CO4	M		M								H	

UNIT – I

Introduction Unconventional Machining Processes:

Introduction to Unconventional Machining processes (UMP), Limitations of conventional manufacturing processes (CMP), Characteristics of Unconventional Machining processes, and Classification of Unconventional Machining processes, Differences between Conventional Manufacturing Processes and Unconventional Machining processes.

Abrasive Jet Machining: Need, Selection, Principles of operation, process parameters, characteristics, equipment, merits, demerits and applications of Abrasive Jet Machining process.

UNIT – II

Ultrasonic Machining: Need, Selection, Principles of operation, process parameters, characteristics, equipment, merits, demerits and applications of Ultrasonic Machining process, tool feeding mechanisms.

Electric Discharge Machining: Need, Selection, Principles of operation, process parameters, characteristics, equipment, merits, demerits and applications of Electric Discharge Machining process, properties of dielectric fluids, RC circuit, various methods of flushing of dielectric fluid, Wire cut E D M process.

UNIT – III

Chemical Machining: Need, Selection, Principles of operation, process parameters, characteristics, equipment, merits, demerits and applications of Chemical Machining, Electro Chemical Machining-Effect of Insulation on the tool and Electro Chemical Grinding process.

UNIT – IV

Beam & Arc Machining: Need, Selection, Principles of operation, process parameters, characteristics, equipment, merits, demerits and applications of Laser Beam Machining, Plasma Arc Machining and Electron Beam Machining processes.

Text books:

1. P C Pandey and H S Shan, "Modern machining processes", Ist edition, 1980, TMH.
2. Rahul Jain, "Unconventional Machufacturing Processes", 3rd edition, 2015, S K Kataria & Sons, New Delhi.

Reference Book:

1. Amitabha Ghosh and A K Mallik, "Manufacturing Science", 2nd edition, East West Press.

Web resources:

1. http://www.waterjets.org/index.php?option=com_content&task=category&sectionid=4&id=46&Itemid=53
2. http://www.ignou.ac.in/upload/modern.pdf
3. http://nptel.iitm.ac.in

Independent Learning

14ME 5506B - WORK STUDY

Course Category	**Independent Learning**	**Credits:**	2
Course Type	**Theory**	**Lecture – Tutorial – Practice**	0 – 0 - 0
Prerequisites	14 ME 1106 Basics of Mechanical Engineering	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes:

- Understand the principles of method study.(a,d)
- Understand the principles of motion study.(a,d)
- Understand the methods of Work measurement.(a,d,e)
- Understand the concept of job evaluation and incentive Schemes.(a,d,e)

Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- Highly Mapped, M-Moderately Mapped, L-Low)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	M			M								
	CO 2	M			M								
	CO 3	M			M	M							
	CO 4	M			M	M							

Unit I

Work study: Purpose of work study, its objectives, procedure and applications;

Method study: Definition and basic procedure, selection of job, various recording techniques like outline process charts, flow process charts, man machine charts, two handed process charts, string diagram, flow diagram, multiple activity chart, critical examination, development, installation and maintenance of improved method;

Unit II

Motion Study: Principles of motion economy and their application in, human body, Design of Tools and Equipment, Arrangement of workplace, micro motion study simo, cyclographs and chrono-cyclographs Methods Time Measurement (MTM)

Unit III

Work measurement: Introduction & definition, objectives and basic procedure of work measurement; time study: basic procedure, equipments needed, breaking a job into elements; numbers of cycles to be timed; rating and methods of rating, allowances, calculation of standard time.

Work sampling: Basic procedure, design of work sampling study conducting work sampling study and establishment of standard-time.

Unit IV

Job evaluation and incentive schemes: Starlight line, Tailor, Merrick and Gantt incentive plans Standard data system; elemental and non-elemental predetermined motion systems, work factors system.

Text Book:

1. ILO; work-study; International Labour Organization.

References:

1. Barrnes RM; Motion and Time Study; Wiley pub
2. Megaw ED; Contenmprory ergonomics; Taylor & fracis Currie RM; Work study; BIM publications

14 ME 3507 - METAL CUTTING AND MACHINE TOOLS

Course Category	**Program Core**	**Credits:**	3
Course Type	**Theory**	**Lecture – Tutorial – Practice**	3 – 1 - 0
Prerequisites	14 ME 3307 Manufacturing Processes 14 ME 1107 Mechanics for Engineers	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO1	Understand the basic principles, constructional features of Lathe and its mechanisms and operations.
	CO2	Differentiate various machining processes such as Drilling, Shaping Planing and Grinding machines.
	CO3	Understand the working principle, operations of Milling machines and broaching machines. .
	CO4	Understand the fundamental concepts of Metal Cutting, cutting tool materials, and tool life.

Contribution of Course Outcomes towards achievement of Program Outcomes (H- Highly Mapped, M- Moderately Mapped, L- Low)		PO a	PO b	PO c	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	H												
	CO2	H												
	CO3	H												
	CO4	M				H								

Course Content	
	Unit I: **Machining Processes and Machine Tools:** Introduction, Primary and Auxiliary Motions in Machine Tools, Parameters. Defining working motions of a Machine tool. **Lathe:** Constructional details, specifications, classification of lathes. **Lathe Mechanisms:** Spindle speed Mechanisms in Belt driven and All Geared Head stock, Apron and Half-nut mechanisms, Lathe accessories, Lathe operations including taper turning and thread cutting and related problems.
	Unit II: **Drilling Machines:** Types and specifications, Spindle feed mechanism, drilling operations, drilling time. **Shaping and Planning:** Constructional details, types of Shapers and Planers, specifications, tool holding and work holding devices, Quick Return Mechanism and automatic feed mechanisms.

	Grinding Machines: General Principles, Wheel materials, Selection and specifications, Truing and Dressing of grinding wheels, types of grinding machines, Honing and Lapping operations and burnishing operations.
	Unit III: **Milling Machines:** Working Principle, Size and Specification, Up and Down Milling, Types of milling machines, Description and working of Universal Milling machine, Milling operations, Milling cutters, Indexing methods and Indexing Head, related problems. **Broaching:** Introduction to Broaching, broaches, broaching methods and Machines.
	Unit IV: Theory of Metal Cutting: Introduction, Basic elements of machining, Nomenclature of single point cutting tool, Tool Geometry, Mechanics of chip formation, Types of chips. Determination of shear angle and chip thickness ratio, stress and strain in the chip, velocity relations, Merchant's theory of orthogonal Heat Generation and cutting tool temperature and its measurement, cutting fluids - types and required characteristics. Cutting tool materials: Requirements of Tool materials and types**: C**utting forces, related simple problems. Tool wear, Tool life and Tool life criteria.
Text Books and Reference Books	**Text Books**: 1. Workshop Technology Vol.II by Hazra Chowdary, 11th Edition,2002. 2. Production Engineering by P.C. Sharma, S.Chand & Co. 10th Edition,2008 **Reference books:** 1. Materials and Processes in Manufacturing by E.Paul De Garmo, J.T.Black and Ronald A.Kohser. 11th Edition, 2008. 2. P. N. Rao, "Manufacturing Technology – vol. 2 : Metal Cutting and Machine Tools", McGraw Hill Education (India) Pvt. Ltd., New Delhi, 3 rd edition, 2013. 3. Manufacturing Science by Ghosh & Mallick, 2nd Edition, John Wiley & Sons, New York, 1986.
E- resources and other digital material	**Web resources:** 1. www.hgfarley.com 2. www.kennametal.com/ - United States 3. www.mini-lathe.com/links.htm machinedesign.com/.../designer-s-guide-to-metalcutting-machinery-0608 – 4. www.metalwebnews.com/wc.html 5. www.britannica.com/EBchecked/topic/463000/planer 6. www.americanmachinist.com 7. www.machinetools.net.tw/parts/taiwan_voltage_regulator

14ME 3551 - GEOMETRICAL MODELING LAB

Course Category:	**Program Core**	**Credits:**	2
Course Type:	**Laboratory**	**Lecture - Tutorial - Practice:**	0 - 0 - 3
Prerequisites:	14PH 1251 Engineering Graphics 14ME 3351 Computer Aided-Drafting Lab.	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Construct sketches in Pro-E & CATIA software.
	CO2	Generate part modeling of machine components using Pro-E.
	CO3	Develop surface Models using CATIA
	CO4	Assemble Various parts of Machine and generate their orthographic views.
	CO5	Export geometric models to other file formats.

Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
CO1	L		L						M		H	
CO2	L		L						M		H	
CO3	L		L						M		H	
CO4	L		L						M		H	
CO5			L						M		H	

Course Content

Lab Exercises:

1. Construction of 2D sketches.
2. Modelling of simple machine components.
3. Assembly of Machine components.
4. Orthographic views of the assembled components.
5. Modelling of Simple surfaces.
6. Solid/Surface modelling of a real component
7. Exporting the files for various other softwares

References

1. Pro/Engineer Wildfire 5.0 by Roger Toogood, Jack Zecher, SDC Publications, 28-Feb-2010.
2. CATIA V5R17 for engineers & designers By Prof. Sham Tickoo, published by Dreamtech Press, 2009; ISBN:10-81-7722-815-3, 13-978-81-7722-815-1
3. CAD/CAM theory and Practice, Ibrahim Zied,Tata McGraw-Hill publishers

	4. CAD/CAM computer aided design and manufacturing, M.Groover, E. Zimmers, Pearson education, 13th impression.
E-resources and other digital material	**Web Resources:** 1. http://www.proetutorials.com/ 2. http://learningexchange.ptc.com/tutorials/by_sub_product/ptc-creo-elements-pro-pro-engineer/sub_product_id:1 3. http://www.eng-tips.com/viewthread.cfm?qid=48209 4. https://catiatutor.com/ 5. www.v5train.com **NPTEL Video references**: 1. https://www.youtube.com/watch?v=6glpCzXvCbw 2. https://www.youtube.com/watch?v=F4QenBl44qA&list=PLk6t3bkiFC1ooKc1rGZk44imDmVDSUBTi 3. https://www.youtube.com/watch?v=zoyUDzr1064 4. https://www.youtube.com/watch?v=MPcc-5khZms 5. https://www.youtube.com/watch?v=N3EDfVfE9PU&list=PL965F8ECDBCA83A62 6. https://www.youtube.com/watch?v=G1-Y4R34wwk 7. https://www.youtube.com/watch?v=R8YEA4e9hm4&list=PLkMYhICFMsGbYCvbGrrygtqGiBGguIzbf 8. https://www.youtube.com/watch?v=KLblVt7QL8M 9. https://www.youtube.com/watch?v=gGbqbim8U7k

14ME 3552 - SM & FM LAB

Course Category:	**Program Core**	**Credits:**	2
Course Type:	**Laboratory**	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	14ME 3302 Mechanics of Materials 14ME 3403 Fluid Mechanics	**Continuous Evaluation:**	30
		Semester end Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Determine Young's modulus by conducting various tests on Mild Steel (a,b,d,e)
	CO2	Determine hardness, Impact and shear strength as per IS code of practice (a,b,d,e)
	CO3	Determine rigidity modulus by conducting torsion test on Mild Steel (a,b,d,e)
	CO4	Determine the coefficient of discharge for Venturimeter, orifice, orificemeter & mouthpiece (a, b, e)
	CO5	Determine the Friction factor for a given pipe (a, b, e)
	CO6	Determine the performance characteristics of Centrifugal pumps, Reciprocating Pumps and Gear pumps (a,b,e)

Contribution of Course Outcomes towards achievement of Program Outcomes (H-Highly Mapped, M-Moderately Mapped, L-Low)

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
CO1	M	H		M	H							
CO2	M	H		M	H							
CO3	M	H		M	H							
CO4	M	H		M	H							
CO5	M	H		M	H							
CO6	M	H		M	H							

Course Content

Strength of Materials Lab:

1. Determination of Young's modulus for Mild Steel by conducting Tension test on UTM
2. Load vs Deflection - Determination of Young's modulus on cantilever beam and propped cantilever beam.
3. Load vs deflection on simply supported and overhanging beams. Determination of Young's modulus of the beam material
4. (a) Rockwell Hardness test - Determination of Hardness Number for different metal specimens such as mild steel, cast iron, Brass, Aluminum (b) Brinnell's Hardness Test
5. Impact Test - (a) Charpy and (b) lzod: Determination of impact strength of mild steel and cast iron specimens
6. Torsion test - Determination of Modulus of Rigidity of the material.
7. Double shear Test - Determination of shear strength of mild steel specimens.

	Fluid Mechanics Lab: 1. Orifice / mouthpiece - Determination of coefficient of discharge 2. Venturimeter / Orifice meter - Determination of coefficient of discharge 3. Pipe friction - Determination of friction factor and size of roughness of a given pipe. 4. Single - stage centrifugal pump - To draw the operating characteristics of the pump and to determine the designed discharge and designed head from it. 5. Single - acting reciprocating pump - To draw the operating characteristic curves at constant speed and determination of efficiency. 6. Gear pump - To draw the operating characteristic curves and determination of overall efficiency

14ME 3601 - HEAT TRANSFER

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 1 - 0
Prerequisites:	14ME 3303 Basic Thermodynamics 14ME 3403 Fluid Mechanics	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO1	Solve heat conduction problems in rectangular, cylindrical and spherical coordinate systems. (a, e)
	CO2	Understand the concept and solve transient heat conduction and convective heat transfer problems. (a, e).
	CO3	Design heat exchangers. (a, c, e).
	CO4	Understand the Laws of radiation and compute radiation heat transfer in black and non-black bodies. (a, e)

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	H				M							
	CO 2	H				M							
	CO 3	M		M		M							
	CO 4	M				M							

Course Content	**UNIT I :**
	Introduction: Basic Modes and laws of Heat transfer, thermal conductivity, Steady state Heat Conduction, General conduction equation in Cartesian, Cylindrical and Spherical coordinates, initial and boundary conditions. **One-dimensional heat conduction:** Heat flow through plane wall, cylinder and sphere with constant thermal conductivity, Heat flow through composite slabs and Cylinders, Thermal resistance, Electrical analogy, Thermal contact resistance, critical insulation thickness, Heat source systems- Simple systems with uniform heat generation in slabs and cylinders. **Extended surfaces:** Types and Applications, Heat transfer from fins of uniform cross section, Fin efficiency and Effectiveness.
	UNIT II : **Transient heat conduction:** One dimensional lumped heat capacity systems. **Forced convection:** Introduction, Hydrodynamic and Thermal boundary layers, concept of turbulence, Empirical and semi empirical relations for heat transfer in Laminar and Turbulent flows over a flat plate, Reynolds-Colburn Analogy, Laminar and Turbulent flow heat transfer in a pipe - Empirical relations.

	UNIT III : **Natural convection:** Approximate analysis for laminar film on a vertical plate, Correlations for vertical plates, horizontal plates, vertical and horizontal cylinders, inclined surfaces. **Heat exchangers:** Classification and type of heat exchangers, Flow arrangement, Temperature distribution, overall heat transfer coefficient, Fouling factor, LMTD method of Heat exchanger analysis, correction for LMTD for use with multi pass and cross flow Heat Exchanger, Effectiveness - NTU method for Heat Exchanger analysis.
	UNIT IV :
	Radiation: Basic Concepts and definitions, Absorptivity, Reflectivity, Transmissivity, concept of Black body, Laws of Radiation, Kirchhoff's law, Planck's & Wien's law, Stefan Boltzmann's law. **Radiant heat transfer:** Heat Exchange by radiation between two finite parallel surfaces, Electrical analogy, solid angle and Radiation intensity, Heat exchange by radiation between two finite black and gray surfaces, shape factor, Radiation shields.
Text Books and Reference Books	**Text Books:** 1. R.C. Sachdeva, "Heat and Mass Transfer", New age publication, 2010. 2. P.K. Nag, "Heat and Mass Transfer", Tata McGraw Hill, 2011. 3. D.S. Kumar, "Basics of Heat & Mass Transfer", 8th Edition, S. K. Kataria & Sons, 2010.
	Reference Books:
	1. N. Ozisik, "Heat Transfer - A Basic Approach", TMH, 1985. 2 J. P. Holman, "Heat Transfer", 9th Edition, Tata McGraw Hill, 2008. 3 lncropera and Dewitt, "Introduction to Heat Transfer", 6th Edition, John Wiley, 2011.
E-resources and other Digital Material	• IIT video lecturers (NPTEL) • http://web.cecs.pdx.edu/~gerry/heatAnimations/sphereTransient/#TOC • http://study.com/academy/lesson/heat-transfer-phase-changes.html

NOTE: Heat and Mass Transfer Data Book by Kothandaraman and Subramanian to be allowed in the Examinations

14ME 3602 - DESIGN OF TRANSMISSION ELEMENTS

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 1 - 0
Prerequisites:	14ME 1107- Mechanics for Engineers 14ME 3302 - Mechanics of Materials 14ME 3306 - Kinematics of Machines 14ME 3502 – Design of Machine Elements	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course outcomes	Upon successful completion of the course, the student will be able to:												
	CO1	Design shafts, keys and couplings under different loading conditions											
	CO2	Understand the philosophy of lubrication and design the journal and roller bearings											
	CO3	Design different types of clutches and brakes											
	CO4	Determine the key design parameters for belt drives and geared transmission systems like spur and helical gears.											
Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M		H		H							
	CO2	M		H		H							
	CO3	M		H		H							
	CO4	M		H		H							
Course Content	**UNIT I:** **Shafts:** Design of solid and hollow shafts for strength – For Bending, Torsion, Combined bending and torsion and combined bending, torsion and axial loads. **Keys:** Introduction, Design of square and flat keys **Shaft Couplings:** Rigid couplings – Muff, split muff couplings, Flexible coupling **UNIT II:** **Bearings and Lubrication:** Lubrication, Types of lubrications, types of lubricants, properties of lubricants, types of Bearings, Bearing materials, Journal bearing design (using McKee's equation and Raymond and Boyd charts & tables) **Ball and Roller Bearings:** Static load, Dynamic load, Equivalent radial load,												

	selection of ball and roller bearings **UNIT III:** **Brakes:**- Introduction to Brakes, Types, Analysis and design of block brakes, band brakes, block and band brakes, external shoe brakes **Clutches**: Analysis and design of simple and multiple disc clutches, cone clutches and centrifugal clutches, friction materials; comparison of brakes and clutches. **UNIT – IV:** **Spur Gears:** Terminology of spur gear, standard systems of Gear Tooth, Force analysis, Gear tooth failures, Lewis Equation. **Helical Gears:** Terminology of helical gears, virtual number of teeth, Tooth proportions, force analysis, Lewis Equation. **I. C. Engine Components:** Introduction, Design of trunk type piston and connecting rod
Textbooks and Reference books	**Text Book:** 1. Design of machine elements by Bhandari, Tata McGraw Hill book Co. 2. Machine Design by P.C. Sharma & D.K. Agarwal. **Reference books:** 1. Design of Machine Elements by Sharma & Purohit ,PHI 2. Machine Design by Robert L.Norton. 3. Design of Machine Elements by Kannaiah **DATA BOOKS TO BE ALLOWED IN EXAMINATION:** 1. Design data book, Mahadevan & Balaveera Reddy - CBS Publishers 2. Design data book, V.B.Bhandari - Tata McGraw Hill book Co 3. Design data book, P.S.G. College of Technology, Coimbatore **Web Resources:** 1. http://nptel.ac.in/downloads/112105125/ 2. http://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mechanical-design-spring-2009/lecture-notes/

14ME 3603 - OPERATIONS RESEARCH

Course Category:	**Program Core**	**Credits:**	4
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	4 - 1 - 0
Prerequisites:	14MA 1301Complex Analysis and Numerical Methods 14MA 1401 Transformations and Probability Distributions	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course outcomes:

At the end of the completion of this course the student will be able to

CO1: Formulate and solve the LPP with different methods.(a,e,k)
CO2: Solve the transportation and assignment problems.(a,e,k)
CO3: Understand and apply Queuing theory model and project scheduling techniques to real life problems.(a,e,k,l)
CO 4: Understand the concept of game theory and to solve the problems in machine shop scheduling. (a,e,k,l)

(L-Low, M-Medium, H-High)

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	H				H						H	
	CO 2	M				H						H	
	CO 3	M				H						H	H
	CO 4	M				H						H	M

UNIT – I

Introduction: Definition and Scope of Operations Research, Limitations of Operations Research, Model building in Operations Research.

Linear programming: Mathematical formulation of the problem, Graphical method, Simplex method, artificial basis technique, dual Simplex method. Degeneracy, alternative optima, unbounded solution, infeasible solution.

UNIT – II

Transportation problem: Basic feasible solution by north-west corner method, Vogel's approximation method, assignment by inspection method. Finding optimal solution, degeneracy, unbalanced transportation matrix.

Assignment problem: One-to-one assignment problem, optimal solution, unbalanced assignment matrix

UNIT – III

Queuing theory: Queuing systems and their characteristics. M/M/1 : FCFS/ ∞ / ∞

Project planning through networks: Arrow (Network) Diagram representation. Rules for constructing an arrow diagram, PERT and CPM, Critical path calculations, earliest start and latest completion times, Determination of critical path, determination of floats, Probability considerations in project, cost considerations in project scheduling, crashing (least cost project scheduling).

UNIT – IV

Game theory: Optimal solution of two-person zero-sum games, the max-min and min-max principle. Games without saddle points, mixed strategies. Arithmetic and algebraic methods, reduction by dominance and average, method of sub games, graphical method.

Sequencing: Introduction, Job shop Scheduling, Flow shop Scheduling, Solution of Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, Scheduling Criteria's.

Text books:

1. 'Operations Research (units: I, IV)'S D Sharma, 'Kedarnath, Ramnath & Co., Meerut.16th Edition, 2009.Macmillian publishers.
2. Operations Research V K Kapoor.7th edition, 2001.S.Chand

Reference books:

1. Operations Research' R Pannerselvam 2nd EditionPentice Hall of India Pvt Ltd-New Delhi.2006

Web references:

- http://en.wikipedia.org
- http://coral.ie.lehigh.edu
- http://books.google.co.in
- http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm
- http://www.wolfram.com/solutions/OperationsResearch/
- http://www.informs.org/Journal/IJOC/Areas-and-Area-Editors
- http://orion.uwaterloo.ca/~hwolkowi/intrstsites.html

14HS 1604 - ENGINEERING ECONOMICS AND FINANCE

Course Category:	**Institutional Core**	**Credits:**	3
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	3 - 0 - 0
Prerequisites:	14MA 1301Complex Analysis and Numerical Methods 14MA 1401 Transformations and Probability Distributions	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Course Outcomes:

CO1: Understand various forms of organizations and principles of management**. (a,**l)

CO2: Understand the various aspects of business economics. (a,e,l)

CO3: Acquire knowledge on Human resources and Marketing functions. (a,l)

CO4: Understand best alternatives for various investment decisions and different depreciation methods. (a,e,l)

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	M											M
	CO 2	M				H							M
	CO 3	M											M
	CO 4	M				H							M

UNIT I

Forms of Business Organization: Salient Features of Sole Proprietorship, Partnership, Joint Stock Company: Private Limited and Public Limited Companies, Co-operative Society and Public Sector.

Management: Introduction to Management, Management an Art or Science, Functions of Management, Principles of Scientific Management, Henri Fayol's Principles of Management.

UNIT II

Introduction to Economics: Introduction to Basic Economic Concepts, Utility Analysis: Marginal Utility and Total Utility, Law of Diminishing Marginal Utility, Law of Equi Marginal Utility, Demand Analysis: Theory of Demand: Demand Function, Factors Influencing Demand, Demand Schedule and Demand Curve, Shift in Demand, Elasticity of Demand: Elastic and Inelastic Demand, Types of Elasticity, Factors of Production, Production Function, Production with one variable input, Isoquants, Returns to Scale, Cost Function: Cost - Output Relationship in short run and long run, Relationship between AC and MC. Supply Analysis: Supply Schedule and Supply Curve, Factors Influencing Supply, Supply Function, Theory of firm: Price determination under equilibrium of firm, Perfect competition.

UNIT III

Human Resource Management: Meaning and difference between Personnel Management and Human Resource Management, Functions of Human Resource Management, Recruitment and Selection Process.

Marketing Management: Concept of Selling And Marketing – Differences, Functions of Marketing, Product Life Cycle, Concept of Advertising, Sales Promotion, Types of Distribution Channels, Marketing Research, Break-Even Analysis - Problems.

UNIT IV

Financial Management: Functions of Financial Management, Time value of money with cash flow diagrams, Calculation of Simple and Compound Interest -Present worth, Future worth, Annual Equivalent, Methods of Evaluating Alternatives under Present worth method, Future worth method, Annual Equivalent method for choice of decision making among alternative projects.

Production Management: An Overview and significance of Production Management, Objectives, Scope of production management, Production cycle. Depreciation, Causes of depreciation, Factors influencing depreciation, common methods of Depreciation: Straight Line Method, Declining Balance Method, Sum of Year's Digits Method –Problems

Learning Resources:

Text Books:

1. P.Premchand Babu and M.Madan Mohan *Managerial Economics and Financial Analysis* Himalaya publishing house 2011 edition
2. M. Mahajan *Industrial Engineering and Production Management* 2nd Edition Dhanpat Rai Publications.

Reference Books:

1. Theusen & Theusen, "***Engineering economy***".
2. Philip Kotler & Gary Armstrong "***Principles of Marketing***" ,pearson prentice Hall,New Delhi,2012 Edition.
3. B.B Mahapatro, ***"Human Resource Management".***,New Age International ,2011
4. IM Pandey, "***Financial Management***" Vikas Publications 11th Edition
5. R.Panneer selvam, ***"Production and operations management",*** PHI Learning pvt Ltd, New Delhi, 2012

Web Resources:

www.tectime.com
www.exinfm.com
www.slideshare.net
www.economywatch.com

14ME 3605 - ENGINEERING METROLOGY & MEASUREMENTS

Course Category:	**Program Core**	**Credits:**	3
Course Type:	**Theory**	**Lecture - Tutorial - Practice:**	3 - 1 - 0
Prerequisites:	14ME 1106 - Basics of Mechanical Engineering 14PH 1202 - Engineering Physics	**Continuous Evaluation:** **Semester End Evaluation:** **Total Marks:**	30 70 100

Learning Outcomes: At the end of the course the students will be able to

- Understand the standards of measurement, principles of linear and angular measuring instruments. (a)
- Get acquainted with limits, fits, tolerances, interchangeability and gauge design.(a, c, e)
- Understand the surface roughness terminology and types of various surface roughness measuring instruments.(a)
- Understand the principles of strain & temperature measuring instruments. (a)

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO 1	H											
	CO 2	H		M		H							
	CO 3	M											
	CO 4	M											

UNIT – I

Metrology : Introduction , elements of engineering measurements, standards of length ; end and line standards, slip gauges , angle gauges, sine bars, spirit levels, bore gauges, straight edges

UNIT- II

Limits, fits and gauges: Theory of limits, Fits, Tolerances and their selection, Hole Basis and shaft basis system, IS system of limits & fits, Simple problems. Interchangeability, Selective Assembly, Limit gauges, Taylor's Principle of limit gauging, plug gauges, Ring gauges and their applications.

UNIT – III

Comparators: Mechanical comparators- Read comparator, Sigma comparator, Solex pneumatic gauge, electrical & electronic comparator, projectors, Tool Maker's Microscope, Auto collimator, angle dekkor

Measurement of surface finish: Surface texture, roughness, waviness, Indian standard terminology, Various methods of measuring surface finish, Tomilson surface meter and Taylor Hobson Talysurf.

UNIT – IV

Strain measurement: Introduction, electrical resistance strain gauges principle, method of fixing and bridge circuit for measuring strain gauges, gauge factor, Temperature compensation of strain gauge, application

Temperature measurement: Liquid in glass thermometer, Bimetallic strip thermometer, Thermo couple, Thermistry, Pyrometry

Learning Resources:

Text books:

1. Metrology - R.K.Jain, Twenty First Revised edition. 2015, Khanna publishers
2. A Textbook of Metrology by M Mahajan, 2nd edition 2011, Dhanpath Rai Publications.
3. Mechanical Measurements & Control Engineering by D. S. Kumar, 6th Edition, 2002, Metropolitan Book company Ltd.

Reference Books:

1. Engg.Metrology – D.M.Antony
2. A Text book of Engg.Metrology – I.C.Gupta., 7th Edition, Dhanapath rai publications
3. Hand Book of Industrial Metrology – ASTME.
4. Mechanical Measurements by T. G. Beckwith, Roy D. Marangoni, John H. Lienhard V. 6th edition.2009, Pearson Prentice Hall

Web references:

1. http://www.metrologymetro.com
2. http://www. emtoolbox.nist.gov/.
3. http://en.wikipedia.org/wiki/Metrology#Basics

14ME 3651 - FUELS AND I.C.ENGINES LAB

Course Category:	**Program Core**	**Credits:**	2
Course Type:	**Laboratory**	**Lecture - Tutorial - Practice:**	0 - 0 - 3
Prerequisites:	14ME 3504- Knowledge on working of Fuels & I.C.Engines	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes:

Upon successful completion of the course the students will be able to

CO1 Measure the thermal properties of different fuels. (**a,b,j**)

CO2 Determine the Efficiency of Compressor and Blower (**a,b)**

CO3 Analyze the performance and determine the operating characteristics of I.C.engines **(a,b,j)**

CO4 Draw the valve and port timing diagrams of two and four stroke engines. (**a,b)**

CO5 Evaluate the pressure gauge (**a,b)**

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)

		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H-High)	CO 1	M	H								H		
	CO 2	M	H										
	CO 3	M	H								H		
	CO 4	M	H										
	CO5	M	H										

Course Contents:

Any Ten of the following:

Fuels Laboratory:

1. To determine the viscosity of the given sample of oil at various temperatures in redwood standard seconds using Redwood Viscometer.
2. To test the given pressure gauge using dead weight pressure gauge tester.
3. To draw the port/valve time diagram of petrol/diesel engine.
4. To determine the calorific value of the given solid fuel by Bomb Calorimeter
5. To determine the Flash and Fire Points of the given oil by Abel's Apparatus.
6. To determine the calorific value of the given gaseous fuel by Junker's Gas Calorimeter.
7. To study assembling and disassembling of Two stroke, single cylinder petrol engine

I.C.Engines Laboratory:

1. To conduct a performance test on a four stroke, single cylinder Diesel engine with Band brake Dynamometer.
2. To conduct a performance test on twin cylinder diesel engine with electrical Dynamometer.
3. To conduct a test on Air compressor to determine the volumetric efficiency and isothermal efficiency at various delivery pressures.
4. To measure the discharge of air through the blower test rig.
5. To conduct a performance test on a four stroke, single cylinder Petrol engine with Rope brake Dynamometer.
6. To Prepare Heat Balance sheet on single cylinder Diesel/petrol engine.
7. To conduct a performance test on a four stroke, single cylinder Diesel engine with Band brake Dynamometer using Bio-Diesel.

Reference: Internal Combustion Engines - V. Ganesan, TMH Pub.

14ME 3652 - MACHINE TOOLS LAB

Course Category	**Program Core**	**Credits:**	2
Course Type	**Practical**	**Lecture – Tutorial – Practice**	0 – 0 - 3
Prerequisites	14 ME 1153 Workshop Practice 14 ME 3507 Metal Cutting and Machine Tools	**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO1	Get familiarity with Lathe machine and perform various Lathe operations.
	CO2	Perform Drilling and Tapping operations on drilling machine.
	CO3	Get familiarity with Milling machine and perform different Milling operations.
	CO4	Perform Shaping, Planing and Slotting operations.
	CO5	Get familiarity with Surface and Cylindrical Grinding machines.

Contribution of Course Outcomes towards achievement of Program Outcomes (H- Highly Mapped, M- Moderately Mapped, L- Low)		PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
	CO1	M	H										
	CO2	M	H										
	CO3	M	H										
	CO4	M	H										
	CO5	M	H										

Course Content	**1. Turning:** Multi-start threading, Drilling, Boring and Internal threading. Measurement of cutting forces using Lathe tool Dynamometer.
	2. Drilling & Tapping: Drilling and Tapping of Different threads on drilling machine.
	3. Milling: Key-way, Spur and Helical Gear Milling.
	4. Shaping: At least three models involving production of flat surface, Stepped surface, Cutting dovetail and rectangular grooves.
	5. Planing and Slotting: Working on Planning and Slotting Machines.
	6. Grinding At least one model on surface grinder and Cylindrical grinder.

14ME 5653 - TERM PAPER

Course Category:	**Independent Learning**	**Credits:**	2
Course Type:	**Lab**	**Lecture - Tutorial - Practice:**	0 - 1 - 0
Prerequisites:		**Continuous Evaluation:**	30
		Semester End Evaluation:	70
		Total Marks:	100

Course Outcomes: At the end of the course the students will be able to

CO1: Familiarize with new technical topics and participate in technical seminars and paper contests (e, g, h, i, j)