Kolhapur Institute of Technology's College of Engineering, Kolhapur

KOLHAPUR INSTITUTE OF TECHNOLOGY'S COLLEGE OF ENGINEERING (AUTONOMOUS), KOLHAPUR

Curriculum (Structure)

for

Mechanical Engineering Programme (Under Graduate Programme)From Academic Year 2019-2020

T.Y.B.TECH SYLLABI

Professor
DEPARTMENT OF ELECTRONICS ENGG.
KIT'S College of Engineering,
KOLHAPUR

Dr. U. S. Bhapkar
Head
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Kolhapur

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Teaching and Evaluation scheme for

Second Year B. Tech. Programme in Mechanical Engineering Semester – III

Course Code	Course Name	Teaching Scheme (Hrs/Week)				Evaluation Scheme			
						Component	Marks		
		L	T	P	C		Max	Min passing	
UMCH0301	Engineering Mathematics- III	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0302	Engineering Thermodynamics	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0303	Fluid Mechanics	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0304	Manufacturing Processes	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0305	Machine Drawing and Computer Aided Drafting	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH361	Electrical Technology (Audit Course)	2	-	-	0	ESE	100		40
UMCH0330	Object oriented Programming Lab	-		2	1	ISE	25	10	
UMCH0331	Machine Drawing Lab	-		2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0332	Thermal Engineering Lab	-		2	1	ISE	25	10	
						ESE(OE)	25	10	
UMCH0333	Fluid Mechanics Lab	-	-	2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0334	Workshop Practice II	-	-	2	1	ISE	25	10	
	Total	17	2	10	22				
		Contact Hours/Week : 29 Hrs				Total : 800			

Note: **ESE:** End Semester Examination, **MSE:** Mid Semester Examination, **ISE:** In Semester Evaluation.

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Teaching and Evaluation scheme for

Second Year B. Tech. Programme in Mechanical Engineering Semester – IV

Course Code	Course Name	Teaching Scheme (Hrs/Week)				Evaluation Scheme			
						Component	Marks		
		L	T	P	C		Max	Min for Passing	
UMCH0401	Analysis of Mechanical Elements	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0402	Machine Tools	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0403	Kinematics of Machines	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0404	Turbo Machines	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0405	Metallurgy	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH461	Environmental Studies (Audit Course)	2	-	-	0	ESE	100		40
UMCH0431	Workshop Practice III	-	-	2	1	ISE	25	10	
						ESE (POE)	25	10	
UMCH0432	Kinematics of Machines Lab	-	-	2	1	ISE	25	10	
UMCH0433	Turbo Machines Lab	-	-	2	1	ISE	25	10	
UMCH0434	Computer Graphics Lab	-	-	2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0435	Metallurgy Lab	-	-	2	1	ISE	25	10	
						ESE(OE)	25	10	
	Total	17	2	10	22				
		Contact Hours/Week: 29 Hrs				**Total: 800**			

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Teaching and Evaluation scheme for

Third Year B.Tech. Programme in Mechanical Engineering - Semester V

Course Code	Course Name	Teaching Scheme (Hrs/Week)				Evaluation Scheme			
						Component	Marks		
		L	T	P	C		Max	Min For Passing	
UMCH0501	Metrology and Quality Control	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0502	Heat Transfer	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0503	Dynamics of Machines	3		-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0504	Design of Machine Elements	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0505	Manufacturing Engineering	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0561	Control Engineering (Audit Course)	3	-	-	0	ESE	100		40
UMCH0531	CAD/CAM Lab	-	-	2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0532	Measurement Lab	-	-	2	1	ISE	25	10	
UMCH0533	Heat Transfer Lab	-	-	2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0534	Dynamics of Machines Lab.	-	-	2	1	ISE	25	10	
						ESE(OE)	25	10	
UMCH0541	Metrology and Quality Control	-	-	2	1	ISE	25	10	
	Total	18	2	10	22	**Total : 800**			
		Contact Hours/Week: **30 Hrs**							

Note: **ESE:** End Semester Examination, **MSE:** Mid Semester Examination, **ISE:** In Semester Evaluation

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Teaching and Evaluation scheme for

Third Year B.Tech. Programme in Mechanical Engineering - Semester VI

Code	Course Name	Teaching Scheme (Hrs/Week)				Evaluation Scheme			
						Component	Marks		
		L	T	P	C		Max	Min For Passing	
UMCH0601	Machine Design	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0602	Industrial Hydraulics and Pneumatics	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0603	Internal Combustion Engines	3	-	-	3	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0621*	Professional Elective – I	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH0671#	Open Elective- I	3	1	-	4	ISE- I	10		40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
UMCH661	Process Engineering (Audit Course)	2	-	-	0	ESE	100		40
UMCH0631	Workshop Practice IV	-	-	2	1	ISE	50	20	
						ESE(POE)	25	10	
UMCH0632	Industrial Hydraulics and Pneumatics Lab			2	1	ISE	25	10	
UMCH0634	I C Engines Lab	-	-	2	1	ISE	25	10	
						ESE(POE)	25	10	
UMCH0635	Machine Design Lab	-	-	2	1	ISE	25	10	
						ESE(OE)	25	10	
UMCH0641	Industrial Training and Mini Project	-		2	1	ISE	50	20	
	Total	17	2	10	22				
		Contact ours/Week: **29 Hrs**				**Total : 850**			

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Professional Elective I*	
Course Code	**Course Name**
UMCH0621	Safety and Maintenance Engineering
UMCH0622	Computational Fluid Dynamics
UMCH0623	Operations Management
UMCH0624	Industrial Product Design
UMCH0625	Industrial Automation and Robotics
UMCH0626	Applied Numerical Methods

Open Elective I #	
Course Code	**Course Name**
UMCH0671	Energy Conservation and Management
UMCH0672	Biomedical Engineering

Title of the Course: Metrology & Quality Control	**L**	**T**	**P**	**Credit**
Course Code: UMCH0501	**3**	**-**	**-**	**3**

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Metric and SI units of physical quantities
2. Statistics
3. Trigonometry and basics of manufacturing engineering

Course Description:

In today's world of high-technology products, the most important requirements of dimensional and other accuracy controls are becoming very stringent as a very important aspect in achieving quality and reliability in the service of any product in dimensional control. Unless the manufactured parts are accurately measured, assurance of quality cannot be given. In this context, the course deals with the basic principles of dimensional measuring instruments and precision measurement techniques.

Course Objectives:

1. To elaborate basic concepts of metrology, various standards and methods of dimensional measurement.
2. To explain importance of measurement of various parameters of screw threads, gears and surface quality by using different tools.
3. To make the students to identify quality aspects at various stages of product development.
4. To train the students to apply knowledge of statistical tools for analysis of quality.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	**Select** proper measuring instrument for specific application	I	Knowledge & skill
CO2	**Explain** working principle of measuring instruments	II	Knowledge
CO3	**Explain** calibration methodology and error analysis related to measuring instruments	II	Knowledge
CO4	**Demonstrate** use of metrological tools for linear, angular measurements	II	Understanding
CO5	**Scrutinize** quality aspects of measurement and quality characteristics of product.	IV	Analyzing
CO6	**Estimate** limits of gauges and control charts.	V	Evaluating

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**			**1**	**2**								**3**		**2**
CO2		**2**	**2**	**2**	**2**								**2**	**2**	
CO3				**3**	**2**		**2**						**2**	**2**	**2**
CO4		**2**	**2**	**2**	**3**								**2**	**2**	
CO5				**3**	**3**		**2**						**2**	**2**	**2**
CO6		**3**	**3**	**2**	**3**								**2**	**3**	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to Metrology Need of measurement, errors in measurement, standards of measurement. Linear measurement: slip gauges and other devices of linear measurements. Angular measurement: Bevel Protractor, Spirit level, Clinometers, Angle Dekkor, Sine bar, Angle slip gauges. Need for Calibration. Tolerances and Gauging: Unilateral and bilateral tolerances, Limit and Fits, Types of Fits, plain gauges and gauge design, interchangeability and selective assembly. Geometric dimensioning & Tolerances (GD&T) (Introductory only)	9 **Hrs.**
Unit 2:--- Comparators & Interferometry Comparators: Mechanical, Pneumatic, Optical, Electrical (LVDT).Checking all geometrical forms. Interferometry: Principle of Interferometry and application in checking of flatness, angle and height.	4 **Hrs.**
Unit 3:--- Metrology of Thread, Gears and Advance Metrology Measurement of Thread form: Thread form errors, Measurement of Minor, Major and Effective diameter (Three Wire Method), Flank angle, pitch, Floating Carriage Micrometer (Numerical). Gear Metrology: Types of errors, Gear tooth Vernier, Constant chord, Base tangent (Numerical), Gear Rolling Tester. Profile Projector, Tool makers microscope and their applications. Advancements in Metrology: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology, Automatic inspection system, Machine vision for online-offline inspection.	8 **Hrs.**
Unit 4:--- Surface finish measurement Surface Finish: Types of textures obtained during m/c operation, CLA, Ra, RMS, Rz values and their interpretation, direction of lay, texture symbols, Symbol for designating surface finish, straightness, flatness, squareness, roundness on drawing, instruments used in surface finish assessment. Coordinate measuring machine (CMM)	7 **Hrs.**
Unit 5:--- Introduction to Quality and Quality Tools Concept of Quality and quality control, elements of quality, quality of design and conformance, balance between cost of quality and value of quality, Deming's cycles & 14 Points, Juran Trilogy approach, Repeatability and Reproducibility study, Seven Quality Tools (new), Criteria for Quality Award (National & International).Inspection, stages of inspection , sampling inspection, single and double sampling plans	6 **Hrs.**
Unit 6:--- Statistical Methods in Quality Control Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability(Indices: cp, cpk, ppk), Statistical Process Control (Numerical). Production Part Approval Method (PPAP). Acceptance Sampling: operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AOQL, LTPD.	8 **Hrs.**

Textbooks:

1. R.K. Jain, "Engineering Metrology", Khanna Publisher,
2. I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications.,
3. M. Mahajan, "Statistical Quality Control" Dhanpat Rai & Co., 2012

References:

1. N.V Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, 2014.
2. J.F.W. Gayler and C.R. Shotbolt, "Metrology for Engineers", Cassell, 1990
3. K.W.B. Sharp, "Practical Engineering Metrology", Pitman London, 1st Edition 1973
4. R.C. Gupta, "Statistical Quality Control", Khanna Publication, 1st Edition,1978

Industrial Visit to study Latest Metrological Instruments.

Unit wise Measurable students Learning Outcomes:

1. Students will define different terms in measurement
2. Students will select proper instrument for measurement
3. Students will define terminology of limit system
4. Students will identify different types of fits
5. Students will design a gauge
6. Students will identify different types of magnification methods and comparators
7. Students will demonstrates use of various angle measuring Instruments
8. Students will demonstrates concept of Interferometry and its use in Flatness measurement
9. Students will demonstrates various parameters of surface finish
10. Students will demonstrates various methods of surface finish Measuring instruments
11. Student will measure different parameters of External thread by various measurement methods
12. Student will measure different parameter s of Gear by various measurement methods
13. Students will explain concepts of Quality and Quality Control
14. Students will explain SQC terms and its use in Quality Control
15. Students will explain Acceptance Sampling and its relevance in practical

Title of the Course: HEAT TRANSFER	**L**	**T**	**P**	**Credit**
Course Code: UMCH0502	**3**	**-**	**-**	**3**

Course Pre-Requisite: Differential calculus, integral calculus, Fluid mechanics.

Course Description: The course deals with fundamentals aspects of heat transfer. The knowledge of heat transfer in necessary for design of thermal equipments in the industry and simulation using Computational Fluid dynamics and Heat transfer.

Course Objectives:

1. To prepare students of Mechanical Engineering to excel in heat transfer problems related to thermal Engineering so as to succeed in careers in industry, technical professions or entrepreneurship.
2. To provide students with a solid foundation in mathematics, science and engineering fundamentals required to solve engineering problems in heat and also to pursue higher studies.
3. To train students with good scientific and engineering breadth in the areas of heat transfer so as to comprehend, analyze, design and create novel products and solutions for the real life problems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamentals of Heat and Mass Transfer mechanisms.	2	Understanding
CO2	Develop differential equations for Heat Transfer mechanisms .	3	Applying
CO3	Analyze the performance of heat exchangers.	4	Analyzing
CO4	Estimate the rate of heat transfer at specified temperature difference.	5	Evaluating

CO-PO,PSO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	2	-	-	-	3	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	1	3	2	-

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

UNIT 1: BASICS OF HEAT TRANSFER AND ONE DIMENSIONAL STEADY STATE HEAT CONDUCTION — 08 **Hrs.**

1.1 Basics of Heat Transfer:
Thermodynamics and Heat Transfer, Heat Transfer Mechanisms and Basic Laws Simultaneous Heat Transfer Mechanisms. Problem Solving Techniques in Heat Transfer.

1.2 Heat Conduction Equation: General Heat Conduction Equation: Rectangular Coordinates, Cylindrical Coordinates and Spherical Coordinates.

1.2.1 One Dimensional Steady State Heat Conduction Without Heat Generation: Plane Wall, Cylinder, Sphere. Boundary and Initial Conditions. Variable Thermal Conductivity. Concept of Thermal Resistance Thermal Contact Resistance, Overall Heat Transfer Coefficient. Critical Radius of Insulation.

1.2.2 One Dimensional Steady State Heat Conduction With Heat Generation: Plane Wall, Cylinder and Sphere.

UNIT 2: ONE DIMENSIONAL UNSTEADY STATE HEAT CONDUCTION AND EXTENDED SURFACES — 06 **Hrs.**

1.2.2: Transient Heat Conduction: Lumped System Analysis, Significance of Biot and Fourier Number. Transient Heat Conduction in Large Plane Walls, Long Cylinders, and Spheres With Spatial Effects Transient Heat Conduction in Semi-Infinite Solids.

1.2.3 Extended Surfaces (Finned Surfaces): Types of fins, applications, Expression for Heat Transfer, Temperature Distribution, fin efficiency and Fin effectiveness based fin tip condition, Error estimation in Thermowell.

UNIT 3: CONVECTION — 06 **Hrs.**

3.1 Fundamentals of Convection: Physical Mechanism of Convection, Velocity and Thermal Boundary Layer, Differential Convection Equations (Mass, Momentum and Energy Equations), Solution of Convection Equations for a Flat Plate. Reynolds and Chilton-Colburn Analogy. Buckingham's Pi Theorem applied to Forced and Free Convection, Physical Significance of dimensionless numbers.

3.2 External Forced Convection: Local and Average Heat Transfer Coefficient, Parallel Flow over Flat Plates, Flow Across Cylinders and Spheres, Flow Across Tube Banks.

3.3 Internal Forced Convection: Mean Velocity and Mean Temperature, Laminar Flow in tubes, Turbulent Flow in Tubes.

3.4 Natural Convection: Physical Mechanism of natural Convection, Natural

Convection Over surfaces. Natural Convection inside enclosures. Combined Natural Convection and Radiation. Combined Natural and Forced Convection.	
UNIT 4: THERMAL RADIATION **4.1 Fundamentals of Thermal Radiation:** Nature of radiation, electromagnetic wave spectrum, Black Body Radiation, Laws of Radiation, Radiation Intensity, Irradiation, Radiosity, Spectral Quantities, Radiative Properties, The Greenhouse Effect. **4.2 Radiation Heat Transfer:** View Factor, Radiation Heat Transfer Between Black Surfaces, Radiation Heat Transfer Between Non-Black Surfaces, Radiation Shields, Problem Solving using Electrical Analogy, Radiation Effect on Temperature Measurements.	08 **Hrs.**
UNIT 5: HEAT EXCHANGERS Types of Heat Exchangers, Overall Heat Transfer Coefficient, Effect of Fouling, Analysis of Heat Exchangers (Parallel and Counter Flow); LMTD and Effectiveness NTU Methods, Multi pass and Cross Flow Heat Exchangers. Selection of Heat Exchangers.	08 **Hrs.**
UNIT 6: COOLING OF ELECTRONIC EQUIPEMENT Introduction and History, Importance of Heat Transfer in Electronics, Cooling Load of Electronic Equipment, Conduction Cooling, Air Cooling, Liquid Cooling, Immersion Cooling, Heat Pipes, Thermoelectric Coolers, Electrohydrodyanmic Flow, Synthetic Jet, Microchannel Cooling, Cooling by nano fluids.	04**Hrs.**
Textbooks: **1.** Heat Transfer: A Practical Approach**,** Yunus A. Cengel , McGraw-Hill Higher Education; 2 edition **2.** Fundamentals of Heat & Mass Transfer ,7th Edition, Frank P. Incropera, Wiley. **3.** A Course in Heat and Mass Transfer,: S. C. Arora (Author), S. Domkundwar (Author), Anand V. Domkundwar 4 Heat and Mass transfer**:** J Holman (Author), Souvik Bhattacharyya , McGraw Hill Education; 10 edition 5. Heat Transfer- Thermal Management of Electronics, Younes Shabany, CRC Press, Indian Edition.	
References: 1 Fundamentals of Engineering Heat and mass trasnfer, R C Sachdeva, NEW AGE; Fourth edition 2. Heat And Mass Transfer, Data Book, C.P. Kothandaraman, New Age International Private Limited; Ninth edition.	
Unit wise Measurable students Learning Outcomes: **1.** Graduates will be able to formulate and solve basic equations of steady state conduction heat transfer problems **2.** Graduates will be able to identify, define, formulate, and solve transient state conduction heat transfer and extended surface problems **3** . Graduates will be able to identify, define, formulate, and solve convection problems **4.** Graduates will be able to demonstrate fundamental knowledge and formulate, and solve radiation heat transfer problems **5** .Graduates will be able to design a heat exchanger per user defined needs and specifications. **6.** Graduates will be able to explain the fundamentals of electronic cooling techniques.	

Title of the Course: Dynamics of Machines	**L**	**T**	**P**	**Credit**
Course Code: UMCH0503	**3**	**-**	**-**	**3**

Course Pre-Requisite: Engineering Physics, Applied Mechanics, Kinematics of Machines.

Course Description:

This course is an introduction to the dynamics and Vibrations of Lumped-Parameter models of Mechanical Systems. Topics covered include Inertia forces and torques in mechanisms. Balancing of multi-cylinder in-line engines. Balancing of radial and V- engines. Gyroscopic motion: simple theory of gyroscopic couple, gyroscopic effects in machinery, applications of gyroscopes. Fluctuation of energy and speed in machines: crank-effort and turning moment diagrams in flywheels. Free and forced vibrations of one-degree of freedom systems with and without viscous damping. Introduction to torsional vibration. Vibration of single degree of freedom systems with and without damping.

Course Objectives:

1. Analyze the various types of gear trains used for transmission of motion and power.
2. Study the gyroscopic effects on vehicles, aero plane and ship and turning moment diagram.
3. Study and analyze the problems on balancing of rotary and reciprocating masses
4. Study force analysis of simple mechanisms and balancing
5. Study basic concepts of vibration analysis

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Define various terminology related to gear train, flywheel, gyroscope and vibration.	3	Applying
CO2	Indentify the various mechanism and its components.	3	Applying
CO3	Apply analytical formulae to simple mechanisms to calculate design parameters.	3	Applying
CO4	Analyze dynamics of simple mechanisms.	4	Analyze

CO-PO Mapping:

CO	**PO 1**	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
CO 1	3													
CO 2	2	2	1											
CO 3	2	2	2									1		1
CO 4		3	2	1								2		2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Gear Trains Types of Gear trains- Simple, Compound, Reverted, Epicyclic gear train, Tabular method for finding the speeds of elements in Epicyclic gear train, Differential gear box. Equivalent mass and Moment of Inertia applied to gear trains.	06 **Hrs.**
Unit 2:---Gyroscope Gyroscopic couple, Spinning and Precessional motion, Gyroscopic couple and its effect on – i) Aero plane ii) Ship iii) Four-Wheeler iv) Two –Wheeler.	07 **Hrs.**
Unit 3:---Static and Dynamic force analysis Velocity and acceleration of slider crank mechanism by analytical method, Inertia force and torque, D'Alembert's principle, Dynamically equivalent system, force analysis of reciprocating engine mechanism.	07 **Hrs.**
Unit 4:--- Balancing and Flywheel Static and Dynamic balancing of rotary and reciprocating masses. Primary and Secondary forces and couples. Balancing of Single cylinder, Multi cylinder-Inline Engines. Function of flywheel and Study of turning moment diagram.	07 **Hrs.**
Unit 5:---Free Vibrations (SDOF) Basic concepts and definitions, vibration measuring parameters- Displacement, Velocity and acceleration, Free and forced vibrations, Equivalent Springs. Types of damping. Free vibrations with and without damping (Rectilinear, Torsional & Transverse), degree of damping. Logarithmic decrement, equivalent viscous damping, Coulomb damping.	07 **Hrs.**
Unit 6:---Forced Vibrations (SDOF) Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility, forced vibrations due to support excitation. Critical speed of shafts.	06 **Hrs.**

Textbooks:

1. Ratan S.S, "Theory of Machines", Tata McGraw Hill, New Delhi, 3rd Edition, 2011.
2. Sadhu Singh,"Theory of Machines", Pearson Education, 2nd Edition, 2009
3. H. G. Phakatkar,"Theory of Machines I", Edition 2009.Nirali Publication,5th Edition 2009.
4. Mechanical Vibrations by Grover G.K., Nemchand Publications.

References:

1. Hamilton H Mabie and Charles F Reinholtz, (1987), "Mechanisms and Dynamics of Machinery", Fourth Edition, John-Wiley and Sons, Inc., New York.
2. Ghosh A. and Mallick A.K., (1988), "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
3. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, (2004),

"Theory of Vibration with applications", Fifth Edition, Pearson Education Publishers.
4. Theory of Machines by Dr. V.P.Singh, Dhanpat Rai Publications.
5. Theory of Machines by Ballaney, Khanna Publications.
6. Mechanical Vibrations by S.S.Rao, Pearson Education Publications
7. Theory of vibrations with applications by W.T. Thomson (CBS Publications)
8. Kinematics, Dynamics and Design of Machinery by Walidron, Wiley India Publi.
9. Theory of Vibration with applications by W.T.Thomson M.D.Dahleh.C.Padmanabhan Pearson Education

Unit wise Measurable students Learning Outcomes:

1. Identify types of Gear trains
2. Explain the concepts of gyroscope
3. Evaluation of Static and Dynamic force analysis
4. Apply Balancing principles to the Reciprocating and Rotary machines.
5. Understand the fundamental concepts of vibrations.
6. Apply analytical formulae to solve vibratory problems.

Title of the Course: Design of Machine Elements	**L**	**T**	**P**	**Credit**
Course Code: UMCH0504	**3**	**1**	**---**	**4**

Course Pre-Requisite: Analysis of Mechanical Element, Machine Drawing, Kinematics of Machines

Course Description: Design of Machine Elements is the application of mathematics, kinematics, statics, dynamics, mechanics of materials, engineering materials, mechanical technology of metals and engineering drawing. Mechanical design, invention, and engineering tasks involve knowledge of various machine elements and creative combining of these elements into a component or assembly that fills a need. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine.

Course Objectives: The course aims to-:

1. Study fundamental principles in design of machine elements.
2. Learn to use of design data book for design of machine elements.
3. Learn to select machine elements from manufacturer's catalogue.
4. Design machine elements subjected to static loading.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Explain fundamental principles in design of machine elements.	2	Understanding
CO2	Make use of design data book for design of machine elements.	3	Applying
CO3	Select machine elements from manufacturer's catalogue.	4	Analyzing
CO4	Determine the parameters of various machine elements.	4	Analyzing

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1										2		
CO2	2	2													
CO3	1	2	2	1											
CO4	2	1	2	1											

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Fundamentals of Machine Design & Design of Simple Machine Elements — 08 **Hrs.**

A. Concept of Machine Design, Basic design procedure, Factor of safety and its significance, Type of Loads, Selection of engineering material & IS Coding for ferrous material, Factor governing selection of material, Manufacturing Considerations in Design, use of design data hand book, DFMA.

B. Design of machine elements under static loading-Knuckle Joint and Bell Crank Lever.

Unit 2:--- Design of Shafts, Keys and Couplings Design of shafts on the basis of strength, torsional rigidity and A.S.M.E. code, Design of keys and splines, Design of Muff, Flange and Flexible Bushed Pin type Couplings.	07 **Hrs.**
Unit 3:--- Design of Bolted & Welded Joints Design of bolted joints subjected to Eccentric Loading- 1) In a plane containing bolts, 2) Parallel to axis of bolt, 3) Perpendicular to the axis of bolt. Welding symbols, Stresses in butt and fillet welds, Strength of butt, parallel and transverse fillet welds, Eccentric load in plane of welds, Welded joints subjected to bending moment.	07 **Hrs.**
Unit 4:--- Design of Spring Types of springs, materials and their applications, Styles of end, Stress and deflection equations for helical compression Springs, Springs in series and parallel, Design of Helical Compression Spring subjected to static loading.	06 **Hrs.**
Unit 5:--- Design of Power Screw Forms of threads, Terminology of threads, Friction in threads, multiple start screws, Torque analysis for lifting and lowering load, Design of power screws and nut with square, trapezoidal threads, Self locking & Overhauling of screw, Stresses in power screws, Turnbuckle.	07 **Hrs.**
Unit 6:---Design of Pulley and Selection of Belts Design of Pulley-Falt and V belt pulley, Selection of flat belt and V belt as per the standard manufacturer's catalogue.	05 **Hrs.**

Teaching assessment of tutorials will be based on the completion of following assignments/ Case Studies.

Assignment on Fundamental of Machine Design.
Numerical/Case Study on Design of Simple of Machine Elements.
Numerical/Case Study on Design of Shafts, Keys & Couplings.
Numerical/Case Study on Design of bolted & welded joints.
Numerical /Case Study on Design of Spring.
Numerical/Case Study on Design of Power screw
Numerical/Case Study on Selection of Belts from manufacturer catalogues.

Textbooks:

1. Design of Machine Elements, V.B.Bhandari., Tata McGraw Hill Publication, 3rd Edition.
2. Machine Design, R.K.Jain, Khanna Publication.
3. Machine Design, Pandya Shah, Charotar Publication.
4. Machine Design, U.C.Jindal, Pearson Education.
5. Introduction to Machine design, V.B. Bhandari, Tata McGraw Hill Publication, 2nd Edition.

References:

1] Machine Design, Hall, Holowenko Laughlin, Tata McGraw Hill Pub. Schaums Outline Series.
2] Design of Machine Element, J.F. Shigley, Tata McGraw Hill Publication, 9th Edition.
3] Design of Machine Element, M.F.Spotts, Pearson Education Publication, 6th Edition.
4] PSG Design data Book.
5] Machine Component Design, Robert C. Juvniall, Willey Ltd, 5th Edition.
6] Mechanical Design of Machine Elements and Machines, Jack A Collis Henry Busby, George Staab Wiley ltd., 2nd Edition.
7] Machine Design, P. Kannaiah, Scitech Publication, 2nd Edition.
8] Design Data Book, Mahadevan, CBS Publishers and Distributors Pvt Ltd, 4th Edition.

Unit wise Measurable students Learning Outcomes: Student will be able to

1. Apply basic principles of machine design and to design of machine elements like Knuckle Joint and Bell Crank Lever against static loading.
2. Design of solid & hollow shafts, key & couplings.
3. Design of bolted joints & welded joints.
4. Design of Springs.
5. Design of Power Screw.
6. Select flat belt and V belt as per the standard manufacturer's catalogue.

Title of the Course: Manufacturing Engineering **Course Code:** UMCH0505	**L** **3**	**T** **1**	**P** **--**	**Credit** **4**

Course Pre-Requisite: Machine tool, Manufacturing process, Workshop practice, Machine Drawing.

Course Description: This course gives details about the mechanics behind the metal cutting and selection of cutting parameters and different tools w.r.t the different manufacturing processes.

Course Objectives:

1. Study of metal cutting technology including the process, measurements, design and selection of various cutting tools and their industrial specifications.
2. To introduce the students to the design practices of tooling's (Jigs and Fixtures) and die design for presswork.
3. Study of various aspects of CNC machine technology and its tooling.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	Descriptor
CO1	To **Apply** knowledge of conventional metal Cutting processes and identifies parameters of single and multipoint cutting tools.	I	Cognitive (Knowledge)
CO2	To **Analyzing** the problem logically and demonstrate an ability to design jigs.	II	Psychomotor (Skill)
CO3	To **Analyzing** the problem logically and demonstrate an ability to design fixtures	II	Psychomotor (Skill)
CO4	To **Choose** different dies for press working operations	II	Psychomotor (Skill)
CO5	To **Recognize** CNC technology.	III	Affective (Attitude)

CO-PO Mapping:

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO	2														
CO	2	2													
CO		3		3									2	3	
CO		2											2	2	
CO			3										2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:- Theory Of Metal Cutting- Wedge action, Concept of speed, Feed and depth of cut, orthogonal and oblique cutting. Mechanics of metal cutting-Chip formation, Types of chips, cutting ratio, shear plane and shear angle, velocity relationships, force measurement by tool dynamometers, cutting tool materials and their properties, Advanced cutting tools. Machinability of Metals- Factors affecting, improvement and machinability index.	**(07)Hrs.**
Unit 2:- Tool life and Tool geometry **A. Tool life** - Types of wear, relationship with cutting parameters, Taylor's equation, and improvement measures. Surface finish- Factors affecting, effect of cutting parameters, improvements. Heat generation in machining, its effect on cutting force, tool life and surface finish, types and selection criteria of cutting fluids. **(4)** **B. Tool geometry**-Parts, angles and types of single point cutting tools, tool geometry of single point cutting tool, tool geometry of multipoint cutting tools.-drills, milling cutters, reamers. Tool setting procedure **(3)**	**(07)Hrs.**
Unit 3:-Design of Drilling Jigs **A**. **Introduction to Jigs and Fixtures**. Necessity, applications and types, basic concept of jigs and fixtures for different manufacturing processes, **(1)** **B. Location and clamping system :** Principles, types, applications, locating pins, pads, diamond pins, adjustable supports, Vee and post locators, clamping system principle, types, screw clamp, strap, lever, hinge type, cam operated, toggle clamps, centralizer and equalizer clamp, multiple clamping, quick acting clamps, pneumatically operated clamps**.(4)** **C. Design of Jigs**: Principles of jig design, types of jigs- plate, template, box, channel, sandwich, latch, tumble, turn-over, tumble jig etc., types of bushes, selection of bushes and liners, construction of jig and fixture bodies, use of standard parts**(2)**	**(07)Hrs.**
Unit 4:- Design of Milling Fixtures **A**. **Design of fixtures**: Principles of fixture design, types of fixtures- gang, straddle, vertical, slot, string milling fixture etc, selection of the suitable type, design of milling fixtures, use of setting block, tennons, T-bolts etc, Indexing System: Necessity, different indexing systems for jigs and fixtures**.(5)** **B. Computer Aided Fixture Design:-**Introduction to computer Aided Fixture Design,**(3)**	**(08) Hrs.**
Unit 5:- Press Tools Dies, punches, types of presses, clearances, types of dies, strip layout, calculation of press capacity, center of pressure, Design consideration for die elements(Theoretical treatment only).	**(06) Hrs.**
Unit 6:- CNC Technology and Tooling CNC Technology and CNC tooling: Introduction, Construction and working of CNC, DNC and machining center. CNC axes & drives. Automatic Tool Changer (ATC) and Automatic pallet changer (APC) New trends in Tool Materials, Turning tool geometry, Tool inserts (coated and uncoated), Modular tooling system for Turning. Milling tooling systems, Tools presetting, Work holding.	**(06) Hrs.**
Textbooks: 1) S. K Hajra Choudhury , Elements of workshop technology – Vol. II, Media Promoters And Publishers, Mumbai. 2) Text Book of Production Engg.- P.C. Sharma- S. Chand Publication, 3) Machine Tool Engg.-G.R. Nagarpal- Khanna Publication, 4) Principles of Modern manufacturing, Groover, Fifth Edition, Wiley.	
References: 1) S. K. Basu, "Fundamentals of Tool design", Tata Mcgraw Hill Education Private ltd. 2) Jigs & Fixtures- Kempster ,ELBS. 3) Fundamentals of Tool Design design-ASTME Publication. 4) Tool Design-Donaldson –THM Publication	

5) Machine tool Engg.-G.R. Nagarpal- Khanna Publication
6) Theory of Metal Cutting-Sen Bhattacharya
7) Production Engg. Design (Tool Design)-S. Chandar & K. Surendra Satya Praka.-Delhi
8) Production Tooling Equipment-S.A.J.Parsan
9) Metal cutting theory & Tool design- Mr. Arshinnov MIR Publication.
10) Process Engineering for Manufacturing – Eary & Johnson (Prentice Hall)
11) Process Planning: The Design/Manufacturing Interface, –Petert Scallan, (2003), (Buttreworth Heinmann, Elsevier) ISBN: 0-7506-51-29-6
12) A Text Book of Production Engg, P.C. Sharma,(Millennium Edition,2000)S Chand & 13) Automation, Production Systems, and C.I.M. – Groover, M.P. 3/e, (PHI)
14) Workshop Technology Vol. III – Chapman (ELBS)
15) Mechanical Estimating and Costing – TTTI Chennai (TMH)
16) Manufacturers' catalogues for cutting tools and inspection equipments
17) Product Design-Kevin Otto and Kristin Wood (Pearson)
18) Production Technology-HMT –Tata McGraw-Hill Publishing Ltd.
19) Westerman Tables (Metals) (New Age International)
20) Standard manuals of ISO, QS, TS etc

Unit wise Measurable students Learning Outcomes:

UO1.1: Apply knowledge of manufacturing processes and identify parameters of various processes .

UO2.1 Apply knowledge of manufacturing processes and identify parameters of single and multipoint cutting tools.

UO 3.1 Students can study the different design considerations of jigs and fixtures with respect to different operations.

UO4.1: Students can study the different design considerations of jigs and fixtures with respect to different operations. Principles and types of locating, clamping and tool guiding/tool presetting elements.

UO5.1: Students can select and design dies for press working operations.

UO6.1: Students can study of various aspects of CNC machine technology and its tooling, automation, work holding devices, too presetting.

Title of the Course: Control Engineering (Audit Course)	L	T	P	Credit
Course Code:UMCH0561	3	-	-	0

Course Pre-Requisite: There are no formal prerequisites for this course; however you will need some knowledge of material from the following courses: physics, mathematics and electrical engineering.

Course Description: This course provides an introduction to linear systems, transfer functions, and Laplace transforms. It covers stability and feedback, and provides basic design tools for specifications of transient response.

Course Objectives:

1. Understand analogies between different dynamic systems and to be able to model such systems. This assists in understanding the wider implications of these engineering concepts, including responsibility in social, cultural and environmental issues
2. Understand the concept of feedback and how it influences the response of a system.
3. Understand the response of a dynamic system to an input signal and to be able to predict the response of a particular system. This applies the mathematical and engineering sciences, including physics, to real-life problems.
4. To synthesize and demonstrate the efficacy of solutions to part or all of complex engineering problems, including formulating models from first principles of engineering science and mathematics

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Construct models of physical systems in forms suitable for use in the analysis and design of control systems.	3	Applying
CO2	Make use of block diagram reduction, signal flow technique to represent control system	3	Applying
CO3	Identify the time domain responses of first and second-order systems to inputs like step, impulse etc.	3	Applying
CO4	Construct root locus and analyze time domain control system	3	Applying

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PSO1	PSO2	PSO3
CO1	3													
CO2	3	2												
CO3	2	2											2	
CO4					2									

Assessments :

Teacher Assessment:

One End Semester Examination (ESE) having 100% weightage

Assessment	Marks
ESE	100

ESE: Assessment is based on 100% course content

Course Contents:	
Unit 1:--- Introduction: Basic Elements of Control System – Classification of control system: Open loop and Closed loop systems, linear-non linear, SISO-MIMO, etc. Advantages and limitations of open loop and closed loop systems and its applications.	5-- **Hrs.**
Unit 2:- M**athematical Modeling** :Modeling of Electric systems, Translational and rotational mechanical systems – Analogous Systems, Force – Voltage Analog, Force – Current Analog .	6-- **Hrs.**
Unit 3:--- Control system representation: Block diagram Algebra, Signal flow graph- Reduction using mason's gain formula.	6-- **Hrs.**
Unit 4:--- Time Response Analysis: Standard test signals - Time response of first order systems for impulse, step inputs, Transient response of second order systems for unit step input. Time domain specifications.	8-- **Hrs.**
Unit 5:--- State Space Analysis of Continuous Systems: Concepts of state, state variables and state model, State Space Analysis: System Representation, Direct, Parallel, Series and General Programming.	7-- **Hrs.**
Unit 6:--- Stability & Root Locus Analysis: Concept of stability, relative stability. Stability criterion-Routh's stability. Root Locus-significance and construction.	8-- **Hrs.**

Textbooks:

1 .Control System Engineering", R Anand Natarajan, P. Ramesh Babu, SciTech Publication, 2nd Edition.

2"Control Systems" ,A. Anand Kumar, Prentice Hall Publication.

3"Automatic Control Engineering", F.H. Raven Tata McGraw Hill Publication, 5th Edition.

4 "Feedback Control Systems", R.A.Barapte, Tech-Max publications.

References:

1. Modern Control Systems", K Ogata, , Prentice Hall Publication ,3rd Edition.

2. "Automatic Control Systems", B.C. Kuo, Willey India Ltd. / Prentice Hall Publication, 7th Edition.

3. "Automatic Control Engineering", D. Roy and Choudhari, Orient Longman Publication Calcutta.

4."Modern Control Engineering", K. Ogata, Pearson Education

Unit wise Measurable students Learning Outcomes:

- Derive equations to model the dynamics of simple system.
- Draw block diagrams and signal flow graphs to represent different control systems.
- Use Laplace Transforms to derive transfer functions.
- Represent state space model to analyze control systems.
- Construct and use Roots' Loci diagrams to characterize simple dynamical systems.

Title of the Course: CAD/CAM Lab	**L**	**T**	**P**	**Credit**
Course Code: UMCH0531		**-**	**2**	**1**

Course Pre-Requisite: Machine tool, Manufacturing process, Workshop practice, Machine Drawing.

Course Description: This lab gives detail about CAD /CAM knowledge and to design any industrial component in to 3D. This Lab also gives about the fundamentals of rapid prototyping & 3D printer.

Course Objectives:

1. Study of different CAD software's for designing any 3D component.
2. Study of various aspects of CNC machine technology and its tooling.
3. To introduce the students to the advance manufacturing methods like 3D printing.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Interpret the given drawing and use various command to create 3D of given part.	II	Understanding
CO2	Make use of different command to create the surface model.	III	Applying
CO3	Categorize different tolerances on drawing.	IV	Applying
CO4	Develop CNC part program from CAD model using CAM software.	III	Applying
CO5	Create any 3d component with any advanced manufacturing method	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	**2**			3								2	2	
CO2	2	3	**3**		3								3	3	
CO3		3	3										3		
CO4	3	**3**			3								3	3	
CO5	3	3	3		3								3	3	

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE(POE)	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Part /Assembly drawing Internal oral etc. ESE: Assessment is based on oral examination

Course Contents:

1. **Unit 1 :- Introduction to CAD/CAM, GUI, Solid & surface Modeling** Introduction – Introduction to CAD/CAM in PLC, modeling, simulation, analysis and optimization. Introduction to Graphical User Interface (GUI), Parametric solid modeling – fundamentals, apply/modify constraints and dimensions; transform the parametric 2-D sketch into a 3D solid, feature operations, Introduction, various commands in surface modeling.	**04 Hrs.**
2. **Unit 2 Assembly Modeling and Production Drawing** Assembly modeling – Defining relationship between various parts of machine, creation of constraints, generation of exploded view. Production drawing – Generation of 2-D sketches from parts and assembly 3-D model, appropriate dimensioning and tolerance	**04Hrs.**
3. **Unit 3 Part Programming** Introduction to manual part programming, use of G and M codes to generate parts on turning centers, VMC's, HMC's etc	**04Hrs.**
4. **Unit 4 Computer Aided Manufacturing** Introduction to data exchange formats, integration of CAD/CAM software to generate tool path using suitable software,	**02Hrs.**
5. **Unit 5 Advanced Manufacturing Method – Rapid Prototyping** Introduction to Rapid Prototyping, classification of RP Processes, Working principle, models & specification process, application, advantages & disadvantages & one case study of • Stereo Lithography Apparatus (SLA) • 3D Printing. • Fused Deposition Modeling [FDM]	**04Hrs.**

Textbooks:

1) "CAD/CAM- Principals and Applications", P.N. Rao, Tata McGraw Hill, 2nd Edition.
2. "CAD/CAM/CAE",N.K. Chougule, SciTech Publication, Revised Edition.
3. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
4. Radhakrishnan P, SubramanyanS.andRaju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000.

References:

1. "Machine Drawing", N. D. Bhatt and V.M. Panchal, Charoter Publications
2. ASME Y14.5, (2009)
3. "Mastering CAD CAM",Ibrahim Zeid, Tata McGraw-Hill, Special Indian Edition, (2007).
4. Help Manuals and Tutorials of Referred Software
5. "Machine Drawing", N. Siddheshwar, P. Kannaiah, V V S Sastry, Tata McGraw Hill Publications, 2nd Edition.
6. "CAM/CAM – Theory and Practice",Ibrahim Zeid, R. Sivasubramaniam, Tata McGraw Hill,2nd Edition.
7. "CAD/CAM – Concepts and applications", Chennakesava R. Alavala – Prentice Hall of India

Experiment wise Measurable students Learning Outcomes:

UO1.1: Understand the basic fundamentals of computer aided design and manufacturing.
UO2.1 To learn 2D & 3D transformations of the basic entities etc.
UO 3.1 To understand the different geometric modeling techniques like solid modeling, surface
Modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
UO4.1To learn the CNC part programming.
UO5.1To learn the advance manufacturing processes like rapid prototyping with one component.

LIST OF EXPERIMENTS

Term Work:

1. Solid Modeling with drafting - 2 Exercises
2. Surface Modeling like mouse, badminton racket, monitor, hair dryer etc. - 2 Exercises
3. Assembly with minimum 5 components like crane hook, tail stock, screw jack, Universal coupling etc.
4. Part programming for CNC turning center – 2 parts
5. Part programming for Vertical Machining Center – 2 parts
6. Tool path generation by using suitable CAM software – 2 parts
7. Part creation using 3D printing machine -2 parts

Title of the Course: Measurement Lab	**L**	**T**	**P**	**Credit**
Course Code: UMCH0532	**-**	**-**	**2**	**1**

Course Pre-Requisite: Applied Mechanics, Engineering Physics

Course Description: This course deals with demonstration of different measuring devices and systems and conduct of various experiments on the same. It also deals with testing and calibration of various measuring systems.

Course Objectives:

1.To study different measuring systems,
2. To perform testing and calibration of different gauges and measuring devices
3. To study different types of sensors and transducers

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain the working of different measuring devices.	2	Understanding
CO2	Demonstrate testing and calibration of measuring systems.	2	Understanding
CO3	Identify types of sensors and transducers.	3	Applying

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3											3		
CO2	2									2		3		
CO3	3											3		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) .

Assessment	Marks
ISE	25

ISE is based on practical performance and Internal oral.

Course Contents:

Experiment No. 1:--- Assignment on Measurement systems and basic concepts of measurement methods.	**02 Hrs.**
Experiment No. 2:--- Study of different types of Sensors and Transducers.	**02 Hrs.**
Experiment No. 3:--- Angular speed measurement using, Photo-electric pick up and magnetic pick up.	**02 Hrs.**
Experiment No. 4:--- Testing of Mechanical pressure gauge using Dead	**02 Hrs.**

weight pressure gauge tester.	
Experiment No. 5:--- Measurement of displacement using LVDT.	**02 Hrs.**
Experiment No. 6:--- Formation of Thermocouple tip and Calibration of Thermocouple.	**02 Hrs.**
Experiment No. 7:--- Measurement of temperature using Thermocouple RTD, and thermistors.	**02 Hrs.**
Experiment No. 8:-- Force and torque measurement using strain gauges.	**02 Hrs.**

Textbooks:

Mechanical Measurement– Beckwith and Buck, Prentice Hall of India, New Delhi.

2. Mechanical Measurement and Control – D.S. Kumar, Metropolitan Book Co.

Mechanical Measurements – Shirohi and Radha Krishnan H.C., New Age International, New Delhi.

3. Engineering Practices Laboratory Kannaiah, Scitech Publication.

References:

1. Measurement Systems – DoebelinEmesto, McGraw Hill Publishing Co. New York.
2. Mechanical Measurement and Control – A.K. Sawhney and P. Sawhney, DhanpatRaiand Co
3. Theory and design for mechanical measurements – Richard S. Figliola, Donald E. Beasley, Wiley India Edition.

Experiment wise Measurable students Learning Outcomes:

Student will be able to

1. Explain the process of angular speed measurement using various devices.
2. Form thermocouple tip and calibrate the same.
3. Measure temperature using different temperature measuring devices.
4. Carry out testing of mechanical pressure gauge.
5. Carry out measurement of displacement.
6. Make use of strain gauge for force measurement
7. Explain the concept of Sensors and transducers

Title of the Course: HEAT TRANSFER LAB	L	T	P	Credit
Course Code:UMCH0533	-	-	2	1

Course Pre-Requisite: Differential calculus, Integral calculus, Fluid mechanics

Course Description: The course deals with various experiments related to conduction, convection and radiation mode of heat transfer so as to understand the fundamentals and application of governing equations used in heat transfer.

Course Objectives:

CLO1: To provide the students the fundamentals of conduction, convection and radiation.

CLO2:To train students with good scientific and engineering breadth in the areas of heat transfer, so as to comprehend, analyze, design and create novel products and solutions for the real life problems

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamentals of Heat and Mass Transfer mechanisms.	2	Understanding
CO2	Develop differential equations for Heat Transfer mechanisms .	3	Applying
CO3	Analyze the performance of heat exchangers.	4	Analyzing
CO4	Estimate the rate of heat transfer at specified temperature difference.	5	Evaluating

CO-PO, PSO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	2	-	-	-	3	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	1	3	2	-

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Note: Experiment No. 1 to 10 shall be selected for the POE examination and All should be included in Journal.

Course Contents:

Experiment No. 1:Thermal conductivity of insulating powder	**02 Hrs.**
Experiment No. 2: Heat transfer through lagged pipe	**02 Hrs.**
Experiment No. 3: Heat transfer through composite wall	**02 Hrs.**
Experiment No. 4: Heat transfer by natural convection	**02 Hrs.**
Experiment No. 5: Emissivity measurement apparatus	**02 Hrs.**
Experiment No. 6: Stefan -Boltzmann apparatus	**02 Hrs.**
Experiment No. 7: Parallel and counter flow heat exchanger	**02 Hrs.**
Experiment No. 8: Heat transfer by forced convection	**02 Hrs.**
Experiment No. 9: Heat transfer through pin fin	**02 Hrs.**
Experiment No. 10: Heat pipe demonstration	**02 Hrs.**
Experiment No. 11: Study and Demonstration of Drop wise and Film wise Condensation	**02 Hrs.**
Experiment No. 12: Study and Demonstration of Pool Boiling and Forced Boiling.	**02 Hrs.**
Experiment No. 13: Heat Transfer Design Mini Project	

Textbooks:

1. Heat Transfer: A Practical Approach, Yunus A. Cengel , McGraw-Hill Higher Education; 2 edition
2. Fundamentals of Heat & Mass Transfer ,7th Edition, Frank P. Incropera, Wiley.
3. A Course in Heat and Mass Transfer,: S. C. Arora (Author), S. Domkundwar (Author), Anand V. Domkundwar
4 Heat and Mass transfer: J Holman (Author), Souvik Bhattacharyya , McGraw Hill Education; 10 edition

References:

1 Fundamentals of Engineering Heat and mass trasnfer, R C Sachdeva

2. Heat And Mass Transfer, Data Book, C.P. Kothandaraman, New Age International Private Limited; Ninth edition.

Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to

1. Determine the thermal conductivity of insulating powder.
2. Determine the thermal conductivity of insulating material in lagged pipe
3. Determine the equivalent thermal conductivity and thermal resistance of insulating powder.
4. Determine the heat transfer coefficient in natural convection of vertical cylinder.
5. Determine the emissivity of given grey plate.
6. Determine the stefan-boltzmann constant experimentally.
7. Determine the LMTD, effectiveness of parallel and counter flow heat exchanger.
8. Determine the heat transfer coefficient in forced convection.
9. Determine the effectiveness and efficiency of pin fin.
10. Demonstrate the working principle of heat pipe
11. Demonstrate Drop wise and Film wise Condensation
12. Explain Pool Boiling and Forced Boiling Phenomenon
13. Develop a mini project on heat transfer.

Title of the Course: Dynamics of Machines Lab	L	T	P	Credit
Course Code: UMCH0534	-	-	2	1

Course Pre-Requisite: Applied Mechanics, Engineering Physics, Kinematics of Machines.

Course Description:

This course is an introduction to the dynamics and Vibrations of Lumped-Parameter models of Mechanical Systems. Topics covered include Inertia forces and torques in mechanisms. Balancing of multi-cylinder in-line engines. Balancing of radial and V- engines. Gyroscopic motion: simple theory of gyroscopic couple, gyroscopic effects in machinery, applications of gyroscopes. Fluctuation of energy and speed in machines: crank-effort and turning moment diagrams in flywheels. Free and forced vibrations of one-degree of freedom systems with and without viscous damping. Introduction to torsional vibration. Vibration of single degree of freedom systems with and without damping.

Course Objectives:

1. Analyze the various types of gear trains used for transmission of motion and power.
2. Study the gyroscopic effects on vehicles, aero plane and ship and turning moment diagram.
3. Study and analyze the problems on balancing of rotary and reciprocating masses
4. Study force analysis of simple mechanisms and balancing
5. Study basic concepts of vibration analysis

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Define various terminology related to gear train, flywheel, gyroscope and vibration.	3	Applying
CO2	Indentify the various mechanism and its components.	3	Applying
CO3	Apply analytical formulae to simple mechanisms to calculate design parameters.	3	Applying
CO4	Analyze dynamics of simple mechanisms.	4	Analyze

CO-PO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3													
CO2	2	2	1											
CO3	2	2	2									1		1
CO4		3	2	1								2		2

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE(POE)	25

ISE are based on practical performed/ PBL activity/Quiz/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on Practical oral examination

Laboratory Contents:	
Experiment No.1:- Experiment on Epicyclic Gear Train. Aim & Objectives: To study various types of gear trains and analysis of Epicyclic Gear Train. Outcomes: Able to analyze the Epicyclic Gear Train. Experimentation: Use of Tabular method for the Analysis of gear train model available in laboratory. Results and Discussions: Determination of speeds of different wheels in gear train.	02**Hrs.**
Experiment No. 2:- Experiment on Gyroscope. Aim & Objectives: To Verify experimentally the principles of Gyroscope. Outcomes: Able to describe effect of gyroscopic couple on various systems. Experimentation: Verification of active and reactive gyroscopic couples values using experimental setup. Results and Discussions: Calculation of active and reactive gyroscopic couples.	02 **Hrs.**
Experiment No. 3:- Determination of M.I. using Bifilar and Trifilar suspension system. Aim & Objectives: To determine radius of gyration of rectangular bar using Bifilar and Trifilar suspension method. Outcomes: Able to determine radius of gyration of components like Connecting rod. Experimentation: To determine value of Radius of gyration and M.I. of rectangular bar and Circular disc Experimentally. Results and Discussions: To verify the Radius of gyration and M.I. analytically and experimentally.	02 **Hrs.**
Experiment No. 4:- Determination of M.I. of connecting rod by Compound pendulum method. Aim & Objectives: To determine radius of gyration of connecting rod as Compound Pendulum. Outcomes: Able to determine radius of gyration and M.I. of components like Connecting rod. Experimentation: To determine value of Radius of gyration and M.I. of connecting rod Experimentally. Results and Discussions: To verify the Radius of gyration and M.I. analytically and experimentally.	02**Hrs.**
Experiment No. 5:- Experiment on Balancing of rotary masses (Static and Dynamic). Aim & Objectives: To observe the principles of static and dynamic balancing. Outcomes: Able to analyze rotary system for static and dynamic balancing. Experimentation: To arrange the given masses in Angular and linear positions for complete static and Dynamic balance. Results and Discussions: To find Angular and linear positions of masses analytically and to verify the results.	02**Hrs.**
Experiment No. 6:- Experiment on equivalent spring mass system. Aim & Objectives: To determine Natural Frequency of equivalent spring mass system.	02**Hrs.**

Outcomes: Able to determine Natural frequency experimentally. Experimentation: Determination of time period and natural frequency. Results and Discussions: Comparison between Analytical and Experimental natural Frequency.	
Experiment No.7:-Determination of logarithmic decrement for single DOF damped system Aim & Objectives: To determine logarithmic decrement for Torsionally vibratory system. Outcomes: Able to analyze effect of damping on vibratory system Experimentation: Plotting the logarithmic decrement of Torsionally vibratory system. Results and Discussions: calculation of damping coefficient for vibrating systems.	02**Hrs.**
Experiment No. 8:- Experiment on study of forced vibration characteristics Aim & Objectives: To study effect of exciting force on characteristics of vibrations Outcomes: Able to determine forced vibration characteristics like Amplitude and Frequency. Experimentation: To plot the graph Amplitude vs. Time for forced vibrations Results and Discussions: Determination of Maximum Amplitude and Natural Frequency for the Systems subjected to forced vibrations.	02**Hrs.**
Experiment No. 9:- Experiment on Whirling of Shaft Aim & Objectives: To study whirling of shafts Outcomes: Able to measure speed of shaft at which whirling takes place Experimentation: To measure speed of rotating shaft which is whirling. Results and Discussions: To measure critical speed of whirling.	02**Hrs.**
Experiment No. 10:- Study and experiment on Vibration measuring Instrument Aim & Objectives: To study vibration measuring instruments used for measurement of vibration parameters. Outcomes: Able to measure vibration parameters (Displacement, Velocity , Acceleration and Frequency) Experimentation: To measure vibrations imposed to the frame of rotating shaft. Results and Discussions: To measure vibration parameters.	02**Hrs.**
Experiment No.11:- Industrial visit based on above syllabus. Aim & Objectives: To make students acquainted to balancing of components like Gears, Pulleys used in Industry. Outcomes: Able to understand industrial procedure for Static and Dynamic Balancing. Experimentation: Demonstration of Measurement and removal of unbalance of Pulley using Balancing Machine.	02**Hrs.**
Textbooks: 1. Ratan S.S, "Theory of Machines", Tata McGraw Hill, New Delhi, 3rd Edition, 2011. 2. Sadhu Singh,"Theory of Machines", Pearson Education, 2nd Edition, 2009 3. H. G. Phakatkar,"Theory of Machines I", Edition 2009.Nirali Publication,5th Edition 2009. 4. Mechanical Vibrations by Grover G.K., Nemchand Publications.	
References:	

1. Hamilton H Mabie and Charles F Reinholtz, (1987), "Mechanisms and Dynamics of Machinery", Fourth Edition, John-Wiley and Sons, Inc., New York.
2. Ghosh A. and Mallick A.K., (1988), "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
3. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, (2004), "Theory of Vibration with applications", Fifth Edition, Pearson Education Publishers.
4. Theory of Machines by Dr. V.P.Singh, Dhanpat Rai Publications.
5. Theory of Machines by Ballaney, Khanna Publications.
6. Mechanical Vibrations by S.S.Rao, Pearson Education Publications
7. Theory of vibrations with applications by W.T. Thomson (CBS Publications)
8. Kinematics, Dynamics and Design of Machinery by Walidron, Wiley India Publi.
9. Theory of Vibration with applications by W.T.Thomson M.D.Dahleh.C.Padmanabhan Pearson Education

Title of the Course: Metrology and Quality Control Lab	**L**	**T**	**P**	**Credit**
Course Code: UMCH0541	**0**	**0**	**2**	**1**

Course Pre-Requisite: Basic Knowledge of different units, types of errors in measurement and basic electrical components with their principle. Basic knowledge of scale, scale factor and different measurement with units. Also knowledge of Basics of Geometrical Dimensional Tolerances, limit, fits

Course Description:

The course integrates measurements of industrial parts with various mechanical and electronic measuring instruments and their usage.

Course Objectives:

The objective of this course is to make the student aware of:

1. To develop students knowledge of basics of Measurements, Metrology and measuring devices.
2. To know the concepts of various measurement systems & standards with regards to realistic applications.
3. The application of principle of metrology and measurements in industries.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	List various geometrical tolerances used in production drawing	1	Remembering
CO2	Explain the significance of measurement system, errors, calibration of measuring devices	2	Understanding
CO3	Demonstrate use of metrological tools for linear, angular measurements	2	Understanding
CO4	Explain the basics of standards of measurement, limits, fits & tolerances industrial applications	2	Understanding
CO5	Analyze Manufacturing process with the help of Control Charts and Process Capability	4	Analyzing

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**			**1**	**2**								**1**	**2**	**2**
CO2	**2**	**2**	**2**	**2**	**2**		**1**						**3**		
CO3	**2**	**1**		**2**	**2**		**1**						**3**	**2**	
CO4	**2**	**2**	**2**	**2**			**1**						**3**		
CO5	**2**	**2**		**2**	**2**		**1**						**3**	**2**	

Assessments :

Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:	
Experiment No. 1:--- Study & Use of various linear measuring instruments (Vernier and micrometers) **Aim and Objectives:** **Outcomes:** Demonstrate use of linear Measuring Instruments **Theoretical Background:** **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	2Hrs.
Experiment No. 2:--- Calibration of Dial Indicator using slip gauge. **Outcomes:** Demonstrate calibration process **Theoretical Background:** Calibration need and importance **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	2 Hrs.
Experiment No. 3:--- Study and use of mechanical & pneumatic comparator **Outcomes:** Demonstrate use of comparators **Theoretical Background:** Construction & Working of comparators **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	2Hrs.
Experiment No. 4:--- Study & use of Bevel protractor and Sine Bar for measurement of Angle. **Outcomes:** Demonstrate use of Angle Measuring Instruments **Theoretical Background:** Construction & Working of angle measuring instruments **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	2 Hrs.
Experiment No. 5:--- Measurements of Screw thread parameters using two wire method **Outcomes:** **Theoretical Background:** **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	2 Hrs.
Experiment No. 6:--- Measurement of gear tooth thickness using gear tooth verinier caliper.	2 Hrs.

Outcomes: Demonstrate use of Gear Measuring Instruments **Theoretical Background:** **Experimentation:** Use of instrument, calibration , Measurement and Calculation with Interpretation **Results and Discussions:** **Conclusion:**	
Experiment No. 7:--- Study & use of Variable (X-Bar) chart **Outcomes:** Demonstrate use of Gear Measuring Instruments **Theoretical Background: Statistical concepts, Control charts** **Experimentation:** Data collection, use of statistical techniques, data analysis, calculation, plotting of graph with interpretation **Results and Discussions:** **Conclusion:**	2 Hrs.
Experiment No. 8:--- Study & use of Attribute (P) chart **Outcomes:** Demonstrate use of Gear Measuring Instruments **Theoretical Background: Statistical concepts, Control charts** **Experimentation:** Data collection, use of statistical techniques, data analysis, calculation, plotting of graph with interpretation **Results and Discussions:** **Conclusion:**	2 Hrs.

Textbooks:

1. R.K. Jain, "Engineering Metrology", Khanna Publisher,
2. I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications.,
3. N Sidheshwar,P Kannaiah,"Machie Drawing",TATA Magraw hill,2009.
4. Anand Bewoor, Vinay Kulkarni, " Metrology & Measurement" The McGraw-Hill Comp.
5. B.C. Nakara & K. K. Choudhari , "Instrumentation Measurement & Analysis", TATA Magraw hill,2012.
6. Quality Control by Anand Beoor & Vinay Kulkarni Wiley India PVT.Ltd.

References:

1. "Engineering Metrology", I.C. GUPTA, DhanpatRai and Sons, 1988, 2nd Edition.
2. "Practical Engineering Metrology", Sharp K.W.B. Pitman, London, 1973, 1st Edition.
3. Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition,
4. N.V Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, 2014.
5. Serope Kalpakjian and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson, Sixth Edition

Experiment wise Measurable students Learning Outcomes:

1. Students are able to select proper instrument for particular application
2. Students are able to calibrate instrument
3. Students will demonstrate use of pneumatic and mechanical comparator
4. Students will demonstrate use of Bevel protractor and Sine bar.
5. Students will demonstrate use of floating carriage micrometer & two wire method for measurement of thread diameter
6. Students will demonstrate use of Bevel protractor and Sine bar.
7. Students will construct and interpret the control charts for variable data.
8. Students will construct and interpret the control charts for attribute data

Title of the Course: Machine Design	L	T	P	Credit
Course Code:UMCH0601	3	-	-	3

Course Pre-Requisite:
Machine Design I, Analysis of Mechanical Elements,

Course Description:
The Machine design course aims to acquire knowledge of designing procedures of transmission elements and mechanical systems. The design Engineer requires selecting standard components such as rolling contact bearings and sliding contact bearings. The knowledge of Machine design will enable students to understand the procedures of selection of bearings, design the mechanical components against fluctuating load. This course aims to understand design procedure of the transmission elements.

Course Objectives:
1. Analyze the gears with respect to strength point of view.
2. Design of components subjected to dynamic load.
3. Design up to two stage gear box
4. Measure design of parameters of mechanical systems
5. Formulate design parameters of practical problems

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamental principles of fatigue and stress concentration in design of components	II	Understanding
CO2	Identify parameters required for design of mechanical components	III	Applying
CO3	Determine the design parameters of mechanical components and mechanical systems	V	Evaluating
CO4	Design of power transmission elements	VI	Creating

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	--	-	1	-	-
CO2	2	2	1	1	-	-	--	-	-	-	-	1	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1	-	
CO4	-	2	2	1	-	-	-	-	-	-	-	1	-	-

Assessments :
Teacher Assessment:
Two components of in Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:- Design for fluctuating loads Stress concentration, fluctuating stresses, S-N. diagram under fatigue load, endurance limit, notch sensitivity, endurance strength- modifying factors, design for finite and infinite life under reversed stresses, cumulative damage in fatigue failure, Soderberg and Goodman diagrams, modified Goodman diagram, fatigue design for components under combined stresses	05 **Hrs.**
Unit 2: Design of bearings **i) Introduction to Tribological consideration in design :** Friction, Wear, Lubrication. **ii) Rolling Contact Bearing :** Types, static and dynamic load capacities, Stribeck's equation, equivalent bearing load, load-life relationship, Bearing life, Selection of bearing from manufactures catalogue. Ball and Roller bearing, Design for variable load and speed, Bearings with probability of survival other than 90 %. Lubrication and mountings, dismounting and preloading of bearings **iii) Sliding contact bearing :** Types of sliding contact bearing, Basic theory, thick and thin film lubrication, Reynolds's equation, Raimondi and Boyd method relating bearing variables, Sommerfield Number, Design consideration in hydrodynamic bearings, Temperature rise, Introduction to hydrostatic bearings	09 **Hrs.**
Unit 3: Aesthetic and Ergonomic consideration in Design Basic types of product forms, Designing for appearance, shape, Concept of unity- concept of order with variety -concept of purpose style and environment Aesthetic expressions. Ergonomic considerations- Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipments using ergonomics and aesthetic design principles.	04**Hrs.**
Unit 4: Design of Spur and Helical gear **i) Spur Gear:** Gear tooth loads, No. of teeth, face width, strength of gear teeth, static beam strength (Lewis equation), dynamic tooth load, wear strength (Bucking ham's equation), Estimation of module based on beam strength and wear strength. Methods of gear lubrication. Profile shifting of gears, construction of gears **ii) Helical Gears:** Terminology, Formative number of teeth in helical gears, force analysis, beam & wear strength of helical gears, effective load & design of helical gear, Herringbone gears.	09 **Hrs.**
Unit 5:Design of bevel and worm gear drive **i) Bevel Gear :**	09 **Hrs.**

Types of bevel gears, Straight tooth bevel gear terminology and geometrical relations. Guideline for selection of dimensions and minimum number of teeth, Force analysis, Mounting of bevel gear and bearing reactions, Beam and wear strength, Dynamic tooth load, Design of straight tooth bevel gears based on beam and wear strength. **ii) Worm and worm wheel drive :** Terminology and geometrical relations. Standard dimensions and recommendation of worm gearing, Force analysis, Friction, Efficiency of worm gear drive, Design of worm drive as per IS 7443-1974 based on beam strength and wear strength rating, Thermal consideration in worm drive.	
Unit 6: P**ressure Vessel Design:-** Thin and thick cylinders; failure criteria of vessels; Lame's equation, Clavarino's and Birnie's equation, Autofrettage and compound cylinders, introduction to design of pressure vessels as per IS Codes. Shell and end closures	06 **Hrs.**

Textbooks:

1. Bhandari V. B." Design of Machine Elements, Tata McGraw Hill New edition
2. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd.

References:

1. Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill Book Co. Ltd.
2. Maleev V.L., Hartman J.B, "Mechanical Design of Machine", CBS Pub. & Distributors,
3. Design Data Handbook" – P.S.G. College of Technology, Coimbatore.
4. Hall A.S.; Holowenko A.R. and Laughlin H.G. – "Theory and Problems of Machine Design" Schaum's outline series.

Unit wise Measurable students Learning Outcomes:

1. Student should be able to know basic principles of design of mechanical component against fluctuating load
2. Student should be able to select and recommend suitable bearing for particular application
3 Student should be able to understand principles of aesthetics and ergonomics
4. Student should be able to design spur and helical gear
5. Student should be able to design bevel and worm gear
6. Student should be able to design pressure vessels as per IS standard

Title of the Course: Industrial Hydraulics and Pneumatics	**L**	**T**	**P**	**Credit**
Course Code: UMCH0602	**3**	**--**	**--**	**3**

Course Pre-Requisite: Preliminary knowledge of Fluid Mechanics

Course Description: This course aims to impart knowledge of fluid power systems such as hydraulics and pneumatics w.r.t. their components, circuits and their applications, design of system and maintenance and troubleshooting of the system.

Course Objectives:

1. To study application of fluid mechanics and governing laws in hydraulic and pneumatic systems.
2. Study of working principle of various components used in hydraulic and pneumatic systems.
3. Study of ISO/JIC symbols of fluid power systems.
4. Selection of different components used in hydraulic and pneumatic systems.
5. Design of hydraulic and pneumatic circuits.
6. Industrial applications of hydraulic and pneumatic circuits.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive level**	**Descriptor**
CO1	**Explain** the construction and working of various elements of hydraulic and pneumatic systems.	2	Understanding
CO2	**Make use of** ISO/JIC symbols of fluid power systems to prepare fluid power circuits.	3	Applying
CO3	**Develop** the hydraulic or pneumatic circuits as per the given requirements.	3	Applying
CO4	**Identify** troubleshooting and maintenance of hydraulic and pneumatic system.	3	Applying

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**P011**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2												2		2
CO2		2	2										2		2
CO3			3									3	3		3
CO4			3	3								2	3		3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course

content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1: Introduction to Hydraulics and Pneumatics Basic elements of fluid power system, Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations, applications of fluid power systems in various fields of engineering, comparison between hydraulic and pneumatic system, Service properties of hydraulic fluid, Types of hydraulic fluids, selection of fluid, ISO/JIC symbols of various elements of fluid power systems. Sources of contamination of hydraulic oil and its control, strainer, filter	**7 Hrs.**
Unit 2: Elements of Hydraulic System ▪ Classification and types of seals, sealing material, Fluid conductors, heat-exchanger, hydraulic oil reservoir**.** ▪ Hydraulic pumps: Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial piston pumps, power and efficiency calculations, characteristics curves, selection of pumps. ▪ Actuators-linear and rotary, hydraulic motors, types of hydraulic cylinders and their mountings. Calculation of piston velocity, thrust under static and dynamic applications, Design considerations for cylinders. Cushioning of cylinders. (Numerical treatment on pumps and hydraulic actuators).	**7 Hrs.**
Unit 3: Control of Oil Hydraulic Power ▪ Requirements of Pressure control, direction control and flow control valves. ▪ Pressure control valves: Pressure relief valve, directly operated and pilot operated pressure relief valve, pressure reducing valve, sequence valves, counter balance valve. ▪ Types of direction Control valves: 2/2, 3/2, 4/2, 4/3, 5/2. Open center, close center, tandem center, manual operated, mechanical operated solenoid, pilot operated direction control valves, check valves. ▪ Flow control valves: temperature compensated, pressure compensated, temperature and pressure compensated flow control valve. ▪ Accumulators, intensifier and their applications.(Numerical on accumulators)	**7 Hrs.**
Unit 4: Elements of Pneumatic System ▪ Air compressors: Types, piston, screw and vane, Selection criteria for air compressor, piping layout, Servicing of compressed air – FRL unit. ▪ Direction control valves: (two way, three way, four way), check valves, flow control valves, pressure control valves, speed regulators, quick exhaust valves, time delay valve, shuttle valve and twin pressure valve. Solenoid operated, pilot operated valves. ▪ Pneumatic actuators, Rotary and reciprocating cylinders–types and their mountings, Air motor – types, Comparison with hydraulic and electric motor.	**7 Hrs.**
Unit 5:Hydraulic and Pneumatic Circuits ▪ Hydraulic Circuits such as Speed control circuits(Meter-in, Meter-out, Bleed off), Regenerative circuit, rapid traverse and feed circuit, automatic cylinder reciprocating circuits, Sequence circuits – Travel dependent and Pressure dependent ,cylinder synchronizing circuits, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit. ▪ Pneumatic Circuits such as manual control of single acting and double acting cylinder, Speed control circuits, Impulse operation circuit, Sequence circuits of A+B+A-B- and A+B+B-A- type, Time delay circuit in pneumatics. OR control circuit for pneumatic cylinder, AND control circuit for pneumatic cylinder.	**7Hrs.**

Unit 6: System Design, maintenance and troubleshooting and servo controls	7 **Hrs.**
▪ Design procedure of hydraulic system for industrial applications including points like load, pressure and flow calculations, sizing and selection of components, design constraints considerations, circuit preparation and determination of energy losses in system. ▪ Maintenance, troubleshooting and safety of hydraulic system, ▪ Maintenance, troubleshooting and safety of pneumatic system, ▪ Introduction to Servo control, Hydraulic servo system for pressure and flow control. ▪ Electro-hydraulic system: Introduction, components and applications.	

Textbooks:

1. "Oil hydraulics Systems", S. R. Mujumdar, Tata McGraw Hill Publication.
2. "Pneumatic Systems", S. R. Mujumdar- Tata McGraw Hill Publication.
3. "Industrial Fluid Power",D. S. Pawaskar, Nishant Prakashan.
4. "Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.
5. "Fluid Power with Application", Esposito, Pearson Education, 7th Edition.
6. "Basic Hydraulic – Festo Manual"
7. "Basic Pneumatic – Festo Manual"
8. "Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
9. "Hydraulics and Pnuematics",Dr.Anand Bewoor, Late S.K.Ponde,Nirali Prakashan.

References:

1. "Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
2. "Industrial Hydraulic", J. J. Pipenger, Tata McGraw Hill.
3. "Power Hydraulics", Goodwin 1st Edition.
4. "Introduction to Hydraulic and Pneumatics",S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
5. "Pneumatic Control",Joji P.,Wiley. , 1st Edition.
6. "Fluid Power", Jagadeesha T. Wiley Publications.
7. Eaton (Vickers) Manual.
8. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics.

Unit wise Measurable students Learning Outcomes:

1. Explain the layouts and basic components of hydraulic and pneumatic system.
2. Explain construction and working of hydraulic pumps, actuators, accumulators and intensifiers.
3. Explain and demonstrate the construction and working of various types of control valves used in oil hydraulic system.
4. Explain construction and working of various components of pneumatic system.
5. Prepare and demonstrate various fluid power circuits with their applications.
6. Develop and design hydraulic and pneumatic circuit.

Title of the Course: Internal Combustion Engines	**L**	**T**	**P**	**Credit**
Course Code: UMCH0603	**3**	**-**	**-**	**3**

Course Pre-Requisite: Applied Thermodynamic, Basic Mechanical Engineering, Heat Mass Transfer.

Course Description:

The aim of this course is to provide students with a working knowledge and application of the fundamentals of how the operation of internal combustion engine affect their working, performance, fuel requirements and environmental impact on both SI and CI engines.

The focus is on explaining engine performance in terms of power, energy utilization and exhaust emissions, its relation to internal processes like combustion and gas exchange at varying engine-operating condition.

Course Objectives:

1. To enable the students to analyze the Ideal and actual air standard cycles and valve timing diagrams.
2. To make the students to study of fuel supply system in I.C. Engine.
3. To educate the student about combustion phenomenon and emission characteristics of engines.
4. To impart knowledge about various engine performance characteristics of engine.
5. Comprehend the different technological advances in engines and alternate fuels.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of I. C. Engine	II	Understanding
CO2	Classify different systems if I. C. Engine	II	Understanding
CO3	Solve numerical on I. C. Engine	III	Applying
CO4	Measure performance parameters of I. C. Engine	III	Applying

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3											2		
CO2	3													
CO3		3												
CO4		3											2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:--- Introduction to I. C. Engine Introduction, Classification of I. C. Engines, applications, Engine specifications. Engine Cycles: Engine cycles, Deviation of actual cycles from air standard cycles, Valve timing diagram for high and low speed engine, Port timing diagram.	**05 Hrs.**
Unit 2: Fuel Supply system for SI and CI Engine **Fuel Systems for S.I. Engines:** Engine fuel requirements, complete carburetor, Derivation for calculation of A/F ratio, Calculation of main dimensions of carburetors, Effect of altitude on Air fuel ratio. Electronic Petrol injection system (MPFI). **Fuel Systems for C.I. Engines:** Requirements of injection system, Types of injection systems – Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles- single hole, multi hole, pintle, and pintaux. Governing of C.I. engines. Electronic diesel injection system. Calculations of main dimension of fuel injection system.	**09 Hrs.**
Unit 3:--- Combustion In I. C. Engine **Combustion in S.I Engine** Stages of combustion, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Detonation – phenomena, causes & remedies, Requirements of combustion chambers of S.I. Engines and its types. **Combustion in C.I Engine** Stages of combustion, Delay period, Factors affecting delay period, Abnormal combustion- Diesel knock - phenomena, causes & remedies, comparison of abnormal combustion in S.I. and C.I. Engines Requirements of combustion chambers for C.I. Engines and its types.	**08 Hrs.**
Unit 4:--- Performance Testing of I. C. Engine Performance parameters, I. S. Standard Code10000 (I to XI) to 10004 for testing of engines), Measurement of performance parameters like torque, power, Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal efficiencies. Numerical on Heat Balance Sheet and engine performance, Performance curves, Selection of IC Engine for different applications.	**06 Hrs.**
Unit 5:--- Engine Emission and control S.I. engine emission (HC, CO, NOx) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- Chemical, EGR, Standard pollution Norms like EURO, Bharat, Introduction to alternative fuels for I.C. engines, Introduction to Supercharging and Turbo-charging.	**06 Hrs.**

Unit 6: Advance Technologies in I. C. Engine **Alterative Fuels** Alcohol, hydrogen, Natural gas, Liquefied petroleum gas, Biodiesel, Biogas – merits and demerits. **Recent Treads In I. C. Engine** GDI Engine, HCCI Engine, VCR Engine, Variable Geometry Turbocharger, variable valve timing, Engine downsizing, Engine Management system.	**06 Hrs.**

Textbooks:

1. "Internal Combustion Engines" Mathur and Sharma, Dhanpat Rai Publication , Delhi.
2. Internal Combustion Engines", V. Ganesan, Tata McGraw Hill Publication.
3. Internal Combustion Engines", Domkundwar, Dhanpat Rai Publication.
4. "Internal Combustion Engines",R. K. Rajput, SciTech Publication.

References:

1] "Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication .
2] "Internal Combustion Engines",Maleev, CBS Publication and Distributors.
3]"Internal Combustion Engines",Gills and Smith, Oxford and IBH Publishing Company
4] "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication , New York.

Unit wise Measurable students Learning Outcomes:

1. Describe the contractional detailing of IC engines and analyze the Ideal and Actual cycle.
2. Understand the working of fuel supply system for SI and CI engine.
3. Analyze various stages of combustion in SI and CI engine.
4. Plot performance characteristics curve during testing and prepare a performance report.
5. Student should able to know engine emission.
6. Understand advance technology in IC engine.

Title of the Course: Safety and Maintenance Engineering Course Code:UMCH0621	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Preliminary knowledge of various types of machines and introduction to functions of management

Course Description: This course aims to impart knowledge of maintenance of equipment in industries. In order to survive and progress proper maintenance of equipment is necessary to be done in industry. This course provides information about wear, corrosion, lubrication, preventive maintenance; decision tree to diagnose faults, important provisions of factory act, alignment of equipment etc. This course also provides basic knowledge and skills regarding maintenance problems, their causes and remedies in industries.

Course Objectives:

1. To understand safety engineering aspects in industry.
2. To educate and train for safety in order to prevent causes and cost of accident.
3. To understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
4. To understand the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain** the importance of safety	II	Understanding
CO2	**Demonstrate** various factories acts and rules related to employee's safety	II	Understanding
CO3	**Make use of** preventive maintenance to carry out plant maintenance	III	Applying
CO4	**Identify** and avoid accidental hazards.	III	Applying
CO5	**Choose** appropriate method for reconditioning and retrofitting process of machine elements	V	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12	PSO1	PSO2	PSO3
CO1	2	2													
CO2	2	2													
CO3			3						2					2	
CO4			3											2	
CO5			2	3										2	

Assessments :

Teacher Assessment:√

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1: Introduction to the development of industrial safety and management: History and development of Industrial safety: Implementation of factories act, Formation of various councils, Safety and productivity, Safety organizations. Safety committees, safety committee structure, Roll of management and roll of Government in Industrial safety, Safety analysis.	**5Hrs.**
Unit 2: Accident preventions, personal protective equipments: Personal protective equipment(PPE), safety in handling hand held electrical appliances tools and medical equipments, Survey the plant for locations and hazards, Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines-capacity and protection of conductor-joints-and connections, overload and short circuit protection-no load protection-earth fault protection Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Firefighting equipment, Accident reporting, Investigations, Industrial psychology in accident prevention, Safety trials.	**8Hrs.**
Unit 3: Safety Acts: Features of Factory Act, Introduction of Explosive Act, Boiler Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health. Introduction to OSHA, NSCI Safety Awards Scheme - An Overview. Introduction to SIL(Safety Integrity level).Types of hazardous waste and their disposal	**5 Hrs.**
Unit 4: Principles of Maintenance planning: Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity. Safety Officer's Role in Maintenance Work. Importance and benefits of sound Maintenance systems – Reliability and machine availability, Equipment Life cycle, Measures for Maintenance Performance: Equipments breakdowns, Mean Time Between Failures, Mean Time To Repair, Factors of availability, Maintenance organization, Maintenance economics.	**7 Hrs.**
Unit 5: Maintenance policies and preventive maintenance: Maintenance categories – Comparative merits of each category – Preventive maintenance, Maintenance schedules: Repair cycle, Principles and methods of lubrication, Fault Tree Analysis, Total Productive Maintenance: Methodology and Implementation	**7Hrs.**
Unit 6: Condition Monitoring: Condition Monitoring: Cost comparison with and without Condition Monitoring, On-load testing and off load. Methods and instruments for Condition Monitoring, Temperature sensitive tapes, Pistol thermometers, wear-debris analysis, noise Vibration and harshness analysis of machines. **Introduction to Internet of Things (IoT) and Industry 4.0-** Applications and Advantages	**7 Hrs.**

Text Books:

1. Srivastava, S.K., "Industrial Maintenance Management", S. Chand and Co.
2. Bhattacharya, S.N., "Installation, Servicing and Maintenance", S. Chand and Co.
3. Willie Hammer, "Occupational Safety Management and Engineering", Prentice Hall

Reference Books:

1. White, E.N., "Maintenance Planning", Documentation, Gower Press
2. Garg, M.R., "Industrial Maintenance", S. Chand and Co.
3. Higgins, L.R., "Maintenance Engineering Hand book", 5th Edition, McGraw Hill
4. Armstrong, "Condition Monitoring", BSIRSA
5. Davies, "Handbook of Condition Monitoring", Chapman and Hall
6. Ray Asfahl, C., "Industrial Safety and Health Management", 5th Edition, Prentice Hall
7. S.C.Mishra, "Reliability and Maintenance Engineering", New Age Publishing house

Unit wise Measurable students Learning Outcomes:

1. To get familiar with implementation of factories act, formation of various councils, safety and productivity, safety organizations.
2. To be able to prevent accidental hazards by using personal protective equipments.
3. To understand different types of safety acts.
4 To be able to carry out periodic inspection in mechanical systems and plan preventive maintenance of major mechanical systems
5 To select appropriate recovery method for machine elements and explain reconditioning and retrofitting

Practicals:

1. Study and demonstrate use of various types of tools. (Fix spanners, box spanners, ring spanners, allen keys, types of pliers, screw drivers, bearing puller, etc.)
2. Maintenance of any two from following. Batch may be divided in to two groups and each group may be given one case viz. Head stock, Tail stock, Feed box, Indexing head, Pump(Dismantle of given case, observe rules, follow sequence of dismantling operations, cleaning, inspection, measuring deviations , recovery methods, testing and assembling).
3. Prepare a preventive maintenance schedule of any workshop having- air compressors, car washing pumps, tyre changer, lifts, welding machines, and wheel alignment.
4. Demonstrate use of fire fighting and safety related equipments process

Title of the Course: COMPUTATIONAL FLUID DYNAMICS	**L**	**T**	**P**	**Credit**
Course Code: UMCH0622	**3**	**1**	**-**	**3**

Course Pre-Requisite: Fluid Mechanics, Heat Transfer, Elementary Numerical Analysis, ODE, PDE

Course Description:

Computational fluid dynamics (**CFD**) is a branch of fluid mechanics that uses numerical analysis and data structures to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions

Course Objectives:

Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems.

2. Provide the essential numerical background for solving the partial differential equations governing the fluid flow.

3. Develop students' skills of using a commercial software package

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Build flow problem properly within CFD context.	3	Applying
CO2	Take part in solid modeling and meshing.	4	Analyzing
CO3	Assess the CFD results by comparing with available data, and discuss the findings.	5	Evaluating

CO-PO,PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	2	-	-	-	3	2	-

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

UNIT 1: **Introduction to Computational Fluid Dynamics :** Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Numerical vs Analytical vs Experimental, Modeling vs Experimentation. **Principles of Conservation:** Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation. **Classification of Partial Differential Equations and Physical Behaviour:** Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations	07 **Hrs.**
UNIT 2: **Approximate Solutions of Differential Equations:** Error Minimization Principles, Functional involving higher order derivatives, Approximate solution of differential equations through variational formulation, Boundary conditions in the variational form: Primary and secondary variables, Essential and natural boundary conditions, Approximate solutions of differential equations, Properties of variational form, Weighted residual approach: trial function and weighting function, Requirement of trial function and weighting function, Least square method, Point Collocation method, Galerkin's method, Rayleigh-Ritz method	07 **Hrs.**
UNIT 3: **Fundamentals of Discretisation:** Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, **Finite Volume Method:** Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: FV Discretisation of a 1-D steady state diffusion type problem, Implementation of boundary conditions	06 **Hrs.**
UNIT 4: **Discretisation of Unsteady State Problems:** 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme**.** Consequences of time-discretisation in finite discretisation, Consistency, Stability, Convergence, Stability analysis of parabolic equations (1-D unsteady state diffusion problems), Stability analysis of parabolic equations (1-D unsteady state diffusion problems), Stability analysis of hyperbolic equations: **Solution of Systems of Linear Algebraic Equations:** Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations, Generalized analysis of the iterative methods, Sufficient condition for convergence, Rate of convergence, Relaxation methods, Gradient search methods: Steepest descent method and Conjugate gradient method	08 **Hrs.**
UNIT 5: **Discretisation of Convection-Diffusion Equations:** A Finite Volume Approach: Finite volume discretisation of convection-diffusion problem: Generalized convection-diffusion formulation, **Discretisation of Navier Stokes Equations:** Discretisation of the Momentum Equation: SIMPLE Algorithm, SIMPLER Algorithm **Unstructured Grid Formulation:** Discretisation of the Momentum Equation using unstructured grid	06 **Hrs.**
UNIT 6: **What is there in implementing a CFD code?:** The basic structure of a CFD code: Pre-processor, Solver and Post-processor, User-defined-subroutines, Solution to some basic problems in heat transfer and fluid flow. **Introduction to Turbulence Modeling:** Important features of turbulent flow,	06**Hrs.**

Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, More two-equation models: RNG κ-ε model and κ-ω model, Reynolds stress model (RSM),Large eddy Simulation (LES),Direct numerical simulation (DNS)	

Textbooks:

1. H. K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.
2. John D. Anderson Jr., Computational Fluid Dynamics, McGraw Hill Book Company.
3. J. Blazek, Computational Fluid Dynamics: Principles and Applications, Elsevier.

References:

1. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
3. J. H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer.
4. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.

Unit wise Measurable students Learning Outcomes:

1. Graduates will be able to formulate equations of computational fluid dynamics.
2. Graduates will be able to solve differential equations of computational fluid dynamics.
3 . Graduates will be able to discretise the computational fluid dynamics problem
4. Graduates will be able to discretise the Unsteady State Problems.
5 .Graduates will be able to discretise Convection-Diffusion Equations and Navier Stokes Equations
6. Graduates will be able to explain the fundamentals of Turbulence Modeling

Title of the Course: Operations Management	**L**	**T**	**P**	**Credit**
Course Code:UMCH0623	**3**	**1**	**-**	**4**

Course Pre-Requisite: Functions of Management

Course Description:

Operations management focuses on carefully managing the processes to produce and distribute products and services. Major overall activities often include product creation, development, production and distribution. The course deals with all operations within the organization and the related activities including managing purchases, inventory control, quality control, storage, logistics and evaluations

Course Objectives:

1. To understand the strategic importance of Operations Management and how it can provide a competitive advantage in the marketplace
2. To develop knowledge of the issues related to facility layout& Material Handling system.
3. To develop MRP & ERP Modules for industry.
4.To apply advanced operations management tools to solve industrial problems

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	To classify the Operations management Strategy Framework	II	Understanding
CO2	To choose different facility & MHS for new plant layout.	III	Applying
CO3	To apply the systematic approach for PPC	III	Applying
CO4	To categorize and forecast the demands in Operational Activity.	IV	Analyzing

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2			3									2	3		
CO3			3									2	3		
CO4				3								2			

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction: An overview of Operations Management	**6 Hrs.**
Operations Management: Introduction and overview**,** Operations Management Strategy framework**,** understanding similarities and difference among products, goods and services**,** historical evolution of operations management-Changes &Challenges	

Unit 2:--- Manufacturing system Design Facilities Layout and Material Handling Strategy, Group Technology, Flexible manufacturing system, Assembly line balancing introduction to project Management-CPM PERT, Line of Balance (LOB)	**6 Hrs.**
Unit 3:--- Production Planning & Control (PPC), Demand Forecasting **Demand Forecasting:** Forecasting as a Planning Tool, Forecasting Time, Horizon, Sources of Data for forecasting, Accuracy of Forecast, Capacity Planning. **Production Planning:** Introduction to PLM**,** Aggregate production Planning, Alternatives for Managing Demand and Supply, Master Production Schedule, Capacity, Planning - Overview of MRP, CRP, DRP , MRP II, ERP, Introduction to quality tools (KANBANs, SMED, Kaizan, Poka Yoke, Zero defects.) **Production Control:** Scheduling, Loading, Scheduling of Job Shops and Floor Shops.	**8 Hrs.**
Unit 4:--- Planning and managing operations Value chain and Supply chain Management, Purchasing, vendor selection and material management, Just-in-Time Systems, Aggregate Operations Planning Scheduling, sequencing and dispatching	**6 Hrs.**
Unit 5:--- Inventory Planning and Control: Continuous and Intermittent demand System, concept of inventory, need for inventory, types of inventory - seasonal, decoupling, cyclic, pipeline, safety. Implications for Inventory Control Methods. **Inventory Costs:** Concept and behavior of ordering cost, carrying cost, shortage cost. **EOQ:** Basic EOQ Model - EOQ with discounts (Numerical treatment on Basic EOQ, EOQ with discounts & ABC), Inventory turns ratios, Fixed Order quantity Model - Periodic Review and Re-order Point)	**8 Hrs.**
Unit 6:--- Advance operation management Service Operations Management, Lean systems, Computer integrated manufacturing, Analytical tools for DSS(Decision Support Tools) for operations management. **Introduction to Internet of Things (IoT) and Industry 4.0-** Applications and Advantages	**6 Hrs.**

Textbooks:

1. "Industrial Engineering and Production Management", Martand Telsang, S Chand and Company New Delhi, (2009).
2. Operations Management Theory & Practice by B. Mahadevan, Pearson, 2nd Edition.
3. Production & Operations Management - Chary
4. Production & Operations Management - Adam & Ebert
5. Manufacturing & Operations Management - L.C.Jhamb
6. Production and Operations Management Scitech Publications- Sushanta Tripathy
7. Operations Management- K Shridhara Bhat Himalaya Publications

References:

1] Aggarwal L.N, Parag Diwan (1997), Management of Production Systems, Global Business Press.
2] Alan Muhlemann, John Oakland, Keith Lockyer (1978), Production and Operations Management, Mac Milan, India, IV Edition.
3] Chary S N (2004), Production and Operations Management, Tata Mc Graw Hill III Edition.
4] Chase, Jacobs and Aquilano (2005), Operations Management for Competitive advantages, Tata McGraw Hill
5] Operations Management by William J. Stevenson, TMGH, 9th Edition.
6] Operations Management by Lee Krajewski, Larry Ritzman, Manoj Malhotra, Pearson Education, 8th Edition.
7] Introduction to Materials Management, J.R. Tony Arnold, Stephen Chapman, Ramakrishna, Pearson, 5th Edition.

8] Operations Management by Elwood Buffa Published January 1st 1983 by John Wiley & Sons
Unit wise Measurable students Learning Outcomes: **1.** To apply the Operations management Strategy Framework. **2.** To design the different facility layout planning & MHS for new plant layout through new technologies. **3.** To apply the systematic approach for Production Planning & Production Control. **4**. To analyze and forecast the future demands in Operational Activity to overcome the operational losses. **5**. To solve the EOQ models. **6**. To apply the advance operation management tools.

Title of the Course: Industrial Product Design **Course Code:** UMCH0624	**L** **3**	**T** **1**	**P** **-**	**Credit** **4**

Course Pre-Requisite:
Manufacturing Processes, Machine Drawing and Computer Aided Drafting, Manufacturing Engineering

Course Description: The course is focused on product development process through innovative ideas, screening of such ideas, feasibility study and building reliable product by gathering needs from the consumers. This course motivates and educates students to develop new products for betterment of society. This course is also useful for young entrepreneurs for converting their ideas into commercial product through systematic product development procedure.

Course Objectives:

1. To prepare students to create and execute design solutions for problems of form, usability, physical ergonomics, marketing, brand development, and sales of industrial products.
2. To educate students to conceptualize and evaluate ideas to create new products by combining art, science and technology.
3. To introduce students to product architecture and prototyping.
4. To estimate costing for a new product and study cost dynamics.
5. To aware students about impacts of developed products on society, environment and introduction to different fault finding techniques to improve reliability of the product.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Demonstrate knowledge of integration of design aspects like product architecture, ergonomics, aesthetics, quality, safety, reliability and product data management.	2	Understand
CO2	Develop different alternative solutions for small sub problems and select most appropriate solution from the set of solutions.	3	Apply
CO3	Estimate cost of new product by considering various components of the costs and Explain importance of designing the product using design for X methodology.	5, 2	Evaluate Understand
CO4	Apply aesthetic and ergonomics considerations while designing controls, displays and user interfaces.	3	Apply

CO-PO Mapping:

CO	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3														
CO2	3														
CO3	3	3											3		2
CO4		2		2									2		2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: --- Introduction Challenges of product development, Identify customer needs, Successful product development, Market Research, Survey.	4 **Hrs.**
Unit 2: --- Product Development Process and Planning Innovation and Creativity in Product Design, Product Planning Processes, Product specifications: Process of setting specifications. (Concept Generation–Selection–Testing). **Reliability of Product:** Fault Tree Analysis (FTA), Debugging Techniques, Failure Mode and Effect Analysis (FMEA), Different product reliability improvement techniques.	9 **Hrs.**
Unit 3: --- Product Architecture Product Architecture: Implication of architecture, Establishing the architecture, Related system level design issue, Product Data Management, Use of Computerized Data Management and Process, Industrial Design: Overview.	7 **Hrs.**
Unit 4: --- Design for X Methodology Rules, guidelines, and methodologies along the product life cycle phases: Development phase, Production phase, Use phase, Disposal phase, Concurrent Engineering. **Product Costing:** Different costs, Pre-requisites for cost accounting, Volume-Varity matrix and its impact on product costing, Value engineering.	7 **Hrs.**
Unit 5: --- Aesthetics: Aesthetic Considerations, Visual Effects of Form and Colour in Product Design. **Ergonomics:** Ergonomics and product design and automated systems, Anthropomorphic data and its applications in ergonomic design, Limitations of Anthropomorphic data, General approach to the Man-Machine Relationship - Workstation Design and environment (working position and posture). **Control, Displays and User Interfaces:** Configurations and sizes of various Control, Displays and User Interfaces, Design of instruments, controls, displays and user interfaces.	8 **Hrs.**
Unit 6: --- Industrial Safety: Personal protective Equipment and Environment Control Prevention and specific safety measures for manufacturing and processing industry and chemical industry. **Introduction to Internet of Things (IoT) and Industry 4.0-** Applications and Advantages	5 **Hrs.**

Textbooks:

1. "Product Design and Development", Karl T. Ulrich, Steven G. Eppinger; Irwin Tata McGraw Hill, 3rd Edition.
2. "Product Design and Manufacturing", A.C. Chitale and R.C. Gupta, Prentice Hall of India, 3rd Edition.
3. "Product Design", Otto and Wood, Pearson education.
4. "Human Factor Engineering", L P Singh, Galgotia Publication Pvt.Ltd, 1st Edition.

References:

1. "Introduction to Ergonomics", R.C. Bridger, Tata McGraw Hill Publication.
2. "New Product Development", Tim Jones, Butterworth, Heinemann, Oxford, (1997).
3. "Industrial Design for Engineers", Mayall W.H, London, Hiffee books Ltd.

Title of the Course: Industrial Automation & Robotics	**L**	**T**	**P**	**Credit**
Course Code: UMCH0625	**3**	**1**		**4**

Course Pre-Requisite: Manufacturing Processes, Basic electronics & electrical, Basic Sciences

Course Description: This course gives knowledge about the automation and Robotics. It also describes the emerging trends in Automation and robotics

Course Objectives

1. To understand basic terminologies and concepts associated with Robotics and
2. Automation
3. To study various Robotic sub-systems and Automation systems
4. To study kinematics and dynamics to understand exact working pattern of robots
5. To study the associated recent updates in Robotics and Automation

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Apply** knowledge of automation tools and other Equipments by taking into account the fundamental principles manufacturing processes and assembly components.	I	Cognitive (Knowledge)
CO2	To **Apply** knowledge and identify parameters of designing different grippers for various operations.	I	Cognitive (Knowledge)
CO3	To **Acquire** knowledge various drives	I	Cognitive (Knowledge)
CO4	To **Analyzing** the problem logically and demonstrate ,& apply knowledge for various kinematics behind robots	II	Psychomotor (Skill)
CO5	To **choose** different programming methods for robots	II	Psychomotor (Skill)
CO6	To **recognize** AI scope in mechanical industries to automate the processes without human interference.	III	Affective (Attitude)

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2	2			3									2	2	
CO3		3			3									2	
CO4		2			3								2		
CO5					2										
CO6					2										

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:- Introduction **Introduction**: - Basic Concepts such as Definition, three laws, DOF, Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, (04) **Automation: -** Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations.(02)	**(06)Hrs.**
Unit 2:- Robot Grippers: - Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. (02) **Sensors**: - Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors:-position sensor, velocity sensors, Tactile sensor, force sensors. Acceleration sensor. Need for sensors and vision system in the working and control of a robot.(04)	**(06)Hrs.**
Unit 3:-Drives: - Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems: - Types of Controllers, Introduction to closed loop control. (03) **Control Technologies in Automation**: - Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.(04)	**(07)Hrs.**
Unit 4:- Kinematics :- Transformation matrices and their arithmetic, link and joint description, Denavit -Hartenberg parameters, frame assignment to links, direct kinematics, inverse kinematics.(Theoretical Treatment Only)	**(07) Hrs.**
Unit 5:-Machine Vision System: - Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. (Theoretical Treatment Only) (03) **Artificial Intelligence**: - Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics: - Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.(04)	**(07) Hrs.**
Unit 6:- Robot Programming: - Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of each type and development of languages for recent robot systems.(03) **Eyantra Robot programming** :- Introduction to Eyantra Robot, Buzzer beep Program, motor interfacing ,and line following robots.(04)	**(07) Hrs.**

Textbooks:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Pearson Education, ISBN 978-81-317-1836-0 3rd Edition, 2009
2. Mikell P. Groover Industrial Robotics: Technology, Programming and Applications, Tata McGraw – Hill International, 3rd reprint 2008.ISBN 13-978-0-07-026509-7
3. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 2001.ISBN0-471-17783-0
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover,Pearson Education. ISBN: 81-7808-511-9 2nd Edition (2004).
5. Industrial Automation: W.P. David, John Wiley and Sons.
6. Introduction to Robotics, Analysis, Control and Applications Niku, Saeed B., Willey Publication, ISBN 9788126533121, 2nd Edition.
7. Robotics-Control, Sensing, Vision and Intelligence Fu, K.S.; Gonzalez, R.C. and Lee, C.S.G., McGraw Hill Intl. Ed., ISBN:0-07-100421-1.

References:

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 2002.
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.
3. "Fundamentals of Robotics, Analysis and Control", Schilling, Robert J, Prentice Hall of India, ISBN: 81-203-1047-0, (2004).
4. "Introduction to Robotics Mechanics and Control" J. J. Craig, Pearson Education,3rdE
5. "Applied Robotics Volume I and II", Edwin Wise, Cengage Learning.

Unit wise Measurable students Learning Outcomes:

UO1.1: Understand the problem and Apply knowledge of automation to simplify and automate the process

UO2.1 Understand and apply the basics fundamentals of gripper selection and design for process under consideration

UO 3.1 Understand and apply the basics fundamentals of drives for different application for different conditions.

UO4.1: Students can study the different design considerations of robot with respect to different kinematic aspect and apply knowledge of D-H parameters.

UO5.1: Understand and apply the programming language.

UO6.1: Students can study of newer methods of robot programming.

Title of the Course: Applied Numerical Methods **Course Code:**UMCH0626	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Pre-Requisite:

Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III

Course Description:

The course is aimed to provide elementary knowledge of numerical methods and statistical techniques and enable students to apply various tools and techniques to solve problems in mechanical engineering. The subject provides the students with a strong background on numerical approximation strategies and a basic knowledge on the theory that supports numerical algorithms. The course starts with introduction of numerical methods and its applicability in mechanical engineering with an introduction to basic computation using C++ or MATLAB. It covers the concepts of solution techniques of linear and non-linear equations and systems of equations. Differentiation and integration using numerical methods are covered. Application of different initial value and boundary value problems in mechanical engineering using finite difference method is taught. An introduction to solution of partial differential equation and finite element method is also covered.

Course Objectives:

1. To explain basic concepts of numerical approximations.
2. To solve introductory engineering problems.
3. To describe functions and advantages of different numerical methods.
4. To correlate numerical results and approximations with actual field results.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Explain procedure, advantages and applications of different numerical methods.	2	Understanding
CO2	Interpret interpolation, statistical data and approximation for mechanical engineering problems.	2	Understanding
CO3	Solve engineering problems by using appropriate numerical methods.	2	Understanding
CO4	Develop algorithms for various numerical methods.	3	Applying

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	

CO1	2	2			1										
CO2		3	1		1									1	
CO3		2	1		1									1	
CO4		1	2		1									1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Roots of Equation **Errors:** Introduction, Types of errors, Rules for estimate errors, Error propagation, Error in the approximation of function Bracketing Method: Bisection Method, False position method Open method: Newton Raphson's, Multiple Roots, Iteration system of non- linear Equations, Secant method. Roots of polynomial: Muller's Method	**7 Hrs.**
Unit 2:--- Linear Algebraic Equation: Gauss Elimination Method- Naïve Gauss Elimination, Pitfalls of Elimination, Techniques of improving solutions, Gauss- Jordan method Matrix Invention- LU decomposition, Gauss Sedial, Jacobi Iteration methodProblems based on engineering application	**5 Hrs.**

Unit 3:---A. Curve Fitting: Least Square Regression – Linear regression, Polynomial Regression Interpolation – Newton's divided difference, Interpolating polynomial, Lagrange's interpolating polynomial **B. Statistics:** Mean and standard deviation, Addition and multiplication laws probabilities, Binomial, Poisson and normal distribution, Problems based on engineering application..	**8 Hrs.**
Unit 4:--- Numerical Differentiation and Integration Newton's cote's Integration of equation: Trapezoidal rule, Simpson's rules, Integration unequal segments. Integration of Equation: Romberg's Integration and Gauss Quadrature. Numerical differentiation, Differentiation formulae, Derivation of unequally spaced data, Forward difference, Central difference, Backward difference Problems based on engineering application.	**7 Hrs.**
Unit 5:--- Ordinary Differential Equation: Taylor's series method, Picard's Method, Runge-Kutta method, Euler's Method, Improved polygon method, System of equation Boundary value and Eigen value problem, Finite Difference Method, Eigen value problem based on polynomial method, Power method Problems based on engineering application.	**6 Hrs.**
Unit 6:--- Partial Differential Equation: Finite Difference – Elliptic equation, Laplace's equation, Liebmen's Method, Secondary variables, Boundary condition. Finite Difference- Parabolic Equation , Explicit Method- Bender- Schmidt method, Implicit method- Crank Nicolson Method Problems based on engineering application. Introduction of MATLAB, Mechanical Engineering Problem solving approach by using MATLAB. Introduction to Internet of Things (IoT), Applications & Advantages, Industry 4.0	**7 Hrs.**
Module wise Measurable Students Learning Outcomes : Obtain root of given function/polynomial using numerical methods. Solve linear simultaneous equations using numerical methods. Analyze the data and apply numerical methods to fit a curve on the data. Solve the complex differential and integral equations in mechanical engineering. Solve the ODE applicable for mechanical engineering using numerical methods. Solve the PDE applicable for mechanical engineering using numerical methods.	
Textbooks: 1. Dr. B. S.Grewal, "Numerical Methods", Khanna Publishers, New Delhi. 2. E. Balguruswamy, "Numerical Methods", Tata Mcgraw Hill Publication Company Ltd. 3. Steven C. Chapra, "*Numerical Methods for Engineers*", Tata McGraw Hill Publications, New Delhi 4. "Numerical Methods", S.Arumugam, A. Thangapandi Isaac and A.Somasundaram, Scitech Publications India Pvt.Ltd.,Chennai.	

References Books:

1. J.N. Kapoor, “Mathematical Modeling”,New Age Mumbai, first Edition,2005. Kreyszig, “Advanced Mathematics”,LaurieRosatone, USA.
2. S.C. Chapra, “Applied Numerical Methods with MATLAB for Engineers and Scientists”, Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. Sigiresu S Rao, “Engineering Optimization”,New Age International Publisher.
4. R. L. Burden and J. D. Faires, “Numerical Analysis Theory and Applications”, Cengage Learning India Pvt. Ltd., New Delhi

TERM WORK:

Students are expected to solve at least two problems on each method by appropriate numerical method on each unit.
Students are expected to develop computer programs on each unit. ((Algorithm, Flow charts, Computer code, problem with analytical treatment)

Course Contents:

Tutorial No. 1:--- Numerical treatment on Roots of equations by Bracketing method	**01 Hrs.**
Tutorial No. 2:--- Numerical treatment on Roots of equations by Open method	**01 Hrs.**
Tutorial No. 3:--- Numerical treatment on Linear Algebraic Equation	**01 Hrs.**
Tutorial No. 4:--- Numerical treatment on Curve Fitting.	**01 Hrs.**
Tutorial No. 5:--- Numerical treatment on interpolation,statistics& probability	**01 Hrs.**
Tutorial No. 6:--- Numerical treatment on Numerical Integration	**01 Hrs.**
Tutorial No. 7:--- Numerical treatment on Numerical Differentiation.	**01 Hrs.**
Tutorial No. 8:--- Numerical treatment on Ordinary Differential Equation	**01 Hrs.**
Tutorial No. 9:--- **N**umerical treatment on Boundary value and Eigen value problem	**01 Hrs.**
Tutorial No. 10:--- Numerical treatment on Partial Differential Equation	**01 Hrs.**

Title of the Course: Energy Conservation and Management	**L**	**T**	**P**	**Credit**
Course Code: UMCH0671	**3**	**1**	**-**	**4**

Course Pre-Requisite: Basic Mechanical Engineering, Applied Thermodynamics, Engineering Thermodynamics

Course Description: After completion of the course, students will have understanding of importance of energy conservation and management. Students will get familiar with the energy audit procedure, the data collection for the audit, opportunities for energy conservation, waste recycling and energy planning.

Course Objectives:

1.The benefits and drivers of an energy audit.
2.Have knowledge of the energy audit of electrical utilities.
3.Understand to plan and carry out an energy audit.
4.Assess the energy consumption of an organization.
5.Analyse the energy systems data of the organization to identify key trends or issues.
6.To select energy efficient solutions.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain the importance of energy conservation and its management.	II	Understanding
CO2	Explain use of renewable energy sources in Energy management.	II	Understanding
CO3	Make use of energy conservation techniques in various sectors like domestic, Industry and commercial.	III	Applying
CO4	Take a part in Energy auditing and economic analysis.	IV	Analyzing

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3												
CO2	3												
CO3		2									2		
CO4			2								2		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction: Introduction, energy problems, energy use trends in developing countries, prospects of changes in energy supply, strategies for sustainable development, finite fossil reserve, Energy and environment, Need for renewable and energy efficiency, Energy conservation principles	**6 Hrs.**
Unit 2:--- Energy management Definitions and significance, Two sides of energy management, Sectors of supply side energy management, Objectives of energy management, Hierarchical levels of supply side energy management, Trade-off between energy and environment, Energy	**8 Hrs.**

and economy, energy management and control system (EMC's or EMS) for demand side, Energy management in end user plant, Seven principles of energy management, Energy policy of supply organization and demand side organization for energy management, Organization of energy management, Training and human resource development, motivation.	
Unit 3:--- Energy Planning Energy strategy, Energy policy and energy planning, Essential imperatives and steps in supply side energy planning, energy planning flow for supply side, Essential data for supply side energy planning, infrastructure planning, Transportation of energy, Per capita energy consumption, Essential imperatives and steps in user side energy planning, Energy policy of demand side organization (energy consumer).	**6 Hrs.**
Unit 4:--- Energy Auditing: Elements and concepts, Types of energy audits, methodology, Instruments used in energy auditing. Portable and On-line instruments Role of Non-Conventional Energy Sources in Energy Conservation. Need and. Qyoto Protocol, Carbon Credits and Clean Development Mechanism (CDM).	**6 Hrs.**
Unit 5:--- Energy Conservation and Recycling Introduction, Listing of energy conservation opportunities, Electrical ECOs, Thermodynamic ECOs, ECOs in chemical processing industries, ECOs in medium and small industries, ECOs in residential buildings, shopping complexes and in university campus, Human and animal bio-muscle energy, Waste management, Recycling of discarded materials and energy recycling, Waste recycling management	**8 Hrs.**
Unit 6:--- Economic Analysis: Simple Payback Period, Return on Investment, Dynamic value of money, Discount Rate Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series. **Costing of Utilities** – specific costs of utilities like, all fuels, steam, compressed air, electricity, water etc. Introduction to Internet of Things (IoT), Applications & Advantages, Industry 4.0	**6 Hrs.**
Textbooks: 1) "Energy Technology", by S. Rao, Dr. B.B. Parulekar, Khanna publications, Delhi 2) A.B. Gill, "Power Plant Performance", Butterworths, 1982 3) "The Efficient use of Energy", Ed: I.G.C. Dryden, Butterworths, London, 1982 4) Wood, A.J., Wollenberg, B.F., Power generation, Operations and control, John Wiley, York,1984	
References Books: 1.P.H. Henderson: India -The energy Sector, Oxford University Press. 2. Callaghan: Energy Conservation IGC Dryden, editor ; The efficient use of energy(Butterworths.) 3.D.A. Ray: Industrial Energy conservation. Pergamon Press 4.W.C. Turner, editor: Energy Management handbook (Willey) 5.Patrick Steven R., Patric Dale R. , and Fordo Stephen : Energy conservation Guide book, The Fairmont Press Inc.7. 6.F. William Payne and Richard E. Thompson: Efficient Boiler Operation Source Book. 7.Albert Thumann: Plant Engineers and managers Guide to Energy conservation	
Unit wise Measurable students Learning Outcomes: **1.** Explain the importance of energy conservation and its management **2.** Explain use of renewable energy sources in Energy management. **3.** Carry out Energy Audit of any organization**.**	

Title of the Course: Biomedical Engineering **Course Code:** UMCH0672	**L** **3**	**T** **1**	**P** **--**	**Credit** **4**

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Electronics Engineering concepts of circuit building
2. Machine Design
3. Anatomy and physiology awareness

Course Description:

In today's world of high-technology products, the most important requirements of dimensional and other accuracy controls are becoming very stringent as a very important aspect in achieving quality and reliability in the service of any product in dimensional control. Unless the manufactured parts are accurately measured, assurance of quality cannot be given. In this context, the course deals with the basic principles of dimensional measuring instruments and precision measurement techniques.

Course Objectives:

1. To understand the basic principle, working and design of various automated diagnostic equipments.
2. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies.
3. To develop awareness in the field of Biomedical Engineering
4. To study various medical instrumentation systems, drug delivery systems and health management systems.

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Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Describe the principles of electronics used in designing various diagnostic equipment.	I	Knowledge
CO2	Describe health management systems	II	Comprehension
CO3	Identify different diagnostic equipments physically for their working principals and applications.	II	Comprehension
CO4	Select proper machine for given application.	VI	Evaluation

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**					**2**								
CO2												**1**		
CO3												**2**		
CO4													**1**	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- A perspective on Medical Instrumentation, Biomedical Instrumentation, Classification of Biomedical Instruments, Justification of biomedical instrumentation, Scope for Biomedical Engineers. Physiotherapy, Electrotherapy Equipments: Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator.	10 **Hrs.**
Unit 2:--- Basic Principal, Construction and operation, of i.BP Apparatus ii. Audiometers iii. Dialyser iv. Pacemaker v. Difibrillator vi. Phonocardiograph vii. Spirometer. Surgical Instruments: Surgical Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers.	08 **Hrs.**
Unit 3:--- Cardiac Pacemakers: Modes of operation, leads and electrodes. Power supply sources. External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker.	08 **Hrs.**
Unit 4:--- Cardiac Defibrillators: DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, defibrillator analyzers. Implantable defibrillator and defibrillator analyzer.	06 **Hrs.**
Unit 5:--- Hemodialysis Machine: Basic principle of Dialysis and its type. Different types of dialyzer membrane, Portable type. Various monitoring circuits.	03 **Hrs.**

Unit 6:--- Hospital equipment safety and organization. Electrical hazards of medical instruments, Devices to protect against electrical hazards, Diagnostic instruments: ultrasound, X-ray, CT scan, MRI, PET Techniques Laser Applications in Biomedical Engineering. Introduction to IoT and Industry 4.0 and its applications and advantages.	05**Hrs.**

Textbooks:

1.R S. Khandpur 2014, Handbook of Biomedical Instrumentation, PH Pub
2.J G. Webster 2014,Medical Instrumentation, Application and Design, John Wiley
3. Carr –Brown ,Introduction to Biomedical Equipment Technology, PH Pub.

References:

1. J G. Webster , Encyclopedia of Medical Devices and Instrumentation:. Vol I- IV PH Pub
2. Various Instruments Manuals..
3. Various internet resources.

Unit wise Measurable students Learning Outcomes:

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1. Student should able to know basic principle, working and technical specifications of various medical instruments.

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2. Student should able to select proper instrument for measurement and also the safety measurement.

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3. Student should able to know the working of Cardiac Pacemakers and calculate its performance.

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4. Student should able to know the working of Cardiac Defibrillators and its performance aspects.

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5. Student should able know basic principle of Dialysis and its type. Various monitoring circuits.

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6. .Student should able to study Laser Applications in Biomedical Engineering, medical Applications, Laser delivery Systems and safety.

Title of the Course: Process Engineering (Audit Course)	L	T	P	Credit
Course Code: UMCH661	2	-	-	0

Course Pre-Requisite: Machine drawing, Manufacturing processes, Limits, fits and tolerances, Engineering Metrology, Machine Tools.

Course Description: This course gives the process planning sequence and how to create any part when design is ready with available manufacturing resources, with given part accuracy requirements.

Course Objectives:

1. To understand the fundamentals of process engineering in a manufacturing industry
2. To understand the information on drawing related to manufacturing process
3. To select the stated tolerances on drawing and select best suitable manufacturing processes.
4. To study the feasibility of the component.
5. To select the standard tooling for creation of part as per requirement on drawing.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Select** proper manufacturing process and machines for generating required tolerances	I	Remembering
CO2	**Interpret** the given part drawing	II	Understanding
CO3	**Choose** proper tooling's for production	III	Applying
CO4	**Inspect** the feasibility of the component	IV	Analyzing
CO5	**Explain** process of industrial component with help of process pictures	V	Evaluating
CO6	**Estimate** the cycle times and production rates for different operations in the formulated process plan.	VI	Creating

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3											3		
CO2		3	3										3	
CO3	3		3											
CO4					3							3	3	
CO5						3						3		
CO6			3							3		3	3	

Assessments :

Teacher Assessment:

One End Semester Examination (ESE) having 100% weightage

Assessment	**Marks**
ESE	**100**

ESE: Assessment is based on 100% course content

Course Contents:

Unit 1:--- Introduction: Process planning function and activities-drawing interpretation, material evaluation and process selection, selection of machines and tooling, setting process parameters, work-holding devices, selecting quality assurance methods, costing and documentation, Inputs and outputs for process planning, Position of product and process engineering department in the organization, functions of product and process engineers.	**7 Hrs.**
Unit 2:---	**7Hrs.**

2.1 Part Print Interpretation: Indentifying Originating process, major and minor operations, identifying useful supplementary information, material specification and treatments, interchangeability and standardization, identifying critical processing factors **(4)** **2.2 Study of Machining Accuracies**: Factors affecting accuracies, work piece control theories, product tolerances, process tolerances, tolerance stack -types and effects. **(3)**	
Unit 3:--- **3.1 Technical Feasibility Study**: Raw material, basic originating process, accuracy level, processes required, machine tools and accessories required Manufacturing feasibility study with illustrations **(4)** **3.2 Selection of Process**: General guidelines for and factors in process selection, process selection method, process and operation sequencing – guidelines; Combining and eliminating operations, economic aspects of processing (A case should be discussed), **(4)**	**8 Hrs.**
Unit 4:--- **4.1 Selection of Equipment**: Various sources of information, technical, economical and managerial considerations, selection criteria for GPMs, SPMs and CNCs for processing in job, batch and mass mode.**(4)** **4.2 Selection of Tooling**: Technical specifications of standard cutting tools and gauges required for various machining operations, selection criteria for cutting tools and gauges, study of special tools, gauges and work holding devices, selection of machining parameters.**(4)**	**08Hrs.**
Unit 5:--- Process Planning: Preparation of process sheet for machining of a component for job, batch and mass production using conventional and CNC machines, Selection of quality assurance method and tools, in process gauging. Process Picture sheet including process symbols. Process sheet design.	**06 Hrs.**
Unit 6:--- Time Estimation: Calculation of standard time and production rates for various operations by consideration of various allowances. (Numerical exercises expected) Takt-time concept.**(2)** **Computer Aided Process planning**: - Advantages over manual process planning, approaches for CAPP: Generative Process Planning, Knowledge-based Process Planning, Feature Recognition in Computer Aided Process Planning, recent trends.**(2)**	**04Hrs.**

Textbooks:

1. Eary D. F., Johnson G. E., ―Process Engineering for manufacture‖ Prentice Hall of India Pvt. Ltd.
2. Narayana K. L., Kannaiah P., Vankata Reddy K., ―Production Drawing‖, New age international Publishers.
3. Groover Mikell P., Automation, Production Systems, and Computer-Integrated Manufacturing, Third Edition, PHI Learning Private Limited.

References:

1) Process Engineering for Manufacturing – Eary & Johnson (Prentice Hall)
2) Process Planning: The Design/Manufacturing Interface, –Petert Scallan, (2003), (Buttreworth Heinmann, Elsevier) ISBN: 0-7506-51-29-6
3) Principles of Machine Tools- Sen, Bhattacharya
4) Automation, Production Systems, and C.I.M. – Groover, M.P. 3/e, (PHI)
5) Workshop Technology Vol. III – Chapman (ELBS)
6) Manufacturing Technology: Principles for Optimisation – Daniel
7) Mechanical Estimating and Costing – TTTI Chennai (TMH)
8) Standard manuals of ISO, QS, TS etc.
9) Manufacturers' catalogues for cutting tools and inspection equipments
10) Product Design-Kevin Otto and Kristin Wood (Pearson)
11) All About Machine Tools-Heinrich Gerling (New Age International)
12) Westerman Tables (Metals) (New Age International)

Unit wise Measurable students Learning Outcomes:

1. UO1.1: Apply knowledge of manufacturing processes and identify parameters of various processes.
2. UO2.1 Apply knowledge of manufacturing processes carry out part print analysis of industrial component drawing
3. UO 3.1 Students will able to do the technical feasibility study
4. UO 4.1 Students will able to design of process sheet on GPM for batch production.
5. UO5.1 Students will able to design of design process sheet for mass production.
6. UO6.1: Students can compute time estimation for given industrial component

Title of the Course: Workshop Practice -IV	**L**	**T**	**P**	**Credit**
Course Code: UMCH0631	**-**	**-**	**2**	**1**

Course Pre-requisite: Workshop Practice-III, Manufacturing Processes,Machine Tools, Manufacturing Engineering.

Course Description: This course is designed to provide students hands on demonstrations on various machines along with the operations carried out on the same. Also, it provides fundamental information regarding gear manufacturing processes.

Course Objectives:

1.To perform various operations on different machine tools.
2.To prepare detailed process sheets for various operations.
3. To understand the concept of die threading and tapping.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain various drilling, milling and die threading operations.	2	Understanding
CO2	Explain the machining operations like grinding, broaching, gear manufacturing and non-conventional machining..	2	Understanding
CO3	Prepare process sheet for given operations	3	Applying
CO4	Perform different operations like drilling, internal taper turning, milling, die threading, tapping,etc.	6	Creating

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3											3		
CO2	2											2		
CO3	3									2		3		
CO4	3									2		3		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	25

ISE : Assessment is based on 100% Lab work.

ESE: Assessment is based on Job performed and oral examination

Course Contents:

1. Introduction to generally used materials for machining , grades of	**02 Hrs.**

materials and demonstration of various machining operations on milling machines	
2. Decide sequence of operations to be performed for given component drawing and prepare process sheets with working drawings for all components.	**02 Hrs**
3. Performing drilling and boring operations on lathe machine.	**02 Hrs**
4. Performing internal taper turning operation on lathe machine.	**02 Hrs**
5. Performing any one of the following operation on milling machine: **a. End milling** **b. Side milling** **c. Straddle milling**	**02 Hrs**
6. a. Introduction to basic standards of Die threading and Tapping **b. Demonstration of different tapping attachments and tapping calculations.**	**02 Hrs**
7. Performing die threading and tapping operations.	**02 Hrs**
8.Demonstration of basic measuring instruments to carry out inspection of job and perform rework if required.	**02 Hrs**
9. Industrial Visit to study the following machining operations: **a. Grinding** **b. Broaching** **c. Gear manufacturing** **d. Non conventional machining** **e. Special purpose machines**	**02 Hrs**
10. Submission of : **a. Industrial Visit Report** **b. Workshop Diary** **c. Process Sheets** **d. Job** **along with Internal Oral**	**02 Hrs**

Textbooks:

1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd.)
2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, (ELBS)
3. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
4. Textbook of Production Engineering by P.C.Sharma (S.Chand Publication)
.

References:

1]Workshop Technology Vol. III – Chapman (ELBS)
2]Workshop Technology Vol. II by Bawa H. S. (TMH)

Experiment wise Measurable students Learning Outcomes:

1. Understand material grades and various machining operations performed on milling machines.
2. Select sequence of operations as per drawing and prepare process sheets.
3. Perform drilling and boring operations on the lathe machine.
4. Perform internal taper turning operation on a lathe machine.
5. Perform various milling operations on the milling machine.
6. Understand basic standards of die threading and tapping operations and perform tapping calculations.
7. Perform die threading and tapping operations.
8. Make use of basic measuring instruments for inspection.
9. Understand grinding, broaching, gear manufacturing and non-conventional machining processes and SPMs.
10. Prepare a detailed visit report to interpret the operations and machines observed.

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Title of the Course: Industrial Hydraulics and Pneumatics Lab	**L**	**T**	**P**	**Credit**
Course Code: UMCH0632	**-**	**-**	**2**	**1**

Course Pre-Requisite: Fluid Mechanics

Course Description: This course aims to impart knowledge of fluid power systems such as hydraulics and pneumatics w.r.t. their components, circuits and their applications, design of system and maintenance and troubleshooting of the system.

Course Objectives:

1. Study of working principle of various components used in hydraulic and pneumatic systems.
2. Study of ISO/JIC symbols of fluid power systems.
3. Study of hydraulic and pneumatic circuits.
4. Design of hydraulic and pneumatic circuits for given application.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Explain** and **demonstrate** basic structure and elements of hydraulic and pneumatic systems.	2	Understanding
CO2	**Explain** and **demonstrate** construction and working of various elements of hydraulic and pneumatic system.	2	Understanding
CO3	**Construct** and **demonstrate** hydraulic and pneumatic circuits.	3	Applying
CO4	**Design** the hydraulic or pneumatic system for given industrial application.	6	Creating

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**P011**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2												2		2
CO2	2												2		2
CO3		2	3						3			3	3		3
CO4		2	3	3	2				3	3	3	3	3		3

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1: Study and Demonstration of layouts of hydraulic and pneumatic system	**02 Hrs.**
Experiment No. 2: Study of ISO/JIC Symbols for hydraulic and pneumatic systems.	**02 Hrs.**
Experiment No. 3: Study and Demonstration of different types of control valves used in hydraulic and pneumatic system.	**02 Hrs.**
Experiment No. 4: Preparation of following circuits on hydraulic circuit trainer; a) Basic hydraulic circuit to obtain motions of linear and rotary actuators.	**02 Hrs.**

b) Speed control circuits c) Sequencing circuit d) Synchronization circuits e) Counterbalancing circuits	
Experiment No. 5: Preparation of at least two circuits on electro-hydraulics circuit trainer	**02 Hrs.**
Experiment No. 6: Preparation of following circuits on pneumatic circuit trainer; a) Automatic reciprocating motion circuits b) Speed control circuits c) Sequencing circuits (travel dependent) d) Circuit involving use of shuttle valve (OR logic circuit) e) AND logic circuit	**02 Hrs.**
Experiment No. 7: Circuit preparations (at least two) by using Fluid Simulation Software.	**02 Hrs.**
Experiment No. 8: Design of hydraulic / pneumatic system and related components for any one of selected industrial/agriculture /any suitable application. Design report should include following points like load, pressure and flow calculations, sizing and selection of components, design constraints considerations, circuit preparation and determination of energy losses in system.	**04 Hrs.**

Textbooks:

1. "Oil hydraulics Systems", S. R. Mujumdar, Tata McGraw Hill Publication.
2. "Pneumatic Systems", S. R. Mujumdar- Tata McGraw Hill Publication.
3. "Industrial Fluid Power",D. S. Pawaskar, Nishant Prakashan.
4. "Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.
5. "Fluid Power with Application", Esposito, Pearson Education, 7th Edition.
6. "Basic Hydraulic – Festo Manual"
7. "Basic Pneumatic – Festo Manual"
8. "Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
9. "Hydraulics and Pnuematics",Dr.Anand Bewoor, Late S.K.Ponde,Nirali Prakashan.

References:

1. "Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
2. "Industrial Hydraulic", J. J. Pipenger, Tata McGraw Hill.
3. "Power Hydraulics", Goodwin 1st Edition.
4. "Introduction to Hydraulic and Pneumatics",S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
5. "Pneumatic Control",Joji P.,Wiley. , 1st Edition.
6. "Fluid Power",Jagadeesha T. , Wiley Publications.
7. Eaton (Vickers) Manual.
8. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics.

Experiment wise Measurable students Learning Outcomes:

1. Explain and demonstrate the structure and layouts of hydraulic and pneumatic systems.
2. Make use of ISO symbols of fluid power systems to represent the system.
3. Explain and demonstrate construction and working of various types of control valves used in hydraulic and pneumatic system.
4. Construct and demonstrate hydraulic circuits on circuit trainer.
5. Construct and demonstrate electro- hydraulic circuits on circuit trainer.
6. Construct and demonstrate pneumatic circuits on circuit trainer.
7. Make use of fluid simulation software.
8. Design the hydraulic or pneumatic system for the given application.

Title of the Course: I C Engines Lab	**L**	**T**	**P**	**Credit**
Course Code: UMCH0634	**-**	**-**	**2**	**1**

Course Pre-Requisite: Applied Thermodynamic, Basic Mechanical Engineering, Heat Mass Transfer.

Course Description:
This course deals with demonstration of different engine components and systems and conduct of various experiments on engine performance in terms of power, energy utilization and exhaust emissions, its relation to internal processes like combustion and gas exchange at varying engine operating conditions.

Course Objectives:
1. To demonstrate the basic engine components and systems.
2. To train the students to measure different engine performances and apply the knowledge to solve real life problems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Explain fundamentals of I. C. Engine	II	Understanding
CO2	Classify and demonstrate different I. C. Engine system.	II	Understanding
CO3	Measure the performance parameters f I. C. Engine.	III	Applying
CO4	Analyze the performance of I. C. Engine	III	Applying

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3											2		
CO2	3													
CO3		3												
CO4		3											2	

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:	
Experiment No. 1:--- Constructional detail of I.C. engines, dismantling and assembly.	2 **Hrs.**
Experiment No. 2:--- Study and Demonstration of Engine systems: Air intake, Exhaust, Cooling, Lubrication systems.	2 **Hrs.**
Experiment No. 3:--- Study and Demonstration of carburetors and petrol injection system.	2 **Hrs.**
Experiment No. 4:--- Study and Demonstration of Ignition system and starting system.	2 **Hrs.**
Experiment No. 5:--- Study and Demonstration of fuel supply system of Diesel Engine.	2 **Hrs.**
Experiment No. 6:--- Heat Balance sheet on Petrol/Diesel engine.	2 **Hrs.**
Experiment No. 7:--- Morse test on Petrol/Diesel engine.	2 **Hrs.**
Experiment No. 8:--- Variable speed test on Petrol/Diesel engine.	2 **Hrs.**
Experiment No. 9:--- Test on computerized Variable compression Ratio Engine.	2 **Hrs.**
Experiment No. 10:--- Visit to engine manufacturing company	2 **Hrs.**

Textbooks:

1. "Internal Combustion Engines" Mathur and Sharma, Dhanpat Rai Publication , Delhi.
2. Internal Combustion Engines", V. Ganesan, Tata McGraw Hill Publication.
3. Internal Combustion Engines", Domkundwar, Dhanpat Rai Publication.

References:

1] "Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication .
2] "Internal Combustion Engines",Maleev, CBS Publication and Distributors.
3]"Internal Combustion Engines",Gills and Smith , Oxford and IBH Publishing Company

Experiment wise Measurable students Learning Outcomes:

1. Identify different components of I. C. Engines.
2. Demonstrate and explain different engine systems.
3. Explain different components and types of carburetors and petrol injection system.
4. Explain different ignition system and starting system of petrol engine.
5. Demonstrate different injection system and fuel injection pump.
6. Demonstrate performance parameters and prepare heat balance sheet of Petro/ Diesel engine.
7. Determine mechanical efficiency of Petrol/Diesel engine.
8. Understand load and speed characteristics of Petrol/Diesel engine.
9. Understand effect of compression ratio on performance of engine.
10. Demonstrate engine components, assembly and testing.

Title of the Course: Machine Design Lab	**L**	**T**	**P**	**Credit**
Course Code:UMCH0635	**-**	**-**	**2**	**1**

Course Pre-Requisite:
Theory of Machine Design

Course Description:
In machine design laboratory students will learn to apply the Knowledge of design of transmission elements. Students will learn to design a gear box upto two stage.

Course Objectives:
1.To learn use of manufacturers, Catalogue
2.Understand the design procedures of transmitting elements

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Select rolling element for a particular application from standard catalogue	II	Remembering
CO2	Develop assembly and production drawings	III	Applying
CO3	Design transmission elements and mechanical systems subjected to static and variable loading	V	Creating

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	**CO1**	3	-	-	-	-	-	-	-	-	--	-	1	-
CO2	**CO2**	2	2	1	1	-	-	--	-	-	-	-	1	-
CO3	**CO3**	2	2	1	1	-	-	-	-	-	-	-	1	-

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:	
Experiment No. 1:--- Problems based on Design for Fluctuating Loads.	02 **Hrs.**
Experiment No. 2:--- Study of Ball bearing mountings and its selection from standard manufacturer's catalogue and preloading of bearings, Mounting and dismounting procedures of rolling contact bearing and false diagnosis	02 **Hrs.**
Experiment No. 3:--- A detail case study of a product analyzing the aesthetics and ergonomic considerations	02 **Hrs.**
Experiment No. 4:--- Problems on pressure vessel design	02 **Hrs.**
Experiment No. 5:-- **Project Work 1-** A detail design report and A2 Size sheet containing working drawing of details and assembly of a gear box (i) Spur gear/ Helical gear.	04 **Hrs.**
Experiment No. 6:-- **Project Work 2-** A detail design report and A2 Size sheet containing working drawing of details and assembly of a gear box (i) Bevel/Worm gear.	04 **Hrs.**
Textbooks: 1. Bhandari V. B." Design of Machine Elements, Tata Mcgraw Hill New edition	
References: 1] Design Data Handbook" – P.S.G. College of Technology, Coimbatore	
Experiment wise Measurable students Learning Outcomes: 1 Student should be able to design mechanical components subjected against fluctuating load 2 Student should be able to select and recommend suitable bearing for particular application 3 Student should be able to understand principles of aesthetics and ergonomics 4 Student should be able to design pressure vessels as per IS standard. 5 Student should be able to design spur and helical gear 6 Student should be able to design bevel and worm gear.	

Title of the Course: Industrial Training and Mini project	**L**	**T**	**P**	**Credit**
Course Code:UMCH0641	**-**	**-**	**2**	**1**

Course Pre-Requisite: Fundamentals of Design, Thermal &Manufacturing Processes.

Course Description:

Industrial training and mini project aims to give exposure to the students to practical knowledge and real life problems

Course Objectives:

1. To understand the working of industry
2. To apply the theoretical knowledge to real life problems
3. To learn to prepare and present the report

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Relate theoretical concepts with industrial practices through practical exposure.	II	Apply
CO2	Develop communication skill and corporate cultural attributes by interacting with industrial persons.	III	Apply
CO3	Organize the information in the prescribed format.	III	Organization (Affective)

CO-PO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3													2
CO2	3								3	3	3			2
CO3	2								3	3	3			2

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) 100% weight

Assessment	Marks
ISE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

A. Industrial Training:

The students have to undergo an industrial training of minimum two weeks in an industry preferably dealing with Mechanical engineering during the semester break after fifth semester and complete within 15 calendar days before the start of sixth semester. The students have to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the

department. i) Students are expected to learn the organization structure, working of different Departments, various systems incorporated in the organisation. ii) Students are expected to work upon a project work or case study. The training report should contain the analysis of case study or project work undertaken iii)Report is based on compilation of work carried out related to facility and layout Planning, Process Engineering, Process capability evaluation, Industrial automation or machinery modification as identified iv) The students shall report the status of training and will be assessed by faculty as per the guide who will be allocated for their miniproject group. **B. Miniproject :** Minimum 4 to maximum 5 students in one group are allowed. Maximum two groups shall work under one faculty member. Group of one student is not allowed under any circumstances. In case of two group allotment, a work load of 2 hours shall be given and in case of one group allotment, a work load of 1 hour shall be given. Project work shall be based on any of the following: 1. Students can preferably identify a problem during their industrial training. 2. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group. 3. Experimental verification of principles used in Mechanical Engineering Applications. 4. Critical analysis of any design or process for optimizing the same. 5. Software development for particular applications. The subject content of the mini project shall be from emerging/ thrust areas, topics of current relevance. The completion of work, the submission of the report and assessment should be done at the end of Part-II (Second Semester). Training and mini project diary shall be maintained by each group. Students shall be evaluated for the Industrial training and Mini project at the end of VI th semester. **Report Format:** Training and report should be of 15 to 20 pages (typed on A4 size sheets). For standardization of the project reports the following format should be strictly followed. 1. Page Size: Trimmed A4 2. Top Margin: 1.00 Inch 3. Bottom Margin: 1.32 Inches 4. Left Margin: 1.5 Inches 5. Right Margin: 1.0 Inch 6. Para Text: Times New Roman 12 Point. Font 7. Line Spacing: 1.5 Lines 8. Page Numbers: Right Aligned at Footer. Font 12 Point. Times New Roman 9. Headings: Times New Roman, 14 Point, Bold Face 10. Certificate: All students should attach standard format of Certificate as	02 hrs /week

described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal/Director 11. Index of Report: a. Title Sheet b. Certificate c. Acknowledgement d. Table of Contents. e. List of Figures f. List of Tables 12. References: References should have the following format For Books: “Title of Book”, Authors, Publisher, Edition	