Autonomous Program Structure
Second Year B. Tech. Fourth Semester
(Mechanical Engineering)
Academic Year: 2021-2022 Onwards

Course Code	Course Title	Teaching Scheme Hours/ Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem	End Sem	Practical	Oral		
20ES401	Elements of Electrical and Electronics Engineering	3	1	0	50	50	0	0	100	4
20ME401	Analysis and Synthesis of Mechanisms (ASM)	2	1	0	50	50	0	0	100	3
20ME402	Fluid Mechanics (FM)	2	1	0	50	50	0	0	100	3
20ME403	Casting, Forming and Joining Processes (CFJP)	3	0	0	50	50	0	0	100	3
20ME404	Machine Design (MD)	3	1	0	50	50	0	0	100	4
20ME405L	Design Lab – I (SOM & ASM)	0	0	2	25	0	0	25	50	1
20ME402L	Fluid Mechanics (FM) Lab	0	0	2	25	0	25	0	50	1
20ME403L	Machine Shop (MS) Lab	0	0	2	25	0	25	0	50	1
20AC401	Audit Course (AC)	0	0	2	0	0	0	0	0	0
	Total	**14**	**4**	**8**	**325**	**250**	**50**	**25**		
	Grand Total	**26**			**575**		**75**		**650**	**20**

S. Y. B. Tech. – Semester-II

Course Code	Elements of Electrical and Electronics Engineering	L	T	P
20ES401		3	1	0
Pre-requisite	20ES01 Basic Electrical and Electronics Engineering	Syllabus Version		
		V:1.1		

Course Objectives:

1. To study principle of operation of DC machines and speed control of DC motors
2. To understand three phase induction motor working and its applications
3. To study Electrical drive system required to drive machines
4. To get acquainted with Electric Vehicle (EV) technology and subsystems
5. To understand Arduino IDE; an open source platform and its basic programming features
6. To interface Atmega328 based Arduino board with different devices and sensors

Course Outcomes:

At the end of this course students will demonstrate the ability to:

- Describe the working principle, characteristics and applications of D.C motor and Induction motor.
- Apply fundamental speed control methods of D.C motor and Induction motor.
- Describe different electrical drive systems and explain emerging technology of Electric Vehicle (EV)
- Explain Microcontroller Architecture of ATMega328 and Arduino IDE
- Interface external peripherals and sensors to ATMega328

Unit :- 1	DC Machines

Construction, working principle of DC Machine, emf equation of DC Machine. Working principle of DC motor. Types of DC motor, back emf, torque equation for DC motor, characteristics of DC motor (series, shunt and compound), Braking of D.C. Motor, methods for speed control of DC shunt and series motors, Industrial applications.

Unit :- 2	Three phase Induction Motor

Constructional feature, working principle of three phase induction motors, types, torque equation, torque slip characteristics, power stages and efficiency. Types of starters, Braking of induction motor, methods of speed control & Industrial applications.

Unit :- 3	**Electrical Drives and Introduction to Electric vehicles**

Electrical Drives: Advantages of Electrical Drives, Parts of electrical drives, choice of electric drive, Status of ac and dc drives, Brush less dc motor drives, stepper motor drives, synchronous motor variable speed drive.
Introduction to electric vehicles: Brief history of Electric Vehicle (EV), Components of EV, Benefits of EV Types of EVs such as Battery EV, Hybrid EV, Plug-in EV, Fuel Cell EV and their comparison, Challenges faced by EV technology

Unit :- 4	**Introduction to Microcontrollers**

Introduction to microcontroller and microprocessors, role of embedded systems, open source embedded platforms, Atmega 328P-features, architecture, port structure, sensors and actuators, data acquisition systems, introduction to Arduino IDE- features, IDE overview, programming concepts: variables, functions, conditional statements.

Unit :- 5	**Peripheral Interface - 1**

Concept of GPIO in Atmega 328P based Arduino board, digital input and output, UART concept, timers, interfacing with LED, LCD and keypad, serial communication using Arduino IDE

Unit :- 6	**Peripheral Interface – 2**

Concept of ADC in Atmega 328P based Arduino board, interfacing with temperature sensor (LM35), LVDT, strain gauge, accelerometer, concept of PWM, DC motor interface using PWM

	Total Theory Lecture hours: 40 hours	

Text Books:

1. Electrical Machines-D P Kothari and I J Nagrath, Tata McGraw Hill ,Third Edition
2. Electrical Machinery-S.K. Bhattacharya, TTTI Chandigad
3. Fundamentals of Elecrical drives-G K Dubey
4. Ajay Deshmukh-Microcontrollers Theory and Applications, TATA McGraw Hill
5. Arduino microcontroller processing for everyone -Steven F Barret,Morgan and Claypool Publisher.
6. C programming with ardino - Warwick Smith Elektor Publication
7. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press
8. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Ed, CRC Press
9. Application notes from "ATMEL micro controller data book.

List of Tutorials:

	Name of the Tutorial
1	Introduction to Microprocessors and Microcontrollers
2	Case studies on Embedded Systems and Applications.
3	Interfacing of LED with Arduino UNO to observe different patterns of LEDs.
4	Interfacing of LCD with Arduino UNO to display the messages.
5	Display data using serial communication using Arduino UNO.
6	Interfacing of Temperature Sensor LM35 to display temperature.
7	Speed control of DC Motor.
8	Speed control of Induction Motor.

Course Code	Analysis and Synthesis of Mechanisms	L	T	P
20ME401		3	1	0
Pre-requisite	Engineering Mechanics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To understand the fundamentals of Mechanisms.
2. To understand analysis of mechanisms by analytical and graphical methods.
3. To understand dimensional synthesis of mechanisms by analytical and graphical methods.
4. To understand the kinematics of Gears and Gear Trains.
5. To understand kinematics of friction

Course Outcomes:

Students will be able to

1. Identify the nature of kinematic pair, chains and Mechanism.
2. Construct and analyze velocity and acceleration polygon of Simple mechanism by analytical and graphical method.
3. Perform dimensional synthesis of mechanisms by analytical and graphical methods.
4. Evaluate Speed ratio and Torque for Gear and Epicyclic Gear train.
5. Evaluate torque transmission in clutches and braking torque in brakes.

Unit :- 1	Fundamentals and Types of Mechanisms	8 hours	CO: 1

Kinematic Link, types of links, kinematic pair, types of constrained motion, types of kinematic Chains, types of joints, mechanism , machine, degree of freedom, Kutzbach criterion, Grubler's criterion, Grashoff's law, four bar chain and its inversion, Slider crank and its inversion, double slider crank and its inversion, straight line mechanism, Peaucellier Mechanism, Scott Rusell Mechanism, Grasshopper Mechanism, Watt Mechanism. Steering Gear Mechanism, Condition for correct steering, Davis and Ackermann Steering Gear Mechanism.

Unit :- 2	Displacement, Velocity, and Acceleration Analysis of Mechanism	11 hours	CO: 2

Kinematics of Rigid Bodies: Types of motions, position velocity and acceleration
Analytical and Graphical method for displacement, position analysis of links with vector and complex algebra methods, Loop Closure equation, chase solution, input and output curves, transmission angle.

Analytical Method-velocity and acceleration analysis for four bar and slider crank mechanisms using vector and complex algebra methods Graphical Method-velocity and acceleration polygons for simple mechanisms as well as for the mechanisms involving the Coriolis component of acceleration. ICR Method.			
Unit :- 3	**Dimensional Synthesis of Mechanism-Analytical and Graphical Method**	**9 hours**	**CO: 3**
Introduction to Synthesis of Mechanism-Type, number and dimensional synthesis, task of dimensional synthesis, path, function and motion generation(body guidance), precision positions, Chebychev spacing, Mechanical and structural errors. Graphical Method: Two and three position synthesis of four bar and slider crank mechanisms. Analytical Method: Three position synthesis of four bar mechanism using Freudenstein's Equation.			
Unit :- 4	**Kinematics of Gear and Gear Train**	**8 hours**	**CO: 4**
Gear Terminology, law of gearing, forms of teeth, path of contact, arc of contact, Number of pairs of teeth in contact (contact ratio), Interference in involute gears, minimum number of teeths, interference between rack and pinion, helical and spiral gear, terminology in helical gear, velocity ratio and centre distance of helical gear, Worm and Worm gear, velocity ratio and centre distance of worm gear, Efficiency of helical, spiral and worm gear. Kinematics of Bevel Gear. Gear Train: types of gear train, Analysis of Epicyclic Gear train.			
Unit :- 5	**Friction**	**4 hours**	**CO: 5**
Laws of Friction, coefficient of friction, screw thread, pivots and collars, friction clutches, rolling friction, Greasy Friction, Friction axis of link, film friction.			
	Total Theory Lecture hours:	**40 hours**	
Tutorial Assignments			
1.	Fundamentals of Mechanisms and Degree of Freedom of Mechanism		
2.	Mechanisms and Its Inversions		
3.	Planar Kinematics of Rigid body		
4.	Planar Kinetics of Rigid body		
5.	Displacement Analysis of Mechanism: Analytical and Graphical Method		
6.	Velocity and Acceleration Analysis of Mechanism: Analytical and Graphical Method		
7.	Dimensional Synthesis of Mechanism analytical method		
8.	Kinematics of Gears		
9.	Analysis of Epicyclic Gear Train		
Text Books:			

1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Asok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.

Reference Books:	
1.	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
2.	Hartenberg, Richard Scheunemann, and Jacques Denavit. „Kinematic Synthesis of linkages". McGraw-Hill, 1964.
3.	Shiley J. E. and Uicker J.J. , „Theory of Machines and Mechanism", McGraw Hill Inc
4	Ashok G. Ambekar, „Mechanisms and Machine Theory", Prentice Hall,India
5.	Sadhu Singh, „Theory of Machines", Pearson
6.	Hall A. S. „Kinematics and Linkage Design",Prentice Hall
7.	Wilson C.E., Sandler J.P. „Kinematics and Dynamics of Machinery", Pearson Education
8.	Erdman A.G. and Sandor G. N. „Mechanism Design, Analysis and Synthesis Vol-I, Prentice Hall

Course Code	Fluid Mechanics	L	T	P
20ME402		**2**	**1**	**-**
Pre-requisite	Engineering Physics, Engineering Mathematics	**Syllabus Version**		
		V:1.1		

Course Objectives:

To make students

1. Applying the mass conservation principle, to engineering problems.
2. Applying the momentum and energy equations to engineering problems.
3. Evaluating head loss in pipes and conduits.
4. Introduction to formation of boundary layer, drag and lift concept associated with it

Course Outcomes:

Students will be able to

1. Apply mass conservation principle to the given system.
2. Understand energy conservation principle for fluid flow.
3. Calculate the pressure drop for a given system.
4. Explain the boundary layer formation on the flat plate.

Unit :- 1	**Fundamental Concepts of Fluid Flow**	**2 hours**	**CO: 1**
Fundamental definitions, Flow characteristics, Classification of fluids, Fluid properties			
Unit :- 2	**Flow Kinematics**	**4 hours**	**CO: 1**
Equations for acceleration, Continuity equation, Irrotational and rotational flow, Potential and stream functions.			
Unit :- 3	**Integral Analysis of Fluid Flow**	**6 hours**	**CO: 2**
Finite control volume analysis (Reynolds Transport Theorem) , Euler and Bernoulli‟s theorems, Applications, Venturi and Orifice meter, Pitot Tube			
Unit :-4	**Pipe Flows**	**5 hours**	**CO: 3**
Types of flow, Reynolds experiment, Laminar flow between parallel plates, Laminar flow in pipes, turbulent flow in pipes. Darcy-Weisbach equation, Moody diagram, Energy losses in pipelines, Minor losses.			

Unit :- 5	**Differential Analysis of Fluid flow**	**6 hours**	**CO: 2,3**
Introduction to Navier- Stokes equations, Exact solutions for simple cases of flow, Plane Poiseuille flow (Pipe and Channel), Coutte flow, Flow on inclined plane			
Unit :- 6	**Flow past immersed Bodies**	**2 hours**	**CO: 4**
Concepts of boundary layer, Drag and lift on immersed bodies.			
	Total hours:	**25 hours**	

Text Books:	
1.	Munson, Okiishi, Young, „Fluid Mechanics", 7th Ed, Wiley, 2016.
2.	Cengel, Cimbala, „Fluid mechanics", Tata Mcgraw hill publishing
Reference Books:	
1.	Gupta and Gupta, „Fluid Mechanics", 3rd Ed, New Age publications, 2016.
2.	Kundu, Cohen, Dowling, „Fluid Mechanics", Elsevier India
3.	K. Muralidhar, G. Biswas, „Advance Fluid Mechanics", 3rd Edition, Narosa Publishing House
4.	Fox, Mcdonald, „Fluid Mechanics", 8th Edition, Wiley.

Course Code	Casting, Forming and Joining Processes (CFJP)	L	T	P
20ME403		3	-	-
Pre-requisite	Machining and Machine Tool Operations	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To study basic production processes
2. To study how to select appropriate production processes for a specific application

Course Outcomes:

Students will be able to

1. Understand basics of manufacturing, elements of casting, construction of pattern, gating system, different types of casting method and their application.
2. Various welding technologies' fundamentals should be recognized, analyzed, and configured.
3. Analyze principles and working of different forming processes such as sheet metal working, forging, rolling and extrusion.
4. Identify different machining operation requirements for non-metal components.

Unit/Module: 1	Metal Casting Processes	9 hours	CO: 1

Dispensable and permanent mould processes, Analysis of melting, pouring and solidification phenomena, design of pattern, core, feeder and gating system, Casting defects and inspection.

Unit/Module: 2	Joining Processes	9 hours	CO: 2

Introduction, Fusion and solid-state welding, Brazing and soldering, Weld joint design, cooling rate, and joint properties, Heat affected zone, Friction stir welding, reduced pressure EB welding, Metal to composite joining, Welding defects and inspection

Unit/Module: 3	Bulk Deformation	9 hours	CO: 3

Plastic deformation and yield criteria, bulk deformation, cold versus hot working. Analysis (load and force estimation) and defects in deformation processes forging, rolling, drawing and extrusion.

Unit/Module: 4	**Sheet Metal forming**	**8 hours**	**CO: 3**
Sheet metal shearing, deep drawing, bending and their applications, drawing ratio, forming limit diagram and analysis			
Unit/Module: 5	**Polymer Processing and sustainable manufacturing**	**7 hours**	**CO: 4**
Polymer basics, Injection molding process and analysis, Compression molding, Blow molding, Introduction to composite manufacturing, Environmental impact in Micro-device manufacturing, cutting tool sustainability, MQL in Machining.			
	Total Lecture hours:	**42 hours**	

Text Books:	
1.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication
Reference Books:	
1.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.
2.	Mechanical Engineers' Handbook, Volume 3: Manufacturing and Management, Myer Kutz, Wiley.
3.	Manufacturing processes Vol. 1 and 2, P. N. Rao, Tata McGraw-Hill.

Course Code	Machine Design	L	T	P
20ME404		3	1	-
Prerequisite	Strength of machine elements (S.O.M.)	Syllabus Version		
		V:1.1		

Course Objectives: To make students

1. To design simple machine elements subjected to static loads.
2. To compute the torque transmission capacity by the given power screw.
3. To analyze the machine elements subjected to fluctuating loads.
4. To apply A.S.M.E. code for shaft design.
5. To calculate the size of a mechanical joint, subjected to eccentric load.
6. To determine the spring dimensions for a given requirement.

Course Outcomes:

After successful completion of the course, student will be able to

1. design simple machine elements subjected to static loads.
2. compute the torque transmission capacity by the given power screw.
3. analyze the machine elements subjected to fluctuating loads.
4. apply A.S.M.E. code for shaft design.
5. calculate the size of a mechanical joint, subjected to eccentric load.
6. design helical spring for given requirements.

Unit/Module: 1	Introduction to design engineering	4 hours	CO: 1

Phases and interactions in design process, design considerations, design tools and resources, design engineer's professional responsibilities, standards and codes, economics aspects.

Unit/Module: 2	Failure Prevention: Design against static load	8 hours	CO: 1

Modes of failures, combined stresses, principal stresses, failure theories and their selection, eccentric loading, design of simple machine elements subjected to static loading.

Unit/Module: 3	Failure Prevention: Design against fluctuating load	8 hours	CO: 3

Fatigue failure, endurance limit and its modifying factors, endurance strength, design for infinite and finite life for completely reversed and fluctuating loads.

Unit/Module: 4	Design of machine elements-I: Transmission Shafts	6 hours	CO: 4

Shaft design based on strength, deflection considerations, torsional and lateral rigidity, ASME code for

shaft design, critical speed of shafts, design of keys and splines.			
Unit/Module: 5	**Design of machine elements-II: Mechanical Springs and Power Screws**	**8 hours**	**CO: 2,6**
Stress and deflection analysis of helical springs, design for static and fatigue loading, springs in combination, leaf springs. Torque analysis of power screws, standard threads, thread and collar friction, efficiency and stresses in power screws.			
Unit/Module: 6	**Design of machine elements-III: Mechanical Joints**	**8 hours**	**CO: 5**
Bolts of uniform strength, fastener stiffness and member stiffness, threaded joints subjected to axial loading and eccentric loading in different planes. Strength of butt and fillet welded joints in torsion and bending, sizing of welded joints subjected to direct and eccentric loads.			
	Total hours:	**42 Hours**	

Reference Books:

1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd
2.	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3.	Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4.	Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5.	"Design Data",P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7.	Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum"s Outline Series.
8.	Michael Nikowitz, „Advanced Hybrid and Electric Vehicles, System Optimization and Vehicle Integration", Springer International Publishing Switzerland 2016.
9.	Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals", CRC PRESS.

Text Books:

1.	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

Course Name	Design Lab- I (ASM & SOM-L)	L	T	P
Course Code	20ME405	-	-	2
Pre-requisite	Analysis and Synthesis of Mechanism, and Strength of Materials	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To understand the fundamentals of Mechanisms for Practical Application.
2. To understand dimensional synthesis of mechanisms by graphical methods
3. To understand the Cam jump phenomenon, Epicyclic Gear Train and Gyroscopic principle
4. To determine experimental data include universal testing machines and torsion equipment.
5. To determine stress analysis and design of beams subjected to bending and shearing loads using several methods.

Course Outcomes:

Students will be able to

1. Draw Mechanisms for practical Application
2. To understand dimensional synthesis of mechanisms by graphical methods
3. To understand and perform experiment for Cam Jump phenomenon , Epicyclic Gear Train and Gyroscopic principle
4. Understand the basic concepts of stress, strain, deformation, and material behaviour under different types of loading (axial, torsion, bending).
5. Perform stress analysis and design of beams subjected to bending and shearing loads using several methods.

Lab Work (Any 8)

1.	To draw mechanisms for Practical Application and straight line mechanisms.
2.	To Synthesize the 4-bar mechanism using relative pole method and inversion methods with 3-precision points.
3.	To synthesize the slider crank mechanism using relative pole method and inversion methods with 3-precision points.
4.	Epicyclic Gear Train
5.	Cam Jump Phenomenon
6.	Gyroscopic Principle

7.	Tension test		
8.	Compression Test		
9.	Direct Shear Test		
10.	Bending Test		
11.	Torsion Test		
12.	Impact test		
	Total Lab hours:	**18 hours**	

Text Books:	
1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Asok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.
3.	Strength of Materials S. Ramamrutham, Dhanpat Rai Pvt. Ltd
Reference Books:	
1.	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
2.	Hartenberg, Richard Scheunemann, and Jacques Denavit. „Kinematic Synthesis of linkages". McGraw-Hill, 1964.
3.	Mechanics of Materials, by Russell C. Hibbeler
4.	Singer and Pytel - Strength of materials - Harper and row Publication.

Course Code	Fluid Mechanics Lab	L	T	P
20ME402L		-	-	2
Pre-requisite	Engineering Physics, Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Applying the mass conservation principle, to engineering problems.
2. Applying the momentum and energy equations to engineering problems.
3. Evaluating head loss in pipes and conduits.
4. Introduction to formation of boundary layer, drag and lift concept associated with it

Course Outcomes:

Students will be able to

1. Students will understand the basic experimental techniques in fluid mechanics.
2. Students will be present the results in the graphical form.
3. Students will able to measure the pressure drop in a pipe determine friction factor.
4. Students will able to understand the process of calibration of flow meters.

Lab Work

1.Measurement of Viscosity and Sp. Gravity

2.Measurement of Pressure and velocity

3.Measurement of coefficient of orifice

4.Verification of Bernoulli's theorem

5.Calibration of Venturi/Orifice meter

6.Flow visualization using Reynolds Apparatus

7.Measurement of coefficient of friction in pipe

8.Verification of momentum equation

9.Project based learning thermal engineering starts

Total Lab hours:- 18 hrs

Text Books:

1.Munson, Okiishi, Young, 'Fluid Mechanics', 7th Ed, Wiley, 2016.

2.Cengel, Cimbala, 'Fluid mechanics', Tata Mcgraw hill publishing

Reference Books:
1. Gupta and Gupta, 'Fluid Mechanics', 3rd Ed, New Age publications, 2016.
2.Kundu, Cohen, Dowling, 'Fluid Mechanics', Elsevier India
3.K. Muralidhar, G. Biswas, 'Advance Fluid Mechanics', 3rd Edition, Narosa Publishing House
4.Fox, Mcdonald, 'Fluid Mechanics', 8th Edition, Wiley.

Course Code	Machine Shop Lab (MS-L)	L	T	P
20ME403L		-	-	2
Pre-requisite	Machining and Machine Tool Operations	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To study basic production processes
2. To study how to select appropriate production processes for a specific application

Course Outcomes:

Students will be able to

1. Various welding technologies' fundamentals should be recognized, analyzed, and configured.
2. Analyze principles and working of different forming processes.
3. Identify different machining operation requirements for non-metal components.
4. Identify different machining operation requirements for assembly manufacturing.

Lab Work

1.	A demonstration of any one welding technique out of TIG/ MIG/Resistance/Gas welding. A job drawing to be prepared by an individual institute with details of welding process parameters with weld joint design such as edge preparation, type and size of electrode used, welding current, voltage etc.
2.	Demonstration of the usage of manufacturing processes like casting, forging, sheet metal.
3.	Manufacturing of Fibre-reinforced Composites by hand lay-up process or spray lay-up techniques.
4.	Demonstration on any one plastic component like bottle, bottle caps, machine handles etc. by injection moulding process/ by additive manufacturing process.
5.	Demonstration on grinding operations, measurement of surface roughness produced and estimation of machining time.
6.	Composite job machining involving minimum four components, employing operations on lathe, precision turning, screw cutting, boring etc. and involving the use of milling and grinding operations. Raw material selection and / estimation, process planning and sales presentation.

	Total Lab hours:	**22 hours**	

Text Books:	
1.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication
Reference Books:	
1.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.
2.	Mechanical Engineers' Handbook, Volume 3: Manufacturing and Management, Myer Kutz, Wiley.
3.	Manufacturing processes Vol. 1 and 2, P. N. Rao, Tata McGraw-Hill.