SEMESTER IV

(MC 401) STRENGTH OF MATERIALS

1. COURSE OBJECTIVES:

Through this course the students will able to understand the fundamentals of solid mechanics, acquire the elementary knowledge of stresses, strains and their effects. They will also analyze the behavior of machine parts under various loads. It is important to understand and analyze various types of loads, stresses and strains, which are the main causes of failure of machine parts. The subject also deals with understanding the properties of engineering materials and applying the same in solving engineering problems.

2. TEACHING AND EXAMINATION SCHEME

Semester IV									
Course code & course title	Periods/Week (in hours)			Total Hours	Examination Scheme				
					Theory Marks		Practical Marks		Total Marks
(MC 401) Strength of Materials	L	T	P	H	TH	TM	TW	PR/OR	
	3	1	1	5	75	25	25	-	125

3. COURSE OUTCOMES:

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

MC401CO1: Describe behaviour of engineering materials under the action of external loads.

MC401CO2: Represent simple stress & strain, SF & BM, Moment of inertia, bending stresses & torsion.

MC401CO3: Solve various problems on simple stresses & strains, SF & BM diagrams, bending stresses, moment of inertia & torsion.

MC401CO4: Analyse the behaviour of materials under various loads.

4. Mapping Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
	Basic & Discipline Specific Knowledge	Problem Analysis	Design and Development of Solutions	Engg. Tools, Experimenting & Testing	Engg. Practices for Society, Sustainability & Environment	Project Management	Life -long Learning		
CO1	3	1	0	0	2	0	2	2	1
CO2	3	3	1	1	0	1	1	2	0
CO3	3	2	2	1	0	0	2	3	0
CO4	3	3	2	1	1	1	2	3	1

Relationship : Low-1 Medium-2 High-3

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	**Thr = Teaching hours**			
Units:		**M**	**Thr**	**CO**
1. SIMPLE STRESS AND STRAIN		15	10	
1.1 Definition of stress and strain (Numericals on stress and strain)				
1.2 Stress – strain Curve for Ductile Material labeling the significant points on the curve.				
1.3 Concept of elastic limit, Hooks law &Young's Modulus of Elasticity				
1.4 Deformation expression of a body subjected to single force [δl = PL/AE]				
1.5 Numericals based on concept of principle of Superposition [Bars of uniform cross section & Bars of different cross sections only]				**CO1 CO2 CO3 CO4**
1.6Concept of lateral strain and Poisson's Ratio. [Numericals on lateral strain & Poisson's Ratio to be covered]				
1.7 Concept of shear stress, shear strain and Modulus of Rigidity.				
1.8 Definition of term- volumetric strain and bulk Modulus [No Numericals] Note: - [Numericals on stresses in composite sections are to be excluded.]				
2. SHEAR FORCE & BENDING MOMENT		15	10	
2.1 Types of beams and Supports.				
2.2 Concepts of shear force & Bending Moment.				**CO1**
2.3 Sign Conventions for shear force & Bending Moment.				**CO2**
2.4 Shear force and bending moment diagram for simple cantilever and simply supported beams subjected to point and uniformly distributed load only.				**CO3 CO4**
3. MOMENT OF INERTIA		15	10	
3.1 Definition of Moment of Inertia				
3.2 Perpendicular & Parallel Axis Theorem.				**CO1**
3.3 Expression of M.I of Rectangular, circular, Triangular & hollow Rectangular sections (No derivations, simple numericals).				**CO2 CO3**
3.5 Numericals on sections like L section, T section and I section				
4. THEORY OF SIMPLE BENDING		15	09	
4.1 Concept of pure Bending.				**CO1**
4.2 Theory of simple Bending, Neutral Axis and Bending equation.				**CO2**
4.3 Bending stress distribution diagram				**CO3**
4.4 Application of bending equation for solid rectangular, solid circular section, hollow rectangular and hollow circular section. (simple numericals)				**CO4**
5. TORSION		15	09	
5.1 Concept of pure Torsion				
5.2 Torsion equation assumptions in Theory of pure torsion.				**CO1**
5.3 Strength of circular solid &hollow shaft in pure torsion.				**CO2**
5.4 Shear stress distribution diagram.				**CO3**
5.5 Polar Modulus, power transmitted by shaft.				**CO4**
Total		**75**	**48**	

N.B: - Question paper will not carry questions on derivations

6. COURSE DELIVERY:

The Course will be delivered through lectures, class room interactions, exercises and tutorials.

7. SPECIFICATION TABLE FOR THEORY/ MACRO-LESSON PLAN

Unit No	Unit	Number of lectures	Marks
1	SIMPLE STRESS AND STRAIN	10	18
2	SHEAR FORCE & BENDING MOMENT	10	18
3	MOMENT OF INERTIA	10	15
4	THEORY OF SIMPLE BENDING	09	12
5	TORSION	09	12
	Total	48	75

8. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS.

No	Practical (no 1 and 2 are compulsory and any 03 from 3 to 8)	Marks
1.	Tensile Test on M.S or Al using UTM	4
2.	Compression Test on wood/Resin sample using UTM	3
3.	Shear Test on M.S using UTM	3
4.	Brinell Hardness Test on Hardness Testing Machine	3
5.	Rockwell Hardness Test on Hardness Testing Machine	3
6.	Izod Impact Test on M.S or Al.	3
7.	Charpy Impact Test on M.S. or Al.	3
8.	Torsion Test on M.S Specimen.	3
	Total	25
No	**Tutorial Exercise**	
1	Solve atleast 5 problems on unit 1	
2	Solve atleast 5 problems on unit 2	
3	Solve atleast 5 problems on unit 3	
4	Solve atleast 5 problems on unit 4	
5.	Solve atleast 5 problems on unit 5	

9. LEARNING RESOURCES

9.1Text Books

S. No.	Author	Title of Books	Publishers
1	R.S Khurmi	Strength of Materials	S.Chand Publisher
2	S.S. Bhavikatti	Strength of Materials	Vikas Publishing
3	S. Ramamurtham	Strength of Materials	DhanpatRai&Sons
4	R. K. Rajput	Strength of Materials	S.Chand Publisher

9.2 Reference Books for further study

S. No.	Author	Title of Books	Publishers
1	F.L. Singer	Strength of Materials	London Harper & row
2	Timoshenko & Gere	Mechanics of Materials	CBS Publisher & Distributors, New Delhi

(MC402) MECHANICAL WORKSHOP PRACTICE

1. COURSE OBJECTIVES:

The students will be able to acquire knowledge to Plan methodology and prepare the job as per given specification by selecting and applying appropriate manufacturing process and Understand the concepts, procedures, types of cutting tools, work holding devices, various operations performed on these machines, their working principles and practices related to various manufacturing processes.

2. TEACHING AND EXAMINATION SCHEME

Semester IV									
Course code & course title	Periods/Week (in hours)			Total Hours	Examination Scheme				
					Theory Marks		Practical Marks		Total Marks
	L	T	P	H	TH	TM	TW	PR/OR	
(MC402) MECHANICAL WORKSHOP PRACTICE	-	-	04	-	-	-	50	50	100

3. COURSE OUTCOMES:

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

MC402CO1: Identify different types of machine tools and machining processes to produce a component.

MC402CO2: Outline a manufacturing sequence to produce a given part.

MC402CO3: Apply basic skills in the use of various machine tools (milling m/c, grinding machine, shaper and lathe) to perform job following safety guidelines.

MC402CO4: Plan a maintenance schedule for effective functioning of machine tools.

4. Mapping Course Outcomes with Program Outcomes

Relationship: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
CO 1	3	1	1	2	2	1	1	1	2
CO 2	3	2	2	1	0	0	0	0	2
CO 3	3	2	2	3	1	1	1	2	3
CO 4	2	1	2	3	1	1	1	1	2

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	**Phr = Practical hours**	

Unit	**M**	**Phr**	**CO**
1. LATHE.			
1.1 Introduction to types of Lathe.			
1.2 Centre Lathe: Tool nomenclature, thread cutting operation. Preventive maintenance, maintenance schedule and lubrication chart. Types of Coolants.			
1.3 Introduction to Capstan and turret lathe, Principal parts of capstan and turret lathe.			**CO1**
1.4 Introduction to CNC lathe, main elements of CNC lathe, Hand operation, operating element. CNC operation- operating and control elements, co-ordinate system. CNC programming- methods of programming-absolute system and Incremental system, Preparatory functions (G-functions), CNC program input format.			**CO2** **CO3**
2. Milling machine			
2.1 Introduction, column and knee type milling machine (horizontal and vertical), milling cutters, milling operations.			**CO1**
2.2 Universal dividing head-construction and working, Indexing-direct and simple indexing only.			**CO2** **CO3** **CO4**
2.3 Preventive maintenance, maintenance schedule and lubrication charts. Coolants.			
3 Grinding.			
3.1 Introduction, grinding machine types. Work holding devices.			**CO1**
3.2 Types of abrasive and bond. Grite, Grade and structure of wheel, dressing and truing of wheel, marking system, mounting of wheel, balancing of wheel.			**CO2** **CO3**
3.2 Use of Coolant			
4 Shaper.			
4.1 Introduction to Shaper.			**CO1**
4.2 Main parts of standard shaper, work holding devices shaper operations.			**CO2**
4.3 Preventive maintenance schedule and lubrication chart.			**CO3** **CO4**
Total		**64**	

6. COURSE DELIVERY:

The Course will be delivered through shop talk, shop floor interactions, demonstrations, assignments, video clips and Practicals.

7. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS HOURS

Sr. No	Unit No	Practicals/Assignment	Phrs
1	1	Job on external threading	04
2	1	Prepare simple job on CNC machine	04
3	2	Produce a hexagonal head/spur gear by indexing device	08
4	2	Machine sides of a rectangular block (centre lathe/milling machine) and mill two slot or opposite sides and a V-groove on one side (V-block)	08
5	3	Prepare job on the following grinding machine 1) Surface grinder-flat surface-01 2) Cylindrical grinder-cylindrical surface-01	04
6	3	Grind lathe tool	04
7	4	Machine two flat horizontal opposite sides of the rectangular block on a shaper (to complete V-block. at Sr. No 4)	08
8	1,2,4	Prepare a preventive maintenance schedule(daily/monthly) and a lubrication chart for any one of the following machine tools (1) Centre lathe (2) Milling machine (3) Shaper	06
09	1,2,4	Identify different types of machine tools in your workshop and write down its specifications and uses	04

Note: A field visit to modern workshop to be arranged during the semester

8. LEARNING RESOURCES

8.1 Text Books

S. No.	Author	Title of Books	Publishers
1	S.K Hajara Chaudhary	Elements of W/s Technology Vol I & II	Media Promoter & Publisher Pvt. Ltd
2	Raghuwanshi	Workshop Technology Vol II	Dhanpat Rai & Co
3	P.C Sharma	Production Technology	S. Chand & Co
4	Kaushik and Gupta	Workshop Technology	

8.2 Reference Books for further study

S. No.	Author	Title of Books	Publishers
1	R.K Jain	Production Technology	Khanna Publishers
2	W.A.J Chapman	Workshop Technology Vol I & II	CBS

(MC 403) MECHATRONICS

1. COURSE OBJECTIVES:

Modern industry demands lot of flexibility in product design and manufacturing processes. While satisfying this need industries cannot afford to compromise with quality, cost and delivery schedule. The area of Mechatronics has a tremendous potential to address such challenges by integrating Mechanical engineering with electrical, Electronics and software components. We can hardly find any field where mechatronics is not applicable. Basic knowledge of this course will definitely enhance the employability of pass-out students in various engineering areas.

2. TEACHING AND EXAMINATION SCHEME

Semester	IV								
Course code & course title		Periods/Week (in hours)			Total Hours	Examination Scheme			
						Theory Marks		Practical Marks		Total Marks
(MC 403) Mechatronics		L	T	P	H	TH	TM	TW	PR/OR	
		3	-	2	5	75	25	25	25	150

3. COURSE OUTCOMES:

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

MC403CO1: Define mechatronics, its basic elements & related terms.

MC403CO2: Explain basic types of mechatronics system and constructional features of different sensors, actuators and controllers.

MC403CO3: Select appropriate sensing and actuating elements having proper compatibility with the controller.

MC403CO4: Analyse the functioning of various mechatronic systems along with relevant control programs.

4. Mapping Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
CO 1	3	2	1	0	0	0	0	1	0
CO 2	3	2	1	1	0	0	0	2	0
CO 3	3	3	3	3	1	1	2	3	2
CO 4	3	3	3	3	2	1	2	3	2

Relationship: Low-1 Medium-2 High-3

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	**Thr = Teaching hours**				
Unit			**M**	**Thr**	**CO**
1. Introduction to Mechatronics			**9**	**4**	
1.1 Introduction to Mechatronics and its scope.					
1.2 advantages and disadvantages of mechatronics.					
1.3 Comparison between Traditional and Mechatronics system					**CO1 CO2 CO4**
1.4 Two types of Mechatronic systems – (i)Measurement type and (ii) Control type; Elements of Measurement system (Block diagram) and examples, Elements of Open loop & Closed loop Control systems (Block diagrams) and examples; Applications of Mechatronics.					
1.5 Case studies of Mechatronics systems: - (i) Measurement type - Digital thermometer (ii) Control type- Engine Management system, Automatic Washing Machine,					
2. Sensors and Transducers			**18**	**12**	
2.1 Introduction of sensors and Transducers, Difference between sensor and transducer.					
2.2 Performance Terminology related with sensor, 2.2.1 Static characteristics - range and span, error, accuracy, sensitivity, repeatability, stability, resolution. 2.2.2 Dynamic characteristics - response time, settling time.					
2.3 Classification of sensors- A) Based on type of Output- (i) Analog (ii) Digital B) Based on need of external power: – (i) Active (ii) Passive C) Based on sensed parameter: – (i) Pressure, Force (ii) Temperature (iii) Motion (displacement, Velocity, Acceleration) (iv) Flow and level (v) light (vi) smoke (vii) Colour (viii) touch (ix) Humidity (x) Proximity (xi) Infrared (IR)					**CO1 CO2 CO3**
2.4 Working principle and application of following sensors / Transducers: - **(i)** Potentiometer (ii) Strain gauge (iii) Linear Variable Differential Transformer (LVDT) (iv) Optical Encoder (v) Photoelectric Proximity sensor (vi) Tach generator (vii) Thermocouple (viii) RTD sensor.					
2.5 Selection criteria for sensors.					
2.6 Signal Conditioning – need, process, functions, ADC and DAC. Block diagram of DAQ.					

3. Actuations Systems	15	10	
3.1 Introduction and Classification of Actuators.			
3.2 Pneumatic Actuation System: Basic Elements of Pneumatic System. Hydraulic Actuation Systems: Basic Elements of hydraulic system.			**CO1 CO2 CO3 CO4**
3.3 Working principle, schematic diagram and symbols of following: - Valves: - Direction control valves (Spool type) - 3/2 DC Valve and 5/2 DC Valve; actuation methods of DC Valves; Check valve, Pressure relief valve, Flow control Valves.			
3.4 Cylinders: - Single Acting and Double acting cylinder. Rotary Actuators: - Gear motors and Vane Motors.			
3.5 Electrical Actuation systems: - Switching devices: Relays, Solenoid type devices: Solenoid valves, Drive systems: Stepper Motor and servo motor (Brief Working with neat sketches).			
4. Microcontroller	15	12	
4.1 Microcontroller: - Introduction, characteristics, classification and applications, Basic Block diagram. Introduction to Arduino platform.			
4.2 Atmel ATmega328 microcontroller: - Pin layout and other features. Arduino UNO R3 Board: - Hardware, main features, input output pins, powering, IDE and its installation, connecting to computer, program (sketch) compilation and uploading,			**CO1 CO2 CO3 CO4**
4.3 Introduction to basic Arduino circuit components: – LED, Resistor, Diode, Bread Board, Jumper, Button, Servo, LCD, LDR, IR LED, Relay.			
4.4 Writing, compiling, uploading and running following programs: –Digital output (LED blinking), Analog output (LED fading).			
4.5 Arduino applications- Home and Industry automation, Robotics and control systems.			
5. Programmable Logic Controller (PLC)	18	10	**CO1 CO2 CO3 CO4**
5.1 Introduction to PLC: Need for PLC, Definition, Advantages and disadvantages of PLC, PLC sizes.			
5.2 Criteria for selection of PLC.			
5.3 PLC system layout (Basic block diagram). Input/output processing. PLC function and operation.			
5.4 ladder programming: Concept of Ladder Diagram, sequence of ladder programming, logic functions, use of latching, internal relays, timers, counters in elementary level Ladder diagrams like motor start and stop, water level control, Output interlock, logic functions.			

Total	**75**	**48**	

6. COURSE DELIVERY:

The Course will be delivered through lectures, class room interactions, exercises and case studies

7. SPECIFICATION TABLE FOR THEORY/ MACRO-LESSON PLAN

Unit No	**Unit**	**Number of lectures hrs**	**Marks**
1	Introduction of Mechatronics	04	09
2	Sensors and Transducers	12	18
3	Actuations Systems	10	15
4	Microcontroller	12	15
5	Programmable Logic Controller (PLC)	10	18
	Total	48	75

8. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS.

No	**Practical**	**Marks**
1.	**Experiment on sensors from any three of the following:** Temperature sensor, Pressure sensor, Flow sensor, level sensor, proximity sensor & force sensor.	3
2.	**Identification, working of different actuating elements:** Relay, solenoid valve, stepper motor, Servo motors, valves, cylinders etc	3
3 & 4	**Experiment to build any two simple Pneumatic circuits.**	3
5,6,7	**Any three experiments on Arduino Board from the following.** i) Blinking and fading effects on LED ii) Turn on LED with button iii) Move the Servo to commanded angle iv) Print "Hallo world" in LCD v) Using a sensor	5
8 & 9	**Any two experiments on PLC trainer by developing ladder diagram from the following.** i) Output interlock	5

	ii) Logic Functions iii) Timers and Counters iv) Water Level control v) Conveyor Belt control vi) Traffic Light control	
10	**Mini project on developing simple Mechatronic system.(Group activity)**	6
	Total	**25**

8. LEARNING RESOURCES

8.1Text Books

S. No.	Author	Title of Books	Publishers
1	W. Bolton	Mechatronics	Pearson Education Ltd
2	John W. Webb	Programmable Logic Controller	PHI
3	Andrew Parr	Hydraulics and Pneumatics	JAICO
4	Massimo Benzi	Make: Getting Started with Arduino	Maker Media

8.2 Reference Books for further study

S. No.	Author	Title of Books	Publishers
1	R. K. Rajput	Mechatronics	S. Chand Publications
2	K.Shanmugasundaram	Hydraulic and Pneumatic Controls	S. Chand
3	K.P. Ramachandran	Mechatronics	Wiley

(MC405) ENERGY CONVERSION

1. COURSE OBJECTIVES:

The students will be able to acquire knowledge about the processes and machines which convert energy from naturally available forms to useful forms viz mechanical power and electrical power. This knowledge is important in design, operation and maintenance of various kinds of mechanical engineering and technological products and processes.

2. TEACHING AND EXAMINATION SCHEME

Semester	IV								
Course code & course title		Periods/Week (in hours)			Total Hours	Examination Scheme			
						Theory Marks		Practical Marks		TotalMarks
(MC405) ENERGY CONVERSION		L	T	P	H	TH	TM	TW	PR/OR	
		3	1	1	5	75	25	25	-	125

3. COURSE OUTCOMES:

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

MC405CO1: Define various terms related to air compressors, IC engines, turbines and power plants.

MC405CO2: Explain the construction and working of air compressors, IC engines, turbines and power plants.

MC405CO3: Calculate the various performance parameters of an IC engine

MC405CO4: Distinguish between various prime movers and power plants.

4. Mapping Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
CO1	3	2	0	0	1	1	1	3	0
CO2	3	1	0	0	0	2	2	3	1
CO3	3	2	2	2	1	1	0	3	0
CO4	3	2	0	0	1	1	1	3	2

Relationship : Low-1 Medium-2 High-3

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	**Thr = Teaching hours**				
Unit			**M**	**Thr**	**CO**
1 Air Compressors			12	07	
1.1 Introduction and uses of compressed air					
1.2 Classification of air compressors					
1.3 Construction and working of reciprocating, centrifugal, axial flow and screw compressors					**CO1 CO2 CO4**
1.4 Definitions of Free Air Delivered, capacity of the compressor, piston displacement, Volumetric Efficiency					
1.5 Advantages of multistage compression					
1.6 Reciprocating compressed air motor					
2 Internal Combustion (IC) Engines			24	16	
2.1 Introduction and classification					
2.2 Engine terminology, Functions of engine parts viz Cylinder, Cylinder head, Piston, Piston rings, Valves, Crank shaft and Connecting rod.					
2.3 Cycle of operations – Otto and Diesel cycles, their P-V diagrams and thermal efficiencies					
2.4 Two-stroke and four-stroke engines, construction and working					**CO1 CO2 CO3 CO4**
2.5 Valve timing diagrams					
2.6 Differences between two-stroke and four-stroke, and between petrol and diesel engines.					
2.7 Schematic flow diagrams of cooling, lubrication and fuel systems; Introduction to MPFI, Turbocharging.					
2.8 Calculation of Brake Power, Indicated Power, various efficiencies and specific fuel consumption. Preparation of heat balance sheet of an IC engine.					
3 Steam Turbines (No Numerical)			12	07	
3.1 Steam nozzle – Function & types of nozzles					**CO1 CO2 CO4**
3.2 Steam Turbine - Classification of turbines, construction and working principle of impulse and reaction turbines.					

3.2 Compounding of steam turbines - Velocity compounding, Pressure compounding and Pressure-Velocity compounding.			
4 Energy Generation Through Power Plants Layouts, functions of different components and basic principle of operations of following power plants:	15	10	**CO1 CO2 CO4**
4.1 Thermal Power plant			
4.2 Hydro-electric Power Plant			
4.3 Nuclear Power Plant			
4.4 Gas Turbine Power Plant			
5 Introduction to Non-Conventional Energy Sources	12	08	
5.1 Solar Energy 5.1.1 Applications of Solar energy 5.1.2 Working of Solar energy-based equipment viz water heater, cooker, solar lighting and solar still.			**CO1 CO2 CO4**
5.2 Wind Energy 5.2.1 Basic principles of wind energy conversion. 5.2.2 Main considerations in selecting a site for wind mills. 5.2.3 Basic components of a Wind Energy Conversion system 5.2.4 Advantages and limitations of wind energy conversion.			
5.3 Energy from Biomass 5.3.1 Introduction 5.3.2 Biomass conversion technologies 5.3.3 Wet processes & Dry processes			
Total	**75**	**48**	

6. COURSE DELIVERY:

The Course will be delivered through lectures, classroom interactions, exercises and industrial visits.

7. SPECIFICATION TABLE FOR THEORY/ MACRO-LESSON PLAN

Unit No	Unit	Number of lectures	Marks

1	Air Compressors	07	12
2	Internal Combustion (IC) Engines	16	24
3	Steam Turbines (No Numerical)	07	12
4	Energy Generation Through Power Plants	10	15
5	Non-Conventional Energy Sources	08	12
	Total	**48**	**75**

8. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS.

No	**Practical (anyone from sr. no 4 to 6)**	**Marks**
1.	To demonstrate the construction and working of reciprocating, centrifugal and screw compressor.	05
2.	To dismantle and assemble a petrol engine or diesel engine	05
3.	To conduct a test on a petrol/diesel engine and determine its brake power,brake thermal efficiency and brake specific fuel consumption. Also, to prepare a heat balance sheet for any load.	05
4.	To demonstrate the construction and working of **any one** conventional power plant. (by making a visit to the plant)/video	05
5.	To demonstrate the construction and working of **any one** solar thermal equipment and **any one** solar photovoltaic equipment. (by making a visit to solar energy park)/video	05
6.	To demonstrate the construction and working of wind power plant or solar-wind hybrid power plant. (by making a visit to the plant)/video	05
7.	To demonstrate the construction and working of **any one** type of biogas plant. (video presentation)	05
	Total	25

9. LEARNING RESOURCES

Text Books

S. No.	Author	Title of Books	Publishers
1	Late R. C. Patel & C. J. Karamchandani	Elements of Heat Engines – Vol I and Vol II	Acharya Publications
2	M. L. Mathur & R. P. Sharma	Internal Combustion Engines	Dhanpat Rai & Co.
3	N. K. Mangal	Diesel Engine Mechanics	Tata McGraw Hill
4	Arora & Domkundwar	Power Plant Engineering	Dhanpat Rai & Co.
5	G. D. Rai	Non-conventional Energy Sources	Khanna publication
6	Dr. B. H. Khan	Non-conventional Energy Sources	Tata McGraw Hill
7	K. M. Mittal	Non-conventional Energy System Principles, Progress and Prospects	Wheeler Publishing

(MC 404) Fluid Machinery

1. COURSE OBJECTIVES:

The students will be able to acquire knowledge to apply the concept introduced in Fluid Machinery to engineering applications such as turbo machinery and flow measurement. Fluid machinery plays an important role in the conversion of hydraulic energy to mechanical energy and vice-versa. Hydraulic turbines are used for meeting our day-to-day power demands. Also, different types of pumps are essential equipment in all the industries. Hydraulic systems have a wide range of applications in machine tools, material handling, marine, mining, metal processing, equipment and other fields.

2. TEACHING AND EXAMINATION SCHEME

Semester	**IV**									
Course code & course title		**Periods/Week (in hours)**			**Total Hours**	**Examination Scheme**				
						Theory Marks		**Practical Marks**		**Total Marks**
(MC 404) Fluid Machinery		**L**	**T**	**P**	**H**	**TH**	**TM**	**TW**	**PR/OR**	
		03	**-**	**02**	**05**	**75**	**25**	**25**	**-**	**125**

3.COURSE OUTCOMES:

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

MC404CO1: Define various terms related to fluid mechanics & fluid machineries.

MC404CO2: Explain fluid properties, fluid pressure, fluid flow, water turbine, pumps, accumulator & intensifier.

MC404CO3: Apply laws and theorems on statics and dynamics to calculate various parameters of fluids, flowing through pipes and various devices.

MC404CO4: Classify fluids, fluid flow, water turbines & pumps.

4. Mapping Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
CO1	2	1	0	1	0	0	1	1	0
CO2	2	1	1	1	1	1	2	2	1
CO3	3	3	3	2	1	1	2	3	0
CO4	3	2	1	1	2	1	3	1	1

Relationship : Low-1 Medium-2 High-3

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	**Thr = Teaching hours**				
Unit			**M**	**Thr**	**CO**
1 Introduction to fluid mechanics and Pressure Measurement			**12**	**10**	
1.1 Definition and classification of fluids, Branches of hydraulic -Hydrostatics & Hydrodynamics					
1.2 Fluid properties Density, Specific gravity, specific weight - (Simple Numerical) Viscosity, surface tension, capillarity, compressibility (No Numerical)					
1.3 SI Units of Pressure, Pressure head, Atmospheric pressure, Positive and Negative Gauge pressure, Absolute pressure (Simple Numerical on pressure, pressure head and conversion to equivalent heads of other liquids)					**CO1 CO2 CO3 CO4**
1.4 Pascal's Law and its applications.					
1.5 Pressure measuring devices Manometers-principle & working of piezometer tube, simple 'U' tube, differential 'U' tube and inverted 'U' tube manometers (Simple Numerical)					
1.6 Bourdon pressure gauge-its working principle & constructions, Calibration of pressure gauges					
2 Hydrostatics			**12**	**06**	
2.1 Total pressure, Centre of Pressure					
2.2 Pressure on plane surfaces immersed in liquid – horizontally, vertically & inclined to free surface, calculation of total pressure and determination of position of centre of pressure for circular, triangular & rectangular surfaces immersed vertically and inclined in one type liquid. (Simple Numerical)					**CO1 CO2 CO3**
3 Hydrodynamics			**21**	**14**	
3.1 Types of flow - steady; unsteady, - uniform, non-uniform, laminar and turbulent flow, compressible, incompressible flow.					
3.2 Continuity equation, Energies of liquid - pressure head, Datum head, velocity head, Total energy of liquid, Bernoulli's theorem (Simple Numerical)					**CO1 CO2 CO3 CO4**
3.3 Application of Bernoulli's theorem: Pitot tube, Venturi-meter (Simple Numerical on Discharge through Horizontal Venturi-meter)					
3.4 Definition of orifice, types, Vena contracta, Hydraulic coefficients Cc, Cv and Cd, Discharge through a circular orifice. (Simple Numerical)					
3.5 Laws of fluid friction, Reynold's number and it significance, Various losses in pipe flow-major and minor losses- loss of head due to entrance, sudden enlargement, sudden contraction. (Simple numerical on loss of head due to friction, sudden expansion and contraction)					

3.6 Hydraulic gradient line, Total energy line (No numerical)			
3.7 Water hammer in pipes - causes, effect and remedial measures			
4 Water Turbines (No numerical in this unit)	**12**	**08**	
4.4 Water Turbines: Classification of water-turbines			**CO1 CO2 CO4**
4.5 Impulse turbines: Pelton Turbine-Construction and working			
4.6 Reaction Turbines: Francis Turbine- construction and working, Kaplan turbine – Construction and working			
4.7 Difference between Impulse turbine and Reaction Turbine			
4.8 Advantages and Disadvantages of Francis Turbine over a Pelton wheel			
5 Pumps, Accumulator and Intensifier (No numerical in this Unit)	**18**	**10**	
5.1 Centrifugal Pumps: Classification, construction & working, Types of casings, Types of impellers, Multistage centrifugal pumps, pumps in series, pumps in parallel, Priming, Cavitation, faults & remedies of centrifugal pumps. Definition of Static head, delivery head, manometric head, NPSH			**CO1 CO2 CO4**
5.2 Reciprocating pumps: Classification of reciprocating pumps, Construction and working of single acting reciprocating pump, Slip and negative slip, Air vessels, functions of air vessels.			
5.3 Difference between centrifugal pump and reciprocating pump.			
5.4 Construction, working and application of rotary vane pump, External Gear pumps			
5.5 Construction, working and application of Accumulator and Intensifier			
Total	**75**	**48**	

6. COURSE DELIVERY:

The Course will be delivered through lectures, class room interactions, exercises and case studies

7. SPECIFICATION TABLE FOR THEORY/ MACRO-LESSON PLAN

Unit No	**Unit**	**Number of lectures**	**Marks**
1	Introduction to fluid mechanics and Pressure Measurement	10	12
2	Hydrostatics	06	12
3	Hydrodynamics	14	21
4	Water Turbines	08	12

5	Pumps, Accumulator and Intensifier	10	18
	Total	48	75

8. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS.

No	Practical	Marks
1.	Measurement of pressure of water in a pipe by manometer	03
2.	Verification of Bernoulli's theorem	03
3.	Determination of coefficient of Discharge of Venturi meter	03
4.	To determine the relationship between loss of head and velocity for pipe flow	03
5.	Demonstrate the construction and operation of a Pelton Turbine	04
6.	Demonstrate the construction and operation of a Francis Turbine	03
7.	Demonstrate the construction and operation of a Centrifugal Pump	03
8.	Demonstrate the construction and operation of a Reciprocating Pump	03
	Total	25

9. LEARNING RESOURCES

Text Books

S. No.	Author	Title of Books	Publishers
1	R.K. Rajput	Fluid Mechanics and Hydraulic Machines	S. Chand Ltd
2	R.K. Bansal	Fluid Mechanics and Hydraulic Machines	Laximi Pvt. Ltd
3	R.S. Khurmi	A Text book of Hydraulics, Fluid Mechanics and Hydraulic Machines	S. Chand Ltd
4	P.N. Modi/S.M. Seth	Hydraulics and Fluid Mechanics including Hydraulic Machines	Rajsons Pvt. Ltd

(MC 406) Metrology and Quality Control

1. COURSE OBJECTIVES:

Metrology and Quality Control is concerned with application of measurements to manufacturing and other processes so that they can be suitably applied in industry to ensure quality product. As this subject form the basis for design of mechanical measurement systems, students will be acquire necessary knowledge and develop required abilities for performing the job effectively and efficiently.

2. TEACHING AND EXAMINATION SCHEME

Semester	IV								
Course code & course title		Periods/Week (in hours)			Total Hours	Examination Scheme			
						Theory Marks		Practical Marks		Total Marks
		L	T	P	H	TH	TM	TW	PR/OR	
(MC 406) Metrology and Quality Control		02	-	02	04	75	25	25	-	125

3. COURSE OUTCOMES:

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

MC406CO1: Define various terms of measurement in metrology & quality control.

MC406CO2: Explain the instruments of linear, angular measurement & quality control charts.

MC406CO3: Select appropriate instruments used for appraisal of product quality.

MC406CO4: Apply the concept of Metrology & Quality control for real time measurement.

4. Mapping Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2
CO1	2	1	2	1	0	1	2	1	2
CO2	2	2	2	2	1	2	3	1	2
CO3	3	3	3	3	1	2	3	2	3
CO4	3	3	3	3	1	2	3	2	3

Relationship : Low-1 Medium-2 High-3

5. DETAILED COURSE CONTENTS / MICRO-LESSON PLAN

M = Marks	Thr = Teaching hours	CO = Course Objectives			
Unit			**M**	**Thr**	**CO**
1 Introduction to metrology			**06**	**03**	
1.1 Definition of metrology, precision and accuracy.					**CO1**
1.2 Concept of Sensitivity, Readability, magnification, Repeatability, Reproducibility.					
1.3 Sources of errors.					
1.4 Calibration-Definition and need.					
2 (Standards & Measuring Instruments)			**12**	**06**	
2.1 Standards in measurement: Line standard and end standard List of Linear and angular measuring instruments. (No description)					**CO1 CO2**
2.2 Slip gauges, angle gauges, Sine bar. (numerical on angle gauges and slip gauges)					**CO3**
2.3 Autocollimator, Spirit Level, Clinometer.					**CO4**
3 Limits, Fits & Tolerances			**12**	**06**	
3.1 Types of Fits, Shaft & Hole basis system, Tolerances.					**CO1 CO2**
3.2Limit gauges. Taylor's principle.					**CO4**
3.3Types of GO and NO-GO gauges. Gauge tolerances					
3.4 Simple numerical on tolerances.					
4 Comparators and Testing			**15**	**07**	

4.1 Working Principle & comparison of Mechanical, pneumatic & Electrical-Electronic Comparators. Construction of Dial indicator, pneumatic & Electrical-Electronic comparator.			
4.2 Testing of straightness, flatness, parallelism, roundness & Surface finish.			**CO1 CO2 CO3 CO4**
4.3 Gear Terminology and errors in gears, screw thread terminology and errors in threads. List of instruments used to measure gear & screw threads parameters. (No description)			
5 Quality Control	**30**	**10**	
5.1 Concept of quality, Characteristics of Quality, Quality Assurance. Total Quality Management: Principles of T.Q.M: a) Customer focus b) Commitment by top management c) Continuous improvement-PDCA d) Quality circles.			
5.2 Statistical Quality Control: Control charts in S.Q.C, X-R chart, P-chart, (Steps in preparation and numerical example). Acceptance sampling: Single and Double sampling curve. Introduction to Six sigma.			**CO1 CO2 CO3 CO4**
5.3 Introduction to ISO 9000, Necessity and importance of I.S.O.			
Total	**75**	**32**	

6. COURSE DELIVERY:

The Course will be delivered through lectures, class room interactions, exercises and case studies

7. SPECIFICATION TABLE FOR THEORY/ MACRO-LESSON PLAN

Unit No	Unit	Number of lectures	Marks
1	Introduction to metrology	3	6
2	Linear and Angular Measurements	6	15
3	Limits, Fits & Tolerances	6	15
4	Comparators and Testing	7	15
5	Quality Control	10	24
	Total	32	75

8. SPECIFICATION TABLE FOR TERM WORK & PRACTICALS.

No	Practical	Marks
	Practical Title	
1	Use of basic measuring instruments. Surface plate, v-block, sprit level, angle gauges, filler gauge, screw pitch gauge, radius gauge, Vernier calliper, micrometre, Universal bevel protractor and slip gauges to measure dimension of given jobs.	
2	Use of Dial indicator to measure as a comparator to compare the given work piece with a standard specimen.	
3	Use of Sine-Bars to measure angle.	
4	Study on Calibration of Vernier caliper	
5	Measurement of different Parameters of Gear.	
6	Measurement of different Parameters of screw thread	
7	Demonstration of optical flats using monochromatic light source.	
8	Demonstration of Tool Maker's microscope/Profile projector.	
9	To draw and interpret the control limit for variable measurement (X, R and P Chart).	
	Total	25

9. LEARNING RESOURCES

9.1Text Books

S. No.	Author	Title of Books	Publishers
1	R. K. Jain	Engineering metrology	Khanna Publisher, Delhi.
2	J.F.W. Galyer and C. R. Shotbolt	Metrology for Engineers	ELBS
3	K. J. Hume	Engineering Metrology	Kalyani publishers
4	I.C. Gupta	A text book of Engineering metrology	DhanpatRai and Sons,
5	M. Adithan and R. Bahn	Metrology Lab. Manual	T.T.T.I. Chandigarh.

9.2 Reference Books for further study

S. No.	Author	Title of Books	Publishers
6	M. Mahajan	Statistical Quality Control	DhanpatRai and Sons ,
7	T.T.T.I. Chennai	Quality control	Tata McGraw Hill,
8	Juran U.M. and Gryna	Quality planning and analysis	Tata McGraw Hill,
9	National productivity council	Inspection and quality control	N.P.C., New Delhi.
10	Metrology and Precision Engineering	A.J.T.Scarr	Tata McGraw Hill

9.3 Indian and International codes needed

S. No.	Author	Title of Books	Publishers
1	IS919-1993	Recommendation for limits. Fits and tolerances.	B.I.S
2	IS2029-1962	Dial Gauges	B.I.S
3	IS2984-1966	Slip Gauges	B.I.S
4	IS4218	Isometric Screw Threads	B.I.S
5	IS5359-1969	Sine Bars	B.I.S

9.4 Internet and Web Resources

S. No.	Author	Title of Books	Publishers
1	AmmarGrouss	Applied Metrology for Manufacturing Engineering	Wiley
2	G.M.S de Silva	Basic Metrology for ISO9000 Certification	Butterworth-Heinemann

9.5 Videos and Multimedia Tutorials

S. No.	Author	Title of Books	Publishers
1	www.nptel.iitm.ac.in	Lectures in Metrology	
2			