A) Course Code : 2037371(025)
B) Course Title : Basic Electrical and Electronics Engineering
C) Pre- requisite Course Code and Title :
D) Rationale :

Engineering diploma holders many times have to deal with electrical systems, Electrical & Electronics devices, Electrical equipment and machines in industrial environment. The laboratory course fundamentally aims at familiarizing the students with various electrical circuits, electrical machines, semiconductor devices, components, display devices and their specific application in switching, rectification, clipping, clamping etc. This course also enable the students to apply the basic principle of electrical & electronics components and devices and their applications in electrical and electronics systems.

E) Course Outcomes:

CO-1 Measure various parameters of DC circuits, single and three phase AC circuits.

CO-2 Analyze the working of Transformers, DC and AC Machines.

CO-3 Use diodes in various electronic circuits.

CO-4 Analyze the working of BJT, JFET and MOSFET in various electronic circuits.

CO-5 Use basic test and measuring instruments.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(c) (L+T+P/2)
1	Electrical and Electronics Engineering	2037371(025)	Basic Electrical and Electronics Engineering	2	-	1	3
2	Electrical and Electronics Engineering	2037361(025)	Basic Electrical and Electronics Engineering(Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work (SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL have to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Electrical and Electronics Engineering	2037371(025)	Basic Electrical and Electronics Engineering	70	20	30	-	-	120
2.	Electrical and Electronics Engineering	2037361(025)	Basic Electrical and Electronics Engineering (Lab)	-	-	-	30	50	80

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam(Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Measure various parameters of DC circuits, single and three phase AC circuits.

(Approx. Hrs: L+P+T = 17)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Identify the voltages of generation, transmission and distribution SO1.2 Measure Voltage, current, power, impedance and power factor in R-L-C Circuits. SO1.3 Differentiate between line and phase values of current and voltage in star/delta circuits. SO1.4 Measure Power in three phase circuits.	LE1.1 Measure Voltages, current, power and power factor in a RLC series circuit. LE1.2 Measure three phase power using two and three wattmeter methods.	**Unit 1.0 DC & AC Circuits** 1.1 DC Circuits Concept of charge, potential difference and current, Kirchhoff's Current and Voltage Law (KCL & KVL), Series and Parallel circuits 1.2 AC Fundamentals Phase Difference, Power Factor-Unity, Lag and lead, RMS Value, Average Value and Form Factor. 1.3 AC Circuits RLC Circuits, Impedance, admittance, Power and Phasor Representation. 1.4 Polyphase circuits Basic Concepts of Three Phase Generation, phase sequence Line, Phase values of voltages and currents and their Relationship in three phase AC circuits. Star and Delta configuration (Balanced load only)	• Differentiate between generation, transmission and distribution voltages • Measure and Observe the Line and Phase values of Voltage and Current in your institute. • Differentiate the value of power factor under different loading conditions

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Select any electric circuit and apply relevant basic laws/theorems to determine voltage and currents.

ii. Collect the electricity bills of at least 5 months of any HT consumer and analyse the status of power factor in the bills

b. Mini Project:

i. Connect three choke in series and 40 watt lamp in series with a switch across a single phase ac supply. Analyze the effect of switching action and comment.
ii. Compare a conventional choke with a electronic choke in terms on construction and working

c. Other Activities (Specify):

i. Seminar on Electrical circuits(DC & Ac)
ii. Seminar on Polyphase circuits

CO-2 Analyze the working of Transformers, DC and AC Machines

(Approx. Hrs: L+P+T = 17)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Describe construction and working principle of transformer. SO2.2 Describe construction and working principle of DC Generator and DC Motor. SO2.3 Describe construction and working principle of three phase and single phase induction SO2.4 Describe construction and working principle of three phase Synchronous machine(Generator and motor) SO2.5 Differentiate between salient and non salient pole rotor construction and its applications	LE2.1 Measure voltage transformation ratio of a single phase transformer. LE2.2 Identify the different parts of a DC machine using cut section model. LE2.3 Measure and plot the terminal voltage with respect to field excitation for a DC generator. LE2.4 Measure the speed of a DC motor and plot a graph with respect to Load Current LE2.5 Measure the slip of three phase squirrel cage induction motor under varying load. LE2.6 Make connection of starting and running winding and run a single phase induction motor.	**Unit 2.0 Transformer & electrical Machines :** (strictly restricted to construction, working principle and emf equation only) 2.1 Transformer – Construction, working principle, Transformation ratio, EMF equation. 2.2 DC Machines – Construction DC Generator- Types, Working principle. EMF Equation. DC Motors- Types, Working principle, EMF Equation, Back emf, Torque 2.3 Three Phase and single phase Induction Motor Construction, working principle. Slip, Torque-Speed characteristics. Single phase induction motor Operating principle and classification. 2.4 Three Phase Synchronous machine - Construction, Rotor construction-Salient and non salient, working principle of Synchronous generator and motor and applications	• Identify types of transformers based on construction, mode of operation and cooling methods • Identify the Parts of DC machine and compare relative resistances of series, shunt field and armature windings • Compare 3 phase with single phase induction motor in terms of size, cost efficiency and pf. • Prepare a report on machines used in industries power plants and commercial purpose

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart highlighting the constructional differences between core and shell type transformer.
ii. Prepare a chart showing the cross sectional view of a DC machine. Identify various parts of a DC machine and also materials used.
iii. Prepare a chart to highlight the difference in rotor construction in Salient and Non-salient type synchronous machine. Label the parts

b. Mini Project:

i. Locate the position, working of electrical motors in domestic appliances. Write down their specification and submit the report
ii. Change the direction of a given 3 phase induction motor by changing the phase sequence

c. Other Activities (Specify):

i. Seminar on Electrical Machines used in domestic appliances
ii. Seminar on Electrical Machines used in industries and power plants

CO-3 Use diodes in various electronic circuits. (Approx. Hrs: L+P+T = 17)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Demonstrate PN junction and solve basic problems of diode SO3.2 Explain the need of rectification in the electronic circuit. SO3.3 Compare different types of rectifiers. SO3.4 Describe the working of Zener diode as a voltage regulator.	LE3.1 Test the performance of PN junction diode and Zener diode. LE3.2 Measure the output voltage of the given Shunt Regulator consists of Zener Diode. LE3.3 Test the Performance of Half Wave & Full Wave Rectifier. LE3.4 Test the Performance of Bridge Rectifier.	**Unit-3.0 Diode and its Applications** 3.1 Introduction of PN junction diode, equivalent circuits of PN junction diode 3.2 V-I characteristics of diode, forward and reverse biased 3.3 Diode current equation 3.4 Need of rectification, Types of rectifiers(half wave and full wave) 3.5 Zener Diode, equivalent circuits of 3.6 Zener diode, Zener diode as a voltage regulator	• Diode applications: Clipper (positive and negative) and Clamper (positive and negative) circuit. • Circuit for Zener diode as 5.0 volts voltage regulator. • Differentiate between PN-diode and Zener Diode.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Prepare a chart to compare the characteristics curve of Si and Ge diode.
ii. Write a note on the construction of Zener diode.

b. Mini Project:

i. Build a bridge rectifier using four diodes, step-down transformer and filter for the 6V.
ii. Make a 6.0 Volts voltage regulator using Zener diode.

c. Other Activities (Specify):

i. Conduct a market survey and prepare the specification of various diodes available in the local market.

CO-4 Analyze the working of BJT, JFET and MOSFET in various electronic circuits.

(Approx. Hrs: L+P+T = 14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Describe the construction and operation of BJT. SO4.2 Explain how transistor work as a switch and amplifier. SO4.3 Explain the need of Biasing and identify different biasing circuits SO4.4 Explain the basic parameter of JFET. SO4.5 Describe the working of the MOSFET.	LE4.1 Obtain the input and output transistor characteristics for CB configuration. LE4.2 Obtain the input & output transistor characteristics for CE configuration. LE4.3 Obtain the input & output transistor characteristics for CC configuration. LE4.4 Verify the operation of BJT and FET as a switch.	**Unit-4.0 BJT, FET and MOSFET** 4.1 Introduction of BJT, types of BJT, construction and operation of NPN and PNP transistor 4.2 Need of transistor biasing Input and output characteristics of all configurations(CE, CB and CC) of transistor 4.3 Transistor's Applications:- Transistor as an amplifier, transistor as a switch 4.4 Introduction of FET, classification of FET types of JFET, construction and operation of N-channel and P-channel JFET 4.5 MOSFET, Construction and operation of depletion type MOSFET, Construction and operation of enhancement type MOSFFET	• Compare construction and working of BJT and FET • List the advantages of FET over BJT

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. Compare construction of BJT and FET.
ii. Prepare a report on the application of MOSFETs

b. Mini Project:

i. Make an amplifier using BJT.
ii. Make an amplifier using FET.

c. Other Activities (Specify):

i. Seminar on working of MOSFET
ii. Prepare a chart to show the construction of FET and MOSFET

iii. Prepare a chart to show the symbolic representation of electronic components

CO-5 Use basic test and measuring instruments. (Approx. Hrs: L+P+T = 15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Describe the steps to measure Voltage and current using Voltmeter, Ammeter and multimeter (Analog and digital) SO5.2 Describe the functions of the function generator SO5.3 Describe operation of CRO SO5.4 Explain the principle of operation of a CRT used in CRO. SO5.5 Explain fundamentals difference between LED and LCD display techniques.	LE5.1 Use analog Ammeter, Voltmeter and multimeter to measure voltage and current in the given circuit. LE5.2 Use Digital multimeter to measure Voltage and current for the given circuit LE5.3 Measure Voltage and frequency of the given signal using CRO. LE5.4 Use function generator to generate sine and square wave and verify the frequency of that signal using CRO.	**Unit-5.0 Test and Measuring Instruments:** 5.1 Multimeter (Analog and Digital multimeter), working of multimeter 5.2 Function Generator (frequency generator), working . 5.3 CRO: Block diagram of CRO, constructional features of CRT, principle of operation, working of various blocks of CRO, Features of dual trace oscilloscopes. 5.4 Block schematic description of digital storage oscilloscope 5.5 Fundamentals of LED and LCD display techniques	• Explain the various controls of CRO. • Explain the functions of front panel of Function generator.

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart representing the block diagram of CRO.
ii. Prepare the front panel controls diagram of Function generator.

b. Mini Project:

i. Control the intensity of LED display using a potentiometer.
ii. Prepare a list of CRO,DSO manufacturing companies and the basic specification.

c. Other Activities (Specify):

i. Seminar on electronic display devices
ii. Seminar on application of CRO

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	DC & AC Circuits	3	6	3	12
II	Transformer & Electrical Machines	4	6	6	16
III	Diode and it's Applications	4	6	4	14
IV	BJT, FET and MOSFET	4	6	6	16
V	Test and Measuring Instruments	4	3	5	12
Total		**19**	**27**	**24**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Measure Voltages, current, power and power factor in a RLC series circuit	15	10	5
LE1.2	Measure three phase power using two and three wattmeter methods.	15	10	5
LE2.1	Measure voltage transformation ratio of a single phase transformer	15	10	5
LE2.2	Identify the different parts of a DC machine using cut section model.	15	10	5
LE2.3	Measure and plot the terminal voltage with respect to field excitation for a DC generator.	15	10	5
LE2.4	Measure and plot speed of a DC motor with respect to Load Current	15	10	5
LE2.5	Measure the slip of three phase squirrel cage induction motor under varying load.	15	10	5
LE2.6	Make connection of starting and running winding and run a single phase induction motor.	15	10	5
LE3.1	Test the performance of PN Junction diode and Zener diode.	15	10	5
LE3.2	Measure the output voltage of the given Shunt Regulator consist of Zener Diode.	15	10	5
LE3.3	Test the Performance of Half Wave & Full Wave Rectifier.	15	10	5
LE3.4	Test the Performance of Bridge Rectifier.	15	10	5
LE4.1	Obtain the input and output transistor characteristics for CB configuration	15	10	5
LE4.2	Obtain the input & output transistor characteristics for CE configuration	15	10	5
LE4.3	Obtain the input & output transistor characteristics for CC configuration.	15	10	5
LE4.4	Verify the operation of BJT and FET as a switch.	15	10	5

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE5.1	Use analog multimeter to measure voltage and current in the given circuit.	15	10	5
LE5.2	Use Digital multimeter to measure Voltage and current for the given circuit	15	10	5
LE5.3	Measure Voltage and frequency of the given signal using CRO.	15	10	5

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	A Textbook of Electrical Technology	Theraja B.L. & Theraja A.K, Volume I & II	A.K., Chand and Co. New Delhi	Latest edition
2.	Basic Electrical Engineering	Mittle V.N.	Tata McGraw-Hill, New Delhi	Latest edition
3.	Principles of Electrical Engineering and Electronics	V.K.Mehta and Rohit Mehta	S. Chand & Co. Ltd.	Latest edition
4.	Principles of Electrical engineering	Del Toro, Vincent,	Prentice Hall of India, New Delhi	Latest edition
5.	Electrical Machines	Bhattacharya, S.K.	Tata McGraw-Hill, New Delhi	Latest edition
6.	Principles of Electronics	Mehta ,V.K.	S. Chand & Co. Ltd.	Latest edition
7.	Electronic Devices and Circuits	Godse, A.P.	Technical publications	Latest edition

S. No.	Titles	Author	Publisher	Edition & Year
8.	Electronic Devices & circuits	Mithal, G.K.,	Khanna Publishers; New Delhi	Latest edition
9.	A Course in Electrical and Electronic Measurement and Instrumentation	A.K. Sawney	Dhanpat Rai and Company	Latest edition

(b) Open source software and website address:

1. DC & AC Circuits:- https://www.youtube.com/watch?v=BcIDRet787k
2. Electrical Machines:- http://www.eeeuniversity.com/2013/07/animation-of-electric-machines.html
3. Transformer:-https://www.youtube.com/watch?v=vh_aCAHThTQ
4. AC /DC Motor and Generator:-https://www.youtube.com/watch?v=4texz0Gn7cw
5. DC Motor & Generator :-https://www.youtube.com/watch?v=LAtPHANEfQo
6. Multimeter:-https://www.youtube.com/watch?v=TdUK6RPdIrA
7. Multimeter:-https://www.electronics-notes.com/articles/test-methods/meters/digital-multimeter-dmm-tutorial.php

(c) Others:

1. Electric Machinery and Transformers, Irving L. Kosovo, Prentice Hall of India, New Delhi
2. Electronic Principles by Malvino, Tata McGraw Hill; New Delhi
3. Integrated Electronics by Millian & Halikias.

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1.	Ammeter	MI - 0-5/10/20 A, MC - 0-2/5/10A	LE1.1 to LE2.6
2.	Voltmeter	MI - 0-150/300/600V MC- 150/220V or equivalent	LE1.1 to LE2.6
3.	Autotransformer	230V - 0-260V,4A single phase 230V - 0-260V,8A single phase 415V - 0-460V,15A three phase	LE1.1 to LE2.6
4.	Wattmeter	0-2.5/5A, 0-150/300V 0-5/10A, 0-150/300V	LE1.1 to LE2.6
5.	Tachometer	0-10000 RPM	LE2.3 to LE2.6
6.	Multimeter	Component testing, voltage and current measurement knob	LE3.1 to LE5.3
7.	CRO/DSO	100 MHz, dual trace, component tester, dual beam	LE3.1 to LE5.3
8.	Function Generator	1-10 MHz frequency range	LE3.1 to LE5.3
9.	Dual Power Supply	+-5V, +-12V, +-15V	LE3.1 to LE5.3

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Measure various parameters of DC circuits, single and three phase AC circuits.	3	1	2	2	1	1	1	2	1	2	2	-
CO-2 Analyze the working of Transformers, DC and AC Machines	2	1	1	1	1	1	1	2	-	1	1	-
CO-3 Use diodes in various electronic circuits.	1	1	3	2	-	-	1	1	1	1	1	-
CO-4 Analyze the working of BJT, JFET and MOSFET in various electronic circuits.	1	1	1	1	-	-	1	1	1	1	1	1
CO-5 Use basic test and measuring instruments.	2	1	2	1	1	1	1	1	1	1	1	-

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Title	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1	CO-1 Measure various parameters of DC circuits, single and three phase AC circuits.	SO1.1 SO1.2 SO1.3 SO1.4	LE1.1 LE1.2	Unit-1.0 DC & AC Circuits 1.1, 1.2, 1.3, 1.4	As mentioned in relevant page numbers.
PO-1,2,3,4,5, 6,7,8,10 PSO-1	CO-2 Analyze the working of Transformers, DC and AC Machines	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	LE2.1 LE2.2 LE2.3 LE2.4 LE2.5 LE2.6	Unit-2.0 Transformer & electrical Machines 2.1, 2.2, 2.3, 2.4	
PO-1,2,3,4, 7,8,9,10 PSO-1	CO-3 Use diodes in various electronic circuits.	SO3.1 SO3.2 SO3.3 SO3.4	LE3.1 LE3.2 LE3.3 LE3.4	Unit-3.0 Diode and it's Applications 3.1, 3.2, 3.3, 3.4, 3.5, 3.6	
PO-1,2,3,4, 7,8,9,10 PSO-1,2	CO-4 Analyze the working of BJT, JFET and MOSFET in various electronic circuits.	SO4.1 SO4.2 SO4.3	LE4.1 LE4.2 LE4.3 LE4.4 LE4.5	Unit-4.0 BJT, FET and MOSFET 4.1, 4.2, 4.3, 4.4, 4.5	
.PO-1,2,3,4,5,6, 7,8,9,10 PSO-1	CO-5 Use basic test and measuring instruments.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	LE5.1 LE5.2 LE5.3 LE5.4	Unit-5.0 Test and Measuring Instruments 5.1, 5.2, 5.3, 5.4, 5.5	

A) Course Code : 2037372(037)

B) Course Title : Strength of Materials

C) Pre- requisite Course Code and Title :

D) Rationale :

The external effects due to action of force system have already been studied in Applied Mechanics in previous Semester. All Mechanical Engineering Components and members are subjected to different loading conditions resulting into different types of stresses accordingly. In this course, estimation of induced stresses, strains and strain energy of determinate structures/components under action of these transverse, axial, thermal and shear loading along with bending and torsion moment are performed. Moreover, this course will lay sound foundation for analysis and design of Machine Components going to be discussed in latter semesters.

E) Course Outcomes:

CO-1 Estimate direct stresses and strains in machine members/components.

CO-2 Determine bending moment and shear force values in different types of beams/components subjected to transverse loading.

CO-3 Calculate bending stresses and shear stresses in different types of beams/components subjected to transverse loading.

CO-4 Calculate slope and deflection in cantilever and simply supported beams/components subjected to transverse loading.

CO-5 Select Springs for given situations based on stiffness and deflection.

CO-6 Calculate principal stress and strain in machine members subjected to multi-load situations.

CO-7 Determine buckling load in Columns and Struts type high slenderness ration components.

CO-8 Estimate shear stresses in shafts subjected to twisting moment.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits (C) L+T+(P/2)
1	Mechanical Engineering	2037372(037)	Strength of Materials	2	-	1	3
2	Mechanical Engineering	2037362(037)	Strength of Materials (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW and SL have to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037372(037)	Strength of Materials	70	20	30	-	-	120
2.	Mechanical Engineering	2037362(037)	Strength of Materials (Lab)	-	-	-	30	50	80

Note i: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam(Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Estimate direct stresses and strains in machine members/components.

(Approx. Hrs: L+P+T = 06)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Identify various types of loadings in the given machine component with justification. SO1.2 Select suitable elastic moduli in the given problem with justification. SO1.3 Evaluate behavior of the given material subjected to static longitudinal, lateral Loads and thermal variation. SO1.4 Estimate direct stresses and strains in the given Composite and Compound Sections. SO1.5 Compute Strain Energy under the	LE1.1 Perform Tension Test on mild steel/ Aluminium on Universal Testing machine as per IS432 (I) LE1.2 Perform Compression test on cast iron on Universal Testing Machine as per IS 14858. LE1.3 Plot Stress-Strain Curve for ductile materials like Mild Steel , Aluminum under tensile loading as per IS 1608. LE1.4 Perform direct Shear Test on mild steel using Universal Testing Machine as per IS 5242. LE1.5 Determine Young's Modulus of Elasticity of different materials. LE1.6 Calculate Impact Value of Mild Steel using IZOD Impact Test Apparatus. LE1.7 Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting	**Unit-1.0 Direct Stresses and Strains in components** 1.1 Different types of Structures and Loads. 1.2 Direct Stress, linear Strain, Hook's Law Calculation of Direct Stress and Linear Strain, Stress- Strain curve of Mild Steel, Modulus of Elasticity, Yield, Breaking and Ultimate Stress and factor of Safety. 1.3 Lateral Strain and Poisson's ratio. 1.4 Temperature Stresses and Strain with and without yielding. 1.5 Shear Stress, Shear Strain and Shear Modulus. 1.6 Bulk Modulus and Volumetric Strain 1.7 Differentiate Sudden, Gradual and Impact Load, Strain Energy and Proof Resilience	• Comparison between static and dynamic loads on machine elements.

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
given types of loading on the given member.	Charpy Impact test as per IS 1598.	for Sudden, Gradual and Impact Load with numerical problems.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Identify different loads and their effects in various domestic and industrial components. Prepare a list of the same.
ii. Solve numerical problems related to direct stresses and strains.
iii. Identify at least five impact and sudden loadings situations in day to day life and prepare a list.
iv. Collect specification of Universal Testing Machine (UTM) in your lab and explain the function of each part.
v. List out different types of test that can be performed on a UTM.

b. Mini Project:

i. Prepare a model showing the effects of thermal stresses on beams.

c. Other Activities (Specify):

i. Visit a nearby industry/workshop to identify the various failures in machine components due to direct stresses.

CO-2 Determine bending moment and shear force values in different types of beams/ components subjected to transverse loading.

(Approx. Hrs: L+P+T = 07)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Draw Shear Force and Bending Moment Diagram for the given Statically Determinate Beam. SO2.2 Identify location of point of contra flexure in the given situation with justification.	LE2.1 Estimate Maximum Bending moment and shear force for simply supported and cantilever beam under point load and UDL using Combined Shear Force and Bending Moment apparatus	**Unit-2.0 Shear Force and Bending Moments in Beam type components** 2.1 Statically Determinate Beams like Cantilever, Simply Supported and Over Hang Beam. 2.2 Relation between Shear Force and Bending Moment. 2.3 Sagging and Hogging Bending Moment and its importance. 2.4 Point of Contra flexure and its importance. 2.5 S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beam. 2.6 Components like shaft, axle and spindle	• SF and BM variations in few standard machine components.

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		subjected to Point Load and/ or Uniformly Distributed Load (UDL).	

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a list of machine components subjected to lateral loads and identify end conditions and type of loading.

ii. Solve numerical problems related to S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams type components.

b. Micro Project:

i. Prepare a model of wood and acrylic showing various beams and their supports.

c. Other Activities (Specify):

i. Prepare a chart to show SF and BM diagrams and its max values for various loading conditions in simply supported beams.

ii. Prepare a chart to show SF and BM diagrams for various loading conditions in cantilever beam.

CO- 3 Calculate bending stresses and shear stresses in different types of beams/components subjected to transverse loading.

(Approx. Hrs: L+P+T = 10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Identify machine components subjected to lateral and axial eccentric loads with justification. SO3.2 Calculate bending stress in the given situation. SO3.3 Calculate resultant stress and draw resultant stress variation diagram for the given axial eccentric situation. SO3.4 Calculate Shear stress in given situation	LE3.1 Measure flexural rigidity (EI) for a given beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	**Unit-3.0 Bending stresses and shear stresses in beam type components** 3.1 Bending Theory Equation Bending stress , Sectional Modulus 3.2 Neutral Axis, application of Bending theory to Statically determinate beams elements like shaft, axle, spindle , pulley arm having rectangular or circular section to find out stresses. 3.3 Structural components subjected to Axial Eccentric Loads. 3.4 Shear stress-Average and Maximum shear stress for	• Analyse Structural components subjected to Axial Eccentric Loads. • Beams of varying cross section • Beams of uniform strength

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		rectangular,circular section.	

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Locate the neutral axis for beams of different cross sections under bending loads.
ii. Solve numerical problems related to bending stresses in machine component loaded with transverse loads.

b. Micro Project:

i. Identify different parts subjected to bending stresses in a lathe/shaper/planer machines in a mechanical workshop and compare them with the standard beams and the loadings. Prepare a report on the same.

CO-4 Calculate slope and deflection in cantilever and simply supported beams subjected to transverse loading.

(Approx. Hrs: **L+P+T = 12**)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Determine deflection and slope in a given Statically determinate Beam mentioned in 4.2 and 4.3.	LE4.1 Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	**Unit-4.0 Deflection of beam type components** 4.1 Slope and Deflection. 4.2 Deflection Formulae for Cantilever Beam subjected to Point Load at free end and with full UDL. 4.3 Formulae for Simply supported Beam subjected to Point Load at Mid Span and with full UDL.	• Deflection of beams subjected to Point load at any point in beam

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart for maximum deflections in Simply Supported and Cantilever beams.
ii. Solve problems related to deflection of components under transverse loading.

b. Micro Project:

i. Prepare a working model to measure deflection in digital form using sensors/potentiometer/transducers of a cantilever beam with facility to vary the position of a point load.

c. Other Activities (Specify):

i. Prepare a list of machine components where deflection is desirable and non desirable for the functioning.
ii. Perform internet search to prepare a list of software used to draw and estimate shear force, bending moment and deflection of beams.

CO-5 Select Springs for given situation based on stiffness and deflection.

(Approx. Hrs: L+P+T = 10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Estimate strain energy for the given spring and axially loaded member. SO5.2 Select a spring based on the given situation with justification. SO5.3 Calculate Stiffness, deflection and maximum stress in the given spring.	LE5.1 Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring' apparatus.	**Unit-5.0 Springs** 5.1 Definition, types and use of springs. 5.2 Spring classification based on size, shape and load- leaf spring, helical and spiral spring. 5.3 Stiffness, deflection and maximum stress in helical open and closed coil springs and leaf springs.	• Spiral springs

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Observe domestic and industrial appliances and prepare a report on the applications of different type of springs.
ii. Justify the selection of helical springs for railway carriages.

b. Micro Project:

i. Visit to automobile service center and tabulate the usage pattern of helical/leaf spring in various automotives Cars/Trucks/Buses.

c. Other Activities (Specify):

i. Collect 5 samples of scrap springs of different sizes and types individually and fix them collectively on a single board with labels.

CO-6 Calculate principal stress and strain in machine members subjected to multi-load situation.

(Approx. Hrs: L+P+T = 15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.1 Identify multi-load situations with justifications.	LE6.1 Measure principal stresses and strains in a beam made of aluminum and	**Unit-6.0 Principal Stresses and Strains** 6.1 Multi load situations and need of	• Stresses induced in a beam due to complex

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.2 Estimate principal stresses and maximum shear stress for a given combined loading by analytical Approach. SO6.3 Estimate principal stresses and maximum shear stress for a given combined loading by Mohr's circle method.	loaded as a cantilever, and compare them with theoretical values using 'Principal stress and strain. Apparatus.	estimating principal stresses. 6.2 Definition of principal plane and principal stresses. 6.3 Expression for normal and tangential stress, maximum shear stress. 6.4 Stresses on inclined planes. 6.5 Position of principal planes and planes of maximum shear. 6.6 Graphical solution using Mohr's circle of Stresses.	loadings.

SW-6 Suggested Sessional Work (SW) :

a. Assignments:

i. List the formula for finding the principal stresses and maximum shear stresses for various 2D stress state loadings.

b. Mini Project:

i. Estimate maximum principal stress and maximum shear stress in the rod used to hang the ceiling fan of the class room. (Hint the rod is subjected to dead weight of the fan and torque both)

CO-7 Determine buckling load in Columns and Struts type high slenderness ration components.

(Approx. Hrs: L+P+T = 10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO7.1 Identify the machine components that can be treated as columns/ struts with justification. SO7.2 Determine the Euler's Crippling Load for column for the given loading situation. SO7.3 Determine Rankin's load / Buckling Load of Column for the	LE7.1 Measure the buckling load of three different slenderness ratio long columns of same lengths using 'Behaviour of column and struts' apparatus.	**Unit-7.0 Buckling stresses in Columns and Struts type components** 7.1 Column and Strut 7.2 Short and Long Column. 7.3 End Condition of Column 7.4 Effective Length of Column. and Modes of Failure in column. 7.5 Radius of Gyration , Slenderness Ratio.	• Buckling/Crippling of beams

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
given loading situation.		7.6 Euler's Crippling Load and its application. 7.7 Rankin's load / Buckling Load and its application in screw of screw jack.	

SW-7 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a list of machine components that can be considered as column and struts and also mention about their end conditions.

ii. Draw graph between slenderness ration and induced stress of a mild steel column and identify the limit up to which the Euler's formula is valid.

b. Micro Project:

i. Prepare a model of acrylic column and make provision for all four types of end conditions. Try to predict the equivalent length from it.

CO-8 Estimate shear stresses in shafts subjected to twisting moment.

(Approx. Hrs: L+P+T = 10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO8.1 Calculate the power transmitted by the given solid and hollow shafts. SO8.2 Calculate angle of twist and shear train in given solid shaft.	LE8.1 Perform the torsion test on MS wire/ Rod using 'Torsion of Bar' apparatus. LE8.2 Determine modulus of rigidity by conducting Torsion Test on MS (Part I) as per IS 1717	**Unit-8.0 Torsion of Shaft** 8.1 Torsion, Angle of Twist, Polar Moment of Inertia, Torsional Rigidity. 8.2 Formula of Torsional Stress. 8.3 Formula for Power Transmitted /Consumed for shaft, spindle and axle of solid and hollow sections subjected to Torsion.	• Compound Shafts

SW-8 Suggested Sessional Work (SW) :

a. Assignments:

i. Compare torsional rigidity for shafts of same length, diameters but different material.

b. Micro Project:

i. Survey the nearby domestic industries (minimum 05 industries) and list the various power transmission devices with their technical specification and use and give justification for

selecting the drive, also state the problems aroused during the use and their remedial measures taken. .

c. Other Activities (Specify):

i. Collect data of three shafts of three different electric motors available in your college like length, diameter and material. Note down the power and speed of the motor and comment on the shaft diameters used.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction) :

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Direct Stress and Strain in components	2	2	4	08
II	Shear Force and Bending Moments in Beam type components	2	2	8	12
III	Bending Stresse and shear stresses In Beam type components	1	2	5	08
IV	Deflection of beam type components	1	2	5	08
V	Springs	1	2	5	08
VI	Principal Stresses and Strains	2	2	6	10
VII	Buckling stresses in Columns and Struts type components	1	2	5	08
VIII	Torsion of Shafts	1	2	5	08
Total		**11**	**16**	**43**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Perform Tension Test on mild steel/ Aluminum on Universal Testing machine as per IS432 (I)	15	10	5
LE1.2	Perform Compression test on cast iron on Universal Testing Machine as per IS 14858	15	10	5
LE1.3	Plot Stress-Strain Curve for ductile materials like Mild Steel, Aluminum under tensile loading as per IS 1608.	15	10	5
LE1.4	Perform direct Shear Test on mild steel using Universal Testing Machine as per IS 5242	15	10	5
LE1.5	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	15	10	5
LE1.6	Calculate Impact Value/toughness of Mild Steel using IZOD Impact Test Apparatus as per IS 1757.	15	10	5
LE1.7	Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1598	15	10	5
LE2.1	Estimate Maximum Bending moment and shear force for simply supported and cantilever beam under point load and UDL using Combined Shear Force and Bending Moment apparatus.	15	10	5

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE 3.1	Measure flexural rigidity (EI) for a given beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	15	10	5
LE4.1	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	15	10	5
LE5.1	Measure Stiffness and deflection of given Spring and Modulus of Rigidity of the Spring wire using 'Extension and compression of Spring' apparatus.	15	10	5
LE6.1	Measure principal stresses and strains in a beam made of aluminum and loaded as a cantilever, and compare them with theoretical values using 'Principal stress and strain. Apparatus.	15	10	5
LE7.1	Measure the buckling load of three different slenderness ratio long columns of same lengths using 'Behaviour of column and struts' apparatus.	15	10	5
LE8.1	Perform the torsion test on MS wire/ Rod using 'Torsion of Bar' apparatus.	15	10	5
LE8.2	Determine modulus of rigidity by conducting Torsion Test on MS (Part I) as per IS 1717	15	10	5

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals ,

Legend: PRA: Process Assessment, PDA : Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher and Edition*
1	Strength of Material and Mechanics of Structures	Dr. B C Punamia	Laxmi Publications (p) Ltd. New Delhi, 10/e, 2015, ISBN-13: 978-8131809259
2	Strength of Material	S Ramamurutham	Dhanpat Rai Publishing Company Private Limited-New Delhi; Eighth edition, 2014, ISBN-13: 978-9384378264
3	Strength of Material	Timoshenko and Gere	CBS,2 edition, 2006, ISBN-13: 978-8123908946
4	Theory of Structures	R S Khurmi	S. Chand Publishing, New Delhi, 2006 , ISBN-13: 978-8121928229
5	Strength of Materials	R.K. Rajput	S. Chand Publishing (6th Edition) (2015) ISBN-13: 978-9385401367
6	Strength of Materials	Rattan S.S.	McGraw Hill Education; Third edition, 2016, ISBN-13: 978-9385965517
7	Strength of Materials (Drabya Samarthya)	S S L Patel	2017, ISBN-9788180142406

*Latest edition of all above books should be referred

(b) Open source software and website address:

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. en.wikipedia.org/wiki/Shear_and_moment_diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Universal Testing Machine	**Universal Testing Machine:** Capacity - 100 tones. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to32 mm. (2) Compression test attachment (3) Shear test attachment with sizes of bushes	LE1.1 to LE1.5

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		5,6,8,10,12,16,20,24 mm, (4) Transverse test attachment with bending Punch,(5)Service tools,(6) Operation and maintenance manuals - 2 nos. (7)Hardness attachment **Digital Extensometer:** Least count - 0.001 mm. Max. Extension = 5 mm. Single dial gauge for 30,40 mm. 60 mm, 80 mm, 100 mm, 125 mm gauge length.	
2	Impact Testing Machine (Izod/Charpy)	**CHARPY Test Apparatus:** Pendulum drop angle 140°; Pendulum effective Wt 20-25 kg; Striking velocity of pendulum 5-6 m/sec; Pendulum impact energy 300 j; Min scale graduation 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum 815 mm. **IZOD Impact Test Apparatus:** Pendulum drop angle: 90°-120; Pendulum effective Wt: 20-25 kg; Striking velocity of pendulum: 3-4 m/sec; Pendulum impact energy: 168 j; Min scale graduation: 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum : 815 mm	LE1.6, LE1.7
3	Combined Shear Force and Bending Moment apparatus	Combined Shear Force and Bending Moment apparatus	LE2.1
4	Slope and Deflection of Beam Apparatus	A bench mounted apparatus with a steel base with support at ends. The supports can be fitted with knife edges or clamp plates. A steel beam and two load hangers are together with two dial gauges for measuring beam deflections and slopes, Micrometer, Calipers, Scale, Weights and hanger.	LE3.1, LE4.1
5	Extension and compression of Springs appratus	The apparatus should be designed to be mounted on a rigid vertical support approximately 1.5metres above floor level. It is used to test tension springs up to 200mm in length. The maximum spring diameter is 38mm, Micrometer, Calipers, Scale, Weights and hanger.	LE5.1
6	Principal stress and strain measuring instrument.	1. Cantilever flexure frame 2. 2024-T6 high-strength aluminum alloy beam; 3x25x320 mm or similar. 3. P-3500 strain indicator or equivalent 4. Micrometer 5. Calipers 6. Scale 7. Weights and hanger	LE6.1
7	Behavior of Column and Struts Apparatus	Apparatus consist of four spring steel columns which are put along a vertical wooden board. These four columns have different end conditions as below: 1. Both ends pinned 2. Both ends fixed 3.	LE7.1

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		One end pinned and other fixed 4. One end fixed and other end free Micrometer, Calipers, Scale, Weights and hanger.	
8	Torsions of bars apparatus OR Torsion Testing Machine	**Torsions of bars apparatus:** To understand and investigate directly the relationship between the torsional load applied to a round bar and the angular twist produced and how this relationship varies with the beam material and it's cross sectional polar moment of area. Specimens are rigidly held in a clamp fixed to one end of the bench top base frame of the apparatus. **Torsion Testing Machine:** Fixed with auto torque selector to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy + 1 % of the true torque Suitable For: Torsion and Twist test on diverse metal rods and flats, Torque Measurement by pendulum dynamometer system	LE8.1, LE 8.2

N) Mapping of POs and PSOs with COs:

Course Outcomes (COs)		Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
		PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1	Estimate direct stresses and strains in machine members/components.	2	3	3	1	1	1	3	2	2	2	-	2	1
CO-2	Determine bending moment and shear force values in different types of beams/components subjected to transverse loading.	3	3	2	1	1	1	3	2	2	2	2	2	1
CO-3	Calculate bending stresses and shear stresses in different types of beams/components subjected to transverse loading.	3	3	2	1	1	1	3	2	2	2	-	2	1
CO-4	Calculate slope and deflection in cantilever and simply supported beams/components subjected to transverse loading.	2	3	2	1	1	1	3	2	2	2	2	2	1
CO-5	Select Springs for given situations based on stiffness and deflection	2	3	2	1	1	1	1	2	2	2	-	2	1
CO-6	Calculate principal stress and strain in machine members subjected to multi-load situations.	3	3	2	1	1	1	1	2	2	2	-	2	1
CO-7	Determine buckling load in	2	3	2	1	1	1	1	2	2	2	-	2	1

Course Outcomes (COs)		Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
		PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
	Columns and Struts type high slenderness ration components.													
CO-8	Estimate shear stresses in shafts subjected to twisting moment.	2	3	2	1	1	1	3	2	2	2	-	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-1** Estimate direct stresses and strains in machine members/components.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	LE1.1 LE1.2 LE1.3 LE1.4 LE1.5 LE1.6 LE1.7	Unit-1.0 Direct Stresses and Strains in components 1.1,1.2,1.3,1.4,1.5, 1.6, 1.7	As mentioned in relevant page numbers.
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 1,2,3	**CO-2** Determine bending moment and shear force values in different types of beams/components subjected to transverse loading.	SO2.1 SO2.2	LE2.1	Unit-2.0 Shear Force and Bending Moments in Beam type components 2.1, 2.2 ,2.3, 2.4, 2.5, 2.6	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-3** Calculate bending stresses and shear stresses in different types of beams/components subjected to transverse loading.	SO3.1 SO3.2 SO3.3	LE3.1	Unit-3.0 Bending stresses and shear stresses in beam type components 3.1, 3.2, 3.3,3.4	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 1,2,3	**CO-4** Calculate slope and deflection in cantilever and simply supported beams/components subjected to transverse loading.	SO4.1	LE4.1	Unit-4.0 Deflection of beam type components 4.1, 4.2, 4.3	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-5** Select Springs for given situations based on stiffness and deflection	SO5.1 SO5.2 SO5.3	LE5.1	Unit-5.0 Springs 5.1, 5.2, 5.3	

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-6** Calculate principal stress and strain in machine members subjected to multi-load situations.	SO6.1 SO6.2 SO6.3	LE6.1	Unit-6.0 Principal Stresses and Strains 6.1, 6.2, 6.3, 6.4, 6.5, 6.6	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-7** Determine buckling load in Columns and Struts type high slenderness ration components.	SO7.1 SO7.2 SO7.3	LE7.1	Unit-7.0 Buckling stresses in Columns and Struts type components 7.1, 7.2, 7.3, 7.4, 7.5, 7.6	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-8** Estimate shear stresses in shafts subjected to twisting moment.	SO8.1 SO8.2	LE8.1 LE8.2	Unit-8.0 Torsion of Shaft 8.1, 8.2, 8.3	

A) Course Code : 2037373(037)
B) Course Title : Thermal Engineering
C) Pre- requisite Course Code and Title :
D) Rationale :

Thermal Engineering incorporates the basic principles of thermodynamics and its application. As large number of engineering processes involve with exchange of energy, so the knowledge of thermal engineering is essential to deal with all above processes. Thermal Engineering is the core subject of mechanical stream as its application includes various fields of engineering application. Present curriculum has been developed to enable the students to efficiently handle the relevant day to day situation arising in their field of working.

E) Course Outcomes:

CO-1 Apply the fundamentals of Thermodynamics to various thermodynamic systems and devices.

CO-2 Investigate the performance parameters of IC engines.

CO-3 Analyze the properties of the steam.

CO-4 Apply the gas laws to the given situation/application.

CO-5 Select relevant air compressor as per the requirement.

CO-6 Select relevant heat exchanger as per the requirement

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits L+T+(P/2)
1.	Mechanical Engineering	2037373(037)	Thermal Engineering	2	-	1	3
2.	Mechanical Engineering	2037363(037)	Thermal Engineering (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL have to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037373(037)	Thermal Engineering	70	20	30	-	-	120
2.	Mechanical Engineering	2037363(037)	Thermal Engineering (Lab)	-	-	-	30	50	80

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam (Theory) and End Semester Exam (Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply the fundamentals of thermodynamics to various thermodynamic systems and Devices

(Approx. Hrs: L+P+T = 20)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Apply first law of thermodynamics to a given thermodynamic system to calculate work and heat transfer. SO1.2 Apply second law of thermodynamics to a given thermodynamic system SO1.3 Draw the given thermodynamic processes on PV and TS diagram. SO1.4 Find the entropy change in a given situation.	LE1.1 Determine the rise in temperature of air due to external work using an air compressor test rig. LE1.2 Determine the coefficient of performance of heat pump.	**Unit-1.0 Basics Concepts of thermodynamics** 1. 1 Basic Concepts - Definition and importance of Thermodynamics, Thermodynamic systems, Thermodynamic properties, Work, heat and energy, Thermodynamic equilibrium, Quasi-static process, work done during Quasi-static process, Zeroth law of Thermodynamics 1. 2 First law of thermodynamics -First law of thermodynamics and its applications, Steady flow energy equation and its applications to boiler, engine, turbine, compressor and nozzle 1.3 Thermodynamic processes and representation on P-V and T-S diagram, Simple Numerical problem on first law of thermodynamics. 1.4 Second Law of Thermodynamics - Limitations of First law of thermodynamics, Second law of thermodynamics: Kelvin Planck's and Clausius statements, Heat	• Available and unavailable heat Energy • Third Law of thermodynamics.

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		reservoir, Heat source and Heat sink, Concept of heat engine, heat pump and refrigerator, Carnot cycle Thermal Efficiency, Coefficient of performance, Parameters affecting thermal efficiency, Means of increasing efficiency, Thermodynamically reversible and irreversible processes. Factors that makes a process irreversible. 1.5 Entropy- Clausius inequality, concept of Entropy, Principle of increase of entropy, T-S and H-S diagrams computation of change in entropy	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. List the devices which convert heat in to work.
ii. List the real life example of open and closed system.
iii. List the Devices working on basis of first law of thermodynamic.
iv. Draw the given thermodynamic process on HS diagram.
v. Deduce the relation between COP of heat pump and refrigerator
vi. Write the limitation of Carnot cycle.

b. Mini Project:

i. Verify the steady flow energy equation for nozzle and turbine for a set of given data/ by data collected from laboratory/industry.
ii. Verify the steady flow energy equation for Pump and Condenser by data collected from laboratory/industry.
iii. Investigate the energy transfer in an IC engine.

CO-2 Investigate the performance parameters of IC engines.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (p)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Interpret given Air Standard Cycles. SO2.2 Represent the given air standard	LE2.1 Determine the BP of four strokes diesel engine using brake dynamometer.	**Unit-2.0 Air Standard Cycles and internal combustion engines** 2.1 Air standard cycles-	• Dual cycle, Erricson cycle, Sterling cycle. • Sterling Engine

Session Outcomes (SOs)	Laboratory Instruction (p)	Class room Instruction (L)	Self Learning (SL)
cycles on PV and TS diagrams. SO2.3 Identify the components from the given IC engine cut section model/picture and explain their functions. SO2.4 Explain the working of the given engines with sketches. SO2.5 Calculate different performance parameters of the given IC engine(s). SO2.6 Calculate IP, BP, FP, Thermal Efficiency, Mechanical efficiency and relative efficiency from the given data.	LE2.2 Determine the BP of four strokes Petrol engines using brake dynamometer. LE2.3 Perform load test on 2 stroke petrol engine.	definition and its purpose, Otto, Diesel cycles, their representation on PV & TS diagrams, Derivation of air standard efficiency and their comparison and limitation. 2.2 Internal Combustion engines Introduction and classification of IC engine, I.C. engine components and their function, Working of two-stroke and four stroke cycle engines and their comparison, 2.3 Indicator diagram, calculation of IP, BP, FP, Thermal Efficiency, Mechanical efficiency and relative efficiency, Pollution from IC engines and emission norms	

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Compare the different air standard cycles.
ii. Draw the air standard cycles on HS diagram.
iii. List the applications of different IC engines.
iv. Compare the petrol and diesel engines.

b. Mini Project:

i. Dismantle two stroke and four stroke petrol engines and compare their construction/components.
ii. Prepare a report on engine's performance parameters of various commercial available passenger and goods carrying vehicles.

CO-3 Analyze the properties of the steam.

(Approx. Hrs: L+P+T =10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Calculate the heat required to convert the given sample of water into steam of	LE3.1 Determine the dryness fraction of given sample of steam using separating and	**Unit-3.0 Pure substances** 3.1 Pure substance, phase, phase changes, steam as a two phase system, steam formation and its	• Calculation of entropy and enthalpy.

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
desire quality SO3.2 Calculate the dryness fraction of given sample of steam data. SO3.3 Represent different vapor processes on different planes in a given situation	throttling calorimeter. LE3.2 Plot the steam properties on h-s diagram (Mollier diagram) for a given sample of steam.	representation on the enthalpy plane 3.2 Representation of wet, dry and saturated and superheated steam on P-V,T-S and H-S planes, Dryness fraction of steam 3.3 Simple calculations on quality of steam using Steam table 3.4 Safety precautions in handling steam.	

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Write the importance of steam quality.

ii. Justify the use of superheated steam in power plant.

b. Mini Project:

i. Visit a nearby power plant and collect the data related to properties of steam at various locations i.e. boiler inlet and exit, turbine inlet and exit, condenser inlet and exit etc. and use it to calculate the changes in quality. enthalpy and entropy of steam

CO-4 Apply the gas laws to the given a situation/application.

(Approx. Hrs: **L+P+T =11**)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Determine the change in properties of gases in the given process. SO4.2 Calculate the mass of a gas and its final condition parameters from the given process. SO4.3 Calculate different energy changes during ideal gas processes. SO4.4 Determine the Characteristics Gas Constant of commonly used gases from given data.	LE4.1 Determine the characteristic Gas constant of commonly used gases from given data	**Unit-4.0 Ideal Gases and Ideal Gas Processes** 4.1 Avogadro's law, Derivation of characteristic gas equation using Boyle's and Charle's law, characteristic gas constant and universal gas constant. , simple numerical problems based on above. 4.2 Ideal gas processes – Isobaric, Isochoric, Isothermal, Isentropic, Polytropic, Throttling and their representation on P-V and T-S diagrams, determination of work, heat, internal energy, enthalpy change and entropy change.	• Mixture of gases – Dalton's law of partial pressure.

SW-4 Suggested Sessional Work (SW) :

a. **Assignments:**

i. Identify and list the application of gases in industries.
ii. Explain the change in properties of air during throttling in throttling valve.
iii. Identify and justify the various thermodynamic process involved in petrol and diesel engines.

CO-5 Select relevant air compressor as per requirement.

(Approx. Hrs: L+P+T =12)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Describe the suitability of given compressor for given applications. SO5.2 Select compressor for the given application with justification. SO5.3 Describe the working and construction of the given Compressor. SO5.4 Calculate work done and efficiencies of compressor.	LE5.1 Determine the performance parameters of a Reciprocating Compressor/Centrifugal compressor. LE 5.2 Determine the capacity of the given reciprocating air compressor.	**Unit-5.0 Air Compressors** 5.1 Basics of compression , industrial uses of compressed air 5.2 Classification of compressors, Description of reciprocating compressor and Centrifugal compressor, Work done in single stage reciprocating compressor, Volumetric, Isothermal and Isentropic efficiencies of reciprocating air compressor, 5.3 Multistage compression and inter cooling and advantages. 5.4 Safety precautions in handling compressed air.	• Axial Flow Compressor

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. List the industrial uses of Compressed air.
ii. List the advantages of intercooling.
iii. List the commercial uses of reciprocating compressor.

b. Mini Project:

i. Prepare a report on the domestic, industrial and field application of compressors, its type, its specifications etc.

CO-6 Select relevant heat exchanger as per the requirement.

(Approx. Hrs: L+P+T =13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.1 Selects the modes of heat transfer for the given situation with justification. SO6.2 Calculate heat transfer through conduction for the given situation. SO6.3 Determine the heat transfer through convection in the given situation. SO6.4 Calculate the amount of heat transfer through Radiation in the given situation. SO6.5 Select heat exchanger as per given situation with justification	LE6.1 Determine Thermal conductivity of a solid metallic rod/plate. LE6.2 Determine thermal conductivity of a given insulating powder. LE6.3 Determine the value of Stefan-Boltzmann constant for radiation	**Unit-6.0 Heat Transfer** 6.1 Modes of heat transfer Conduction, convection and radiation. Terms related to heat transfer - thermal conductivity, Heat transfer coefficient , thermal diffusivity , heat flux, thermal resistance. 6.2 Conduction-Fourier's law of heat conduction, temperature gradient, 6.3 Determination of heat transfer across a flat plate through conduction, engineering applications/examples. 6.4 Convection- Newton's law of cooling, natural and forced convection, engineering applications/examples. Radiation- Stefan-Boltzmann law of thermal radiation, absorptivity, reflectivity, transmissivity, emissivity, Black body, Grey body, Emissive power, shape factor, engineering applications/examples. 6.5 Heat Exchangers - Classification, construction and working of shell and tube, shell and coil, pipe in pipe type & plate type heat exchanger and their applications.	• Automotive heat exchangers

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Identify the modes of heat losses in the various parts of the boiler.
ii. Compare parallel and counter flow heat exchanger.

b. Mini Project:

i. Visit a nearby power plant and identify the modes of heat loss from various components and write a report.
ii. Identify the modes of heat loss in an IC engine.
iii. Prepare a power point presentation on various types of heat exchangers.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Basic Concepts of thermodynamics	3	3	6	12
II	Air Standard Cycles and Internal Combustion Engines	3	3	8	14
III	Pure substance	3	3	6	12
IV	Ideal Gases and Ideal Gas Processes	2	2	6	10
V	Air Compressors	2	2	6	10
VI	Heat Transfer	2	2	8	12
Total		**15**	**15**	**40**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Determine the rise in temperature of air due to external work.	15	10	5
LE1.2	Determine the coefficient of performance of heat pump.	15	10	5
LE 2.1	Determine the BP of four strokes diesel engine using brake dynamometer.	15	10	5
LE2.2	Determine the BP of four strokes Petrol engines using brake dynamometer.	15	10	5
LE2.3	Perform load test on 2 stroke petrol engine.	15	10	5
LE3.1	Determine the dryness fraction of given sample of steam using separating calorimeter.	15	10	5
LE3.1	Plot the steam properties on h-s diagram (Mollier diagram) for a given sample of steam.	15	10	5
LE4.1	Determine the Characteristics Gas Constant of commonly used gases from given data.	15	10	5
LE5.1	Determine the performance parameters of a Reciprocating Compressor/Centrifugal compressor.	15	10	5
LE5.2	Determine the capacity of the given reciprocating air compressor.	15	10	5
LE6.1	Determine Thermal conductivity of a solid metallic rod/plate.	15	10	5
LE6.2	Determine thermal conductivity of a given insulating powder.	15	10	5
LE6.3	Determine the value of Stefan-Boltzmann constant for radiation	15	10	5

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals ,

Legend : PRA: Process Assessment, PDA : Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Demonstration
10. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
11. Brainstorming
12. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	A text book of Thermal Engineering	R.S.Khurmi,	S.Chand	ISBN-10: 8121925738
2	A Course in Thermal Engineering.	R.K. Rajput	Laxmi Publication, Dariya ganj, New Delhi	ISBN 13: 9788131808047
3	Engineering Thermodynamics	P.K. Nag	Tata McGraw Hill	ISBN: 9781259062568
4	Fundamentals of Engineering Thermodynamics	E Radhakrishnan	PHI	ISBN: 9788120327900
5	Thermodynamics	Prasanna Kumar	Pearson	ISBN: 9789332514133
6	Thermal Engineering (Tapiya Abhiyantriki)	S.S.L. Patel	Standard Publishers Distributors, Delhi.	ISBN-9788180141669
7	Introduction to Thermodynamics	Y. V. C. Rao	Universities Press	ISBN: 9788173714610
8	Applied Thermodynamics	R. Yadav	Central Publishing House	ISBN:818544403X
9	Thermodynamics (Ushmagatiki)	Dr Abhitabh Dubey	Balaji Publishers & Distributors,Bhopal	ISBN-978-93-82346-17-3

(b) Open source software and website address:

i. (a)Thermodynamic properties - https://www.youtube.com/watch?v=mdVmfzSMPRw
ii. NPTEL Couses- http://nptel.ac.in/courses/112105123/
iii. 1st law of thermodynamics - https://www.youtube.com/watch?v=YvQp2qy5l60

iv. 2nd law of thermodynamics https://www.youtube.com/watch?v=vPcjOHCPoqQ
v. Entropy- https://www.youtube.com/watch?v=DtS_hc09ozI
vi. internal combustion engine - https://www.youtube.com/watch?v=vIJ50aUiBgM
vii. pure substance-https://www.youtube.com/watch?v=Ig1Fc3pXSLQ
viii. gases and gase mixture- https://www.youtube.com/watch?v=uFwFxgWDm5U
ix. air compressor-https://www.youtube.com/channel/UCRgblwOwpVFdzMzPbs88kGg
x. heat transfer- https://www.youtube.com/watch?v=K4rZgt9ZYuE

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' Manual
4. Users' Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications*	Relevant Experiment Number
1	Heat pump test rig	A test rig consist of hermetically sealed compressor fitted with energy meter , heat rejection chamber expansion device and heat absorption chamber, digital temperature indicator to display temperature at various location.	LE1.2
2	Single cylinder Four stroke diesel engine test rig	Rated power= 5 H.P. or more Rated speed = 1500 RPM Diameter of bore= 80 MM Stroke length= 110 MM Fuel= Diesel	LE2.1
3	Single cylinder Four stroke petrol engine test rig	Rated power= 5 H.P. or more Rated speed = 1500 RPM Diameter of bore= 80 MM Stroke length= 110 MM Fuel= Petrol	LE 2.2
4	Load test apparatus for measuring BP of petrol engine	Dynamometer type= rope brake dynamometer Rated power= 5 H.P. or more Rated speed = 1500 RPM Diameter of bore= 80 MM Stroke length= 110 MM Fuel= petrol.	LE2.3
5	Separating and throttling Calorimeter	Complete set up for measuring the dryness fraction of steam consisting of Separating Chamber made of Stainless Steel insulated with Ceramic Wool with water level indicator, Throttling Chamber provided with gauge to measure inlet pressure before throttling, Heat Exchanger for condensing steam after throttling chamber Steam Generator, Flow, pressure and temperature measuring sensors.	LE3.1
6	Reciprocating air compressor test rig	Two stage reciprocating air compressor Motor- electric motor Steel supply tank and measuring tank,	LE 5.1, 5.2

S. No.	Name of Equipment	Broad Specifications*	Relevant Experiment Number
		Electric supply- 230 v Speed- 1000 rpm, suitable tapings for pressure and temperature measurement.	
7	Centrifugal compressor test rig.	Centrifugal compressor Motor- electric motor Steel supply tank and measuring tank, Electric supply- 230 v Speed- 1000 rpm	LE 5.1
8	Thermal conductivity of metal rod equipment	Type – digital Accuracy- 0.05 % Thermostat- digital Heater- electric Power- 500 w or more	LE6.1
9	Thermal conductivity of insulating powder equipment.	Inner sphere- 100 mm dia material copper Outer sphere – 200 mm dia material copper Heater – round type temperature indicator- Digital	LE6.2
10	Experimental set up to verify Stefan Boltzmann law.	Metal bar- copper Heater – round type temperature indicator- Digital heat input- 2A, 230 V	LE 6.3

*** The specifications shown above are suggestive only.**

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Apply the fundamentals of thermodynamics to various thermodynamic systems and devices	3	3	3	-	-	-	-	1	1	2	-	-	3
CO-2 Investigate the performance parameters of IC engines.	3	3	3	3	3	2	-	1	1	2	-	-	3
CO-3 Analyze the properties of the steam.	3	3	3	3	3	-	-	1	1	2	-	-	3
CO-4 Apply the gas laws to the given situation/application	3	3	3	-	-	-	-	1	1	2	-	-	3
CO-5 Select relevant air compressor as per the requirement	3	3	3	3	2	-	-	1	1	2	-	-	3
CO-6 Select relevant heat exchanger as per the requirement	3	3	3	3	-	-	-	1	1	2	-	-	3

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,8,9,10 PSO-3	CO-1 Apply the fundamentals of thermodynamics to various thermodynamic systems and devices	SO1.1 SO1.2 SO1.3	LE1.1 LE1.2 LE1.3	Unit-1.0 Basics Concepts of thermodynamics 1.1, 1.2, 1.3, 1.4, 1.5	As mentioned in relevant page numbers.
PO-1,2,3,4,5 6,8,9,10 PSO-3	CO-2 Investigate the performance parameters of IC engines.	SO2.1, SO2.2 SO2.3, SO2.4 SO2.5, SO2.6	LE2.1 LE2.2 LE2.3	Unit-2.0 Air Standard Cycles and internal combustion engines 2.1, 2.2 ,2.3	
PO-1,2,3,4,5, 8,9,10 PSO-3	CO-3 Analyze the properties of the steam.	SO3.1 SO3.2 SO3.3	LE3.1	Unit-3.0 Pure Substances 3.1, 3.2, 3.3 3.4	
PO-1,2,3, 8,9,10 PSO-3	CO-4 Apply the gas laws to the given situation/application	SO4.1 SO4.2 SO4.3 SO4.4		Unit-4.0 Ideal Gases 4.1 4.2	
PO-1,2,3,4,5, 8,9,10 PSO-3	CO-5 Select relevant air compressor as per the requirement	SO5.1 SO5.2 SO5.3	LE5.1 LE5.2	Unit-5.0 Air Compressors 5.1, 5.2 ,5.3, 5.4,	
PO-1,2,3,4, 8,9,10 PSO-3	CO-6 Select relevant heat exchanger as per the requirement	SO6.1 SO6.2 SO6.3 SO6.4 SO6.5	LE6.1 LE6.2 LE6.3	Unit-6. Heat Transfer 6.1, 6.2, 6.3 6.4, 6.5	

Note- Performance under Laboratory and Sessional work may appear in more than one COs/Sos.

A) Course Code : 2037374(037)

B) Course Title : Machine Drawing and Computer Aided Drafting

C) Pre- requisite Course Code and Title :

D) Rationale :

The students of mechanical engineering programme are mainly involved in drawing, manufacturing, inspection and planning activities such as preparing process plans, preparing bill of materials, etc.. in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of machine drawing are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. In first semester engineering drawing course one unit was devoted for drawing 2D geometric entities using a computer aided drafting software to develop the basic drafting skills and knowledge, now in this course use of same software is further extended for the development of Isometric and orthographic drawings of simple machine components.

E) Course Outcomes:

CO-1 Draw curves of intersection of different regular solids.

CO-2 Draw the development of surfaces of various regular solids.

CO-3 Use various drawing codes, conventions and symbols as per IS SP-46.

CO-4 Use limits-fits-tolerances, surface finish and welding symbols and values in production drawings.

CO-5 Prepare exploded views from assembly drawing of machine component.

CO-6 Prepare assembly drawings from exploded views of machine component.

CO-7 Draw isometric and orthographic sectional views of simple machine elements manually and using computer aided drafting software.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1.	Mechanical Engineering	2037374(037)	Machine Drawing and Computer Aided Drafting	2	-	1	3
2.	Mechanical Engineering	2037364(037)	Machine Drawing and Computer Aided Drafting (Lab)	-	4	-	2

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work (SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW and SL have to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037374(037)	Machine Drawing and Computer Aided Drafting	70	20	30	-	-	120
2.	Mechanical Engineering	2037364(037)	Machine Drawing and Computer Aided Drafting (Lab)	-	-	-	30	50	80

Note: : i Separate passing is must for TA component of Progressive Assessment, both for theory and practical.

ii. Separate passing is must for End Semester Examination(Theory) and End Semester Examination(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Draw curves of intersection of different regular solids.

(Approx. Hrs: L+P+T=10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Identify parts where concept of intersection of the given solids is required. SO1.2 Explain the procedure to draw curves of intersection of surfaces of given regular solids.	LE1.1 Draw curves of intersection in case of cylinder with cylinder and cylinder with cone of given dimensions. LE1.2 Draw curves of intersection in case of cylinder with square Prism and Prism with Prism (Tri-angular and square) of given dimensions.	**Unit-1.0 Intersection of Solids** 1.1 Curves of intersection of surfaces of the regular solids in the following cases: 1.2 Prism with prism (Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder when i. the axes are at 90° and intersecting ii. The axes are at 90° and Offset 1.3 Cylinder with Cone: when axis of cylinder is parallel to both the reference planes and cone resting on base on HP with axis intersecting and offset from axis of cylinder.	• Cylinder with Cone: when axis of cylinder is parallel to both the reference planes and cone resting on base on HP with axis offset from axis of cylinder.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Draw curves of intersection of the surfaces of the cylinder with cylinder, when the axes are at other than 90° and intersecting each other (without offset).

ii. Draw curves of intersection of the surfaces of the cylinder with cone, when the axes are at other than 90°, with partially or fully intersecting.
iii. Draw intersection of Cylinder with Cone when axis of cylinder is parallel to both the reference planes and cone resting on base on HP with axis offset from axis of cylinder in sketch book/drawing sheet.

b. Mini Project:

i. Prepare models of card sheet for intersection of cylinder with cylinder and cylinder with cone

c. Other Activities (Specify):

i. Prepare a list of different industrial and domestic components where application of intersection of solid is seen. (group work with group size of five students each).
ii. Prepare a chart with photographs of domestic and industrial components where application of intersection of solid is seen. (group work with group size of five students each).

CO-2 Draw the development of surfaces of various regular solids.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Identify parts where concept of development of surfaces is required. SO2.2 Explain the procedure to draw development of surfaces of given regular solids.	LE2.1 Draw development of surfaces of funnel, chimney and pipe bend.	**Unit-2.0 Development of surfaces** 2.1 Development of Lateral surfaces of objects (cylinder, cone & pyramids) and their applications such as funnel, Chimney, pipe bend.	• Development of Prism and frustum of Prism.

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Draw development of lateral surfaces of truncated Prism (rectangular cross sections).
ii. Draw development of lateral surface of frustum of cone.
iii. Draw development of a typical tray.

b. Micro Project:

i. Visit a tailoring shop and observe how body dimensions are used to create dresses. Correlate the same with development of surfaces and prepare a report.
ii. Based on one of the problems solved in drawing sheet, prepare a model using card sheet and validate different dimensions.

c. Other Activities (Specify):

i. Prepare a list of different industrial and domestic components where application of development of surfaces is seen. (group work with group size of five students each)
ii. Prepare a chart with photographs of domestic and industrial components where application of development of surfaces is seen. (group work with group size of five students each)

CO- 3 Use various drawing codes, conventions and symbols as per IS SP-46.

(Approx. Hrs: **L+P+T=17**)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Use IS SP-46 (1988) codes for the given machine component or material. SO3.2 Interpret standard conventions used in the given Mechanical working Drawing.	LE3.1 Draw symbols for representing different machine elements and materials.	**Unit-3.0 Conventional Representations** 3.1 Standard convention as per BIS [SP – 46 (1988)] 3.2 Materials- C.I., M.S, Brass, Bronze, Aluminum, wood, Glass, Concrete and Rubber 3.3 Long and short break in pipe, rod and shaft. 3.4 Ball and Roller Bearings. 3.5 Pipe joints, cocks, valves. 3.6 Internal / external threads, Knurling 3.7 Serrated shafts, splined shafts, and keys and key ways 3.8 Springs with square and flat ends 3.9 Gears, sprocket wheel, chain wheels 3.10 Countersunk & counter bored holes 3.11 Tapers	• Conventional representation of components specifically used in electrical/Civil fields.

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Draw conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shafts, holes on circular pitch, internal and external thread.

b. Micro Project:

i. Collect one production drawing from an industry, interpret different conventional representations and prepare a list of the same (group work with group size of five students each).

CO-4 Use limits-fits-tolerances, surface finish and welding symbols and values in production drawings.

(Approx. Hrs: L+P+T=21)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Interpret different attributes of the given Production Drawing and Process Sheet of various components . SO4.2 Identify fits required between mating parts of machine components based on the given tolerance values. SO4.3 Use limits-fits-tolerance, surface finish and welding symbols in the given production drawing.	LE4.1 Draw limits-fits-tolerance, surface finish, and welding symbols in the given production drawing.	**Unit-4.0 Limits-fits-tolerance, surface finish and welding symbols in Production drawing** 4.1 Limits, fits and tolerances: Definitions, Introduction to ISO system of tolerances - unilateral and bilateral tolerance and its representation on drawing, dimensional tolerances, elements of interchangeable system, hole & shaft base systems, tolerance diagram, Selection of fit (clearance, transition and interference) for engineering applications. 4.2 Geometrical tolerances Definitions, Tolerances of form and position and its geometric representation-tolerance frame, datum feature, magnitude of tolerance and symbol, interpretation of a given symbol on drawing, simple examples. 4.3 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation. 4.4 Characteristics of surface roughness Indication of machining symbol showing direction of lay, roughness grades, machining allowances, manufacturing methods, using ISO code. Relation of surface roughness values with manufacturing processes.	• Interpret other machine symbols and information on a Production drawing

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. List out the types of tolerances used in machine drawing.

ii. Name the types of fits commonly used in production drawing and state their applications.

b. Micro Project:

i. Collect one production drawing from an industry, interpret different limits-fits-tolerance, surface finish and welding symbols and prepare a list of the same (group work with group size of five students each).

c. Other Activities (Specify):

i. Collect information related to fit between, piston cylinder, bearing shaft, late and shaper machine guide ways.

CO-5 Prepare exploded views from assembly drawing.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Interpret details in the given Assembly. SO5.2 State details and assembly sequence of components in the given assembly. SO5.3 Explain the procedure for creating assembly from the given components.	LE5.1 Prepare exploded views of following assemblies: i. Flange coupling ii. Bushed Bearing iii. Plummer Block iv. Lathe Square v. Tool Post vi. Knuckle Joint vii. Cast Iron Pulley viii. Any other assembly consisting of 6 - 10 parts.	**Unit-5.0 Assembly to Detail drawing** 5.1 Introduction, types of assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing. Bill of Material. 5.2 Exploded view of : i. Flange coupling ii. Bushed Bearing iii. Plummer Block iv. Lathe Square Tool Post v. Knuckle Joint vi. Cast Iron Pulley vii. Any other assembly consisting of 6 -10 parts.	• Bench vice & Pipe Vice. • Oldham & Universal couplings (Prepare exploded views of above assemblies)

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare exploded views of Screw jack.
ii. Prepare exploded views of Lathe machine square tool post

b. Micro Project:

i. Collect five sample production drawing of a same component compare them and.

c. Other Activities (Specify):

i. Collect 5 samples of scrap springs of different sizes and types individually and fix them collectively on a single board with labels.

CO-6 Prepare assembly drawings from exploded views of machine component.

(Approx. Hrs: L+P+T=20)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.1 Identify various components in the given assembly and the sequence of dismantling it. SO6.2 Explain procedure to prepare detailed drawing from the given assembly drawing.	LE6.1 Prepare assembly drawing from given exploded views.	**Unit-6.0 Assembly to Details** 6.1 Introduction, types of assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing. Bill of Material. 6.2 Flange coupling 6.3 Plummer Block 6.4 Lathe Square Tool Post 6.5 Knuckle Joint 6.6 Cast Iron Pulley	• Assembly drawing of stuffing box

SW-6 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare assembly drawing of piston, eccentric.

b. Mini Project: Prepare assembly from given exploded views of following manually:

i. Flange coupling
ii. Plummer Block

CO-7 Draw isometric and orthographic sectional views of simple machine elements manually and using computer aided drafting software.

(Approx. Hrs: L+P+T=16)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO7.1 Explain the procedure of drawing isometric and orthographic view(s) of given simple machine elements manually. SO7.2 Explain the procedure of drawing	LE7.1 Draw isometric and Orthographic sectional views of simple machine elements (any four) manually. LE7.2 Draw isometric and Orthographic sectional views of simple machine elements (any four) using computer aided drafting	**Unit-7.0 Isometric and Orthographic Sectional views** 7.1 Recall Isometric and orthographic projections. 7.2 Conversion of pictorial view into Orthographic views and Conversion of orthographic views into isometric View/projection. 7.3 Need for sectional	• Auxiliary views.

Session Outcomes	Laboratory Instruction	Class room Instruction (L)	Self Learning
isometric and orthographic view(s) of given simple machine elements using computer aided drafting software.	software.	views, Cutting plane and line, Sectioning conventions and section lines. 7.4 Types of sections: Full, Half, Broken, Removed, Revolved and Offset 7.5 Recall AutoCAD Draw, Modify, Edit and Plot commands. 7.6 Isometric and Orthogonal drawings using any computer aided drafting software (AutoCAD).	

SW-7 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a list of popularly used Draw, Modify, Edit and Plot commands of AutoCAD software.

b. Micro Project:

i. Draw the sectional views of at least 3 mechanical assemblies mentioned in from Unit 5.0 above using AutoCAD software.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction)):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Intersection of Solids	-	2	8	10
II	Development of surfaces	-	2	8	10
III	Conventional Representations	3	-	4	7
IV	Limits-fits-tolerance, surface finish and welding symbols in Production drawing	3	-	4	7
V	Assembly to Detail drawing	-	3	7	10
VI	Assembly to Details	-	3	7	10
VII	Isometric and Orthographic Sectional views	1	3	12	16
Total		**7**	**13**	**50**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)			Marks are allocated for performance under ESE based on following performance
		Performance		Viva-Voce	
		PRA	PDA		

LE1.1	Draw curves of intersection in case of cylinder with cylinder and cylinder with cone of given dimensions.	15	10	5	**parameters:** • Submission of drawings as per schedule • Neatness, Cleanliness on all prepared drawing sheets • Uniformity in drawing and line work • Dimensioning the given drawing and writing text • Visualization and drawing ability
LE1.2	Draw curves of intersection in case of cylinder with square Prism and Prism with Prism (Tri-angular and square) of given dimensions	15	10	5	
LE2.1	Draw development of surfaces of funnel, chimney and pipe bend.	15	10	5	
LE 3.1	Draw symbols for representing different machine elements and materials.	15	10	5	
LE4.1	Draw limits-fits-tolerance, surface finish, and welding symbols in the given production drawing.	15	10	5	
LE5.1	Prepare exploded views of following assemblies: i Flange coupling ii Bushed Bearing iii Plummer Block iv Lathe Square v Tool Post vi Knuckle Joint vii Cast Iron Pulley Any other assembly consisting of 6 -10 parts.	15	10	5	
LE6.1	Prepare assembly drawing from given exploded views.	15	10	5	
LE7.1	Draw isometric and Orthographic sectional views of simple machine elements (any four) manually.	15	10	5	• Use of appropriate institute templates and commands • Answer to viva-voce questions
LE7.2	Draw isometric and Orthographic sectional views of simple machine elements (any four) using computer aided drafting software.	15	10	5	

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals ,

Legend: PRA: Process Assessment, PDA : Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits

6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition*
1	Machine Drawing	R. K. Dhawan	S. Chand and Company	New Delhi, ISBN:81-219-1431-0
2	Fundamentals of Machine Drawing	Sadhu Singh, P. L. Sah	PHI	Latest
3	Machine Drawing including AutoCad	Ajeet Singh	TMH	Latest
4	Machine Drawing	Bhatt N.D., Panchal V.M.	Charotar Publishing house Pvt. Ltd., Anand, Gujarat,	2013, ISBN 9789380358635
5	Engineering Drawing practice for schools and colleges IS : SP- 46	Bureau of Indian standard	BIS Delhi	Third reprint, October 1998 ISBN8170610912
6	Production Drawing	Narayanan L.K., Kannaich P., VenkatReddy K.	New Age International Publication, New Delhi	2009, ISBN: 9788122435016
7	Engineering Drawing	Bhatt N.D.	Charotar Publishing house Pvt. Ltd. Anand, Gujarat,	ISBN:9789380358178
8	A text book of Machine Drawing	Gill P.S.	S.K.Kataria and Sons, New Delhi	2007, ISBN: 9789350144169
9	Machine Drawing	N. Sidheswar, P. Kannaiah, V. V. S. Sastry	McGraw Hill, New Delhi	2009, ISBN : 9780074603376

*Latest edition of all above books should be referred

(b) Open source software and website address:

1. user.engineering.uiowa.edu/~mie032/support/eg/eg07_section_views.pd
   web.aeromech.usyd.edu.au/.../Engineering%20Drawings%20Lecture%20Sectioning.
2. https://knowledge.autodesk.com/support/autocad/learn-explore
3. nptel.ac.in/courses/112103019/35
4. https://www.youtube.com/watch?v=1ABlR5ePOLQ
5. ebooks.bharathuniv.ac.in/.../Assembly%20Drawing%20of%20Production%20Drawin
6. www.me.metu.edu.tr/courses/me114/Lectures/assembly.htm
7. app.ute.edu.ec/content/3255.../Machine%20Drawing%20-%20Narayana%20K.pdf

8. https://engineering.pages.tcnj.edu/files/2012/02/dimensioning_and_tolerancing.pdf
9. nptel.ac.in/syllabus/112106075/
10. nptel.ac.in/courses/112103019/33
11. https://www.youtube.com/watch?v=5APldtR-xx4
12. https://www.slideshare.net/vagallasuresh/unit-7-interpenetrations-of-solids
13. sketch up 7 software for solid modelling
14. http://www.weldingtechnology.org
15. http://www.newagepublishers.com
16. Engineering graphics and Drawing v 1.0 from cognifront
17. http://www.youtube.com/watch?v=o1YPja2wCYQ
18. http://www.youtube.com/watch?v=9AGD4tihjCg&feature=plcp
19. http://www.youtube.com/watch?v=n65NU32inOU
20. http://www.youtube.com/watch?v=tyRVsSsNiUQ
21. http://www.youtube.com/watch?v=_M5eYB6056M
22. http://www.youtube.com/watch?v=UyROI-bAMu4
23. http://www.youtube.com/watch?v=eix8xbqb93s
24. http://www.youtube.com/watch?v=kWOl6ttDTBc
25. http://www.youtube.com/watch?v=gJbrO2jtoa8&feature=related
26. http://www.youtube.com/watch?v=PXgkBadGHEE
27. Engineering Graphics & Drawing v 1.0 from Cognifront
28. http http://npkauto.com/assignments

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Computer aided drafting software like AutoCAD	Latest educational licensed network version	LE7.1, LE7.2
2	CAD workstations	latest configuration	LE7.1, LE7.2
3	Drawing boards	A1 size	All
4	Interactive board (165 x 130 cm)	Supports dual touch, dual write and intuitive gestures, such as toss, rotate and zoom, available with multi touch operating systems, such as Windows®	All
5	Sample production/construction drawings	From nearby industries, construction companies and developed by senior teachers of the state	LE1.1, LE1.2, LE2.1, LE3.1, LE4.1, LE5.1, LE6.1, LE7.1, LE7.2
6	Printer/plotter	A3 size	LE7.1, LE7.2
7	Models for projection and demonstration	Wooden models	All

N) Mapping of POs and PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Draw curves of intersection of different regular solids.	2	3	3	2	1	1	1	2	2	2	-	2	1
CO-2 Draw the development of surfaces of various regular solids.	2	3	2	2	1	1	1	2	2	2	-	2	1
CO-3 Use various drawing codes, conventions and symbols as per IS SP-46.	1	3	2	2	1	1	3	2	2	2	-	2	1
CO-4 Use limits-fits-tolerances, surface finish and welding symbols and values in production drawings.	2	3	2	2	1	1	3	2	2	2	-	2	1
CO-5 Prepare exploded views from assembly drawing of machine component.	1	3	2	2	1	1	1	2	2	2	-	2	1
CO-6 Prepare assembly drawings from exploded views of machine component.	1	3	2	2	1	1	1	2	2	2	-	2	1
CO-7 Draw isometric and orthographic sectional views of simple machine elements manually and using computer aided drafting software.	1	3	2	3	1	1	1	2	2	2	3	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-1** Draw curves of intersection of different regular solids.	SO1.1 SO1.2	LE1.1 LE1.2	Unit 1.0 Intersection of Solids 1.1,1.2,1.3	As mentioned in relevant page numbers.
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 1,2,3	**CO-2** Draw the development of surfaces of various regular solids.	SO2.1 SO2.2	LE2.1	Unit 2.0 Development of surfaces 2.1	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-3** Use various drawing codes, conventions and symbols as per IS SP-46.	SO3.1 SO3.2	LE3.1	Unit 3.0 Conventional Representations 3.1, 3.2, 3.3,3.4, 3.5, 3.6, 3.7, 3.8, 3.9,3.10, 3.11	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 1,2,3	**CO-4** Use limits-fits-tolerances, surface finish and welding symbols and values in production drawings.	SO4.1 SO4.2 SO4.3	LE4.1	Unit 4.0 Limits-fits-tolerance, surface finish and welding symbols in Production drawing 4.1, 4.2, 4.3, 4.4	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-5** Prepare exploded views from assembly drawing of machine component.	SO5.1 SO5.2 SO5.3	LE5.1	Unit 5.0 Assembly to Detail drawing 5.1, 5.2	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 2,3	**CO-6** Prepare assembly drawings from exploded views of machine component.	SO6.1 SO6.2	LE6.1	Unit 6.0 Assembly to Details 6.1, 6.2, 6.3, 6.4, 6.5, 6.6	
PO – 1,2,3,4,5,6, 7,8,9,10 PSO – 1,2,3	**CO-7** Draw isometric and orthographic sectional views of simple machine elements manually and using computer aided drafting software.	SO7.1 SO7.2	LE7.1	Unit 7.0 Isometric and Orthographic Sectional views 7.1, 7.2, 7.3, 7.4, 7.5, 7.6	

A) Course Code : 2037375(037)
B) Course Title Material Technology
C) Pre- requisite Course Code and Title :
D) Rationale :

Engineering Materials play an important role for solving the problems of material selection and in the production and manufacturing. A diploma student must have the knowledge of properties, composition and behaviour of materials from the point of view of reliability and performance of the product. This curriculum is developed to impart the knowledge properties, structure and behaviour of materials applicable in most of the industries.

E) Course Outcomes:

CO-1 Interpret properties and structure of various engineering materials.

CO-2 Analyze the plastic deformation of metals.

CO-3 Interpret the phase diagrams.

CO-4 Select ferrous and non ferrous materials as per the requirement.

CO-5 Select non-metallic materials as per the requirement.

CO-6 Select heat treatment process as per the requirement.

CO-7 Select relevant material testing method.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1.	Mechanical Engineering	2037375(037)	Materials Technology	2	-	1	3
2.	Mechanical Engineering	2037365(037)	Materials Technology(Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work (SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL have to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037375(037)	Materials Technology	70	20	30	-	-	120
2.	Mechanical Engineering	2037365(037)	Materials Technology (Lab)	-	-	-	30	50	80

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam(Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Interpret properties and structure of various engineering materials.

(Approx. Hrs: L+P+T=10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Explain the properties of the given material. SO1.2 Describe with sketch the crystalline structure of a given material. SO1.3 Explain the effect of grain size on the properties of the given material. SO1.4 Identify the various types of imperfections in the figure or picture of the given material. SO1.5 Interpret the crystal structure of the given material.	LE1.1 Operate metallurgical microscope to examine the given specimen. LE1.2 Macroscopic examination of constitution of a metal or an alloy in relation to its physical and mechanical properties. LE1.3 Microscopy examination of constitution of a metal or an alloy in relation to its physical and mechanical properties. LE1.4 Measure particle size and size distribution of powder using metallographic technique	**Unit-1.0 Properties and Structure of Engineering Materials** 1.1 Classification of engineering materials – Metals and Non-metals 1.2 Properties of engineering materials Physical, Thermal, Electrical, Magnetic and Mechanical properties 1.3 Structure of crystalline solids: Concept of Amorphous and crystalline structure, Crystallization of liquid into solid state, nucleation and growth, formation of polycrystalline and single crystals, effect of grain size on material properties. 1.4 Crystal Structure – space lattice, unit cell, BCC, FCC, HCP lattice 1.5 Structural imperfections: impurity atoms, point imperfection, line imperfection, dislocations, surface imperfection, volume defects 1.6 Metallurgical microscope, its use and care	• Effect of imperfections on material properties.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Generate at least five ideas for recycling (a) metal tin (b) metal cans.

ii. Identify the materials used in the given artifacts. Why has a particular material been selected to be used in artifacts?

b. Mini Project:

i. Prepare a model showing the crystal structure of different materials.
ii. Prepare models showing the different types of crystal structures.

c. Other Activities (Specify):

i. Prepare a power point presentation on structural imperfections, their types and causes.

CO-2 Analyze the plastic deformation of metals.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Explain the elastic and plastic deformation for the given material. SO2.2 Explain the phenomena of slip system in the FCC crystal. SO2.3 Co-relate strain hardening of the given material with the plastic deformation due to dislocations. SO2.4 Draw Stress-Strain curves for the given material. SO2.5 Calculate the relevant elastic, plastic, and fracture properties of the given materials from the stress-strain responses. SO2.6 Explain the process of recovery recrystallisation and grain growth in the given material.	LE2.1 Determine the tensile behavior of the given material	**Unit-2.0 Plastic deformation** 2.1 Elastic and Plastic deformation 2.2 Mechanisms of deformation in crystalline materials – Slip and Twinning 2.3 Stress – Strain curves for polycrystalline materials 2.4 Yield point phenomena 2.5 Strain hardening 2.6 Recovery, recrystallisation and grain growth	• Effect of mechanical work on the structure and macro-properties of metals. • Slip system in various crystal structure

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Draw the stress-strain curves for different brittle and ductile materials.
ii. Suggest remedial measures for overcoming strain hardening.

iii. Explain the yield point phenomena and its importance.
iv. Identify important stages in recrystallisation process.
v. Prepare a power point presentation showing the different mechanisms of plastic deformation.
vi. Prepare a power point presentation on "Carpet Analogy" to understand the weakening of a crystal due to dislocations.
vii. Collect videos from websites on plastic deformation to understand the mechanism of deformation and give the seminar on the topic.

CO-3 Interpret the Phase diagrams.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Interpret the given phase diagram. SO3.2 Distinguish between given types of solid solutions. SO3.3 Plot cooling curve for a given material. SO3.4 Interpret Iron-Carbon equilibrium diagram. SO3.5 Identify the micro structure of the given metal with the help of pictures with justification SO3.6 Identify the metal from the given picture of microstructure with justification	LE3.1 Prepare micro-specimen of the given material. LE3.2 Use Metallurgical Microscope to identify different phases of the given material. LE3.3 Determine the lead-tin (PbSn) equilibrium phase diagram to demonstrate phase equilibrium in a binary system LE3.4 Polish and etch low-carbon steel samples to reveal the equilibrium phase distribution. LE3.5 Identify the effect of non-equilibrium cooling rates on microstructure. LE3.6 Measure cooling curve of a Pb-Sn eutectic alloy using thermocouple	**Unit-3.0 Phase diagrams** 3.1 Concept, definitions and need 3.2 Solid Solution – Types 3.3 Alloy – need for alloying, effect on material properties 3.4 Cooling curves and their importance. 3.5 Types of phase equilibrium diagram - monotectic, Eutectic, Hyper eutectic, hypoeutectic, eutectoid, Hyper and Hypo eutectoid, peritectic and peritectoid system. 3.6 Iron-carbon equilibrium diagram: Development of microstructure in Iron – Carbon system, Allotropic transformations in Iron and Steel 3.7 Microstructure examination: Preparation of micro-specimen, selecting the specimen, grinding and polishing, Etching and etching reagents. use and care of microscope	• Lever Rule, determining amount of phases present

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Apply Gibbs Phase rule to determine the degrees of freedom or number of phases present in a given phase diagram.
ii. Explain the different type of solid solutions.
iii. Alloying elements can be used to improve the properties of pure metals, justify?
iv. Locate eutectic, peritectic and eutectoid points in the iron-carbon equilibrium diagram.
v. Plot the cooling curve for different materials.
vi. Identify the allotropic forms of pure iron with their crystal structures and corresponding temperatures.
vii. Analyze and identify the phases present in the given alloy system from the phase diagram.

b. Mini Project:

i. Collect the sample of different metallic component and determine the microstructure of different metallic components using metallurgical microscope and compare their microstructure.
ii. Experimental determination of the Pb-Sn phase diagram by analyzing cooling curves.
iii. Determine the composition of given samples by comparing quantitative metallography of polished and etched samples to the equilibrium Fe-Fe_3C phase diagram.
iv. Study the melting and solidification of Pb38.1Sn61.9 eutectic alloy using Differential Thermal Analyzer (DTA)

CO-4 Select ferrous and non ferrous materials as per the requirement.

(Approx. Hrs: L+P+T=10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Select relevant steel and cast iron for the given application. SO4.2 Select relevant non ferrous material for the given application SO4.3 Interpret material designations	LE4.1 Use Metallurgical Microscope to determine the Micro structure of given alloy. LE4.2 Use Metallurgical Microscope to determine Micro structure of given steel.	**Unit-4.0 Metallic Materials** Micro- Structure, Properties and application, designation and coding methods of: 4.1 Cast Iron: Gray, White, Malleable, Nodular Cast iron. 4.2 Steels: Low, medium and high carbon steels, Stainless steel, High speed steel, Tool steel, Alloy steels 4.3 Copper, Aluminum, Zinc and their alloys, Bearing materials, Alloying elements	• Micro-Structure, Properties and application**,** the PIG iron, Wrought iron • Explain about Commercial use of steel sof different forms/shape like- plate, rod, channel, angle, T-section, Z-section • Properties and applications of Tin, Lead etc.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Identify various ferrous metals and alloys based on their composition and properties for given applications.
ii. Identify at least 5 metallic components for a given machine / assembly. Also list the material of identified machine / assembly components.

b. Mini Project:

i. Collect at least 10 machine parts made of metals and alloys (Copper, brass, aluminum, cast iron, high speed steel etc.), identify its properties, its structure and its application and prepare a report.

CO-5 Select non-metallic materials as per the requirement.

(Approx. Hrs: L+P+T=10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Select relevant polymers for the given application with justification. SO5.2 Select relevant refractory material for the given application with justification SO5.3 Select relevant composite material for the given application with justification. SO5.4 Explain the type and applications of nano and smart materials.	LE 5.1 Use burning test to identify the different types of plastics. LE 5.2 Characterize the mechanical behavior of Teflon, a polymer, and identify its special characteristics as compared with metals.	**Unit-5.0 Non-metallic Materials** 5.1 Polymers: Types, properties and industrial applications 5.2 Ceramic and refractory: Types, properties and applications 5.3 Composites: types, properties and applications. 5.4 Nano and Smart materials: Definition, types - piezoelectric, thermoresponsive, shape memory alloys, polychromic, chromogenic or halochromic materials, Applications	• Identification codes of plastics • Confirmation tests for thermoplastics and thermosetting plastics.

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Identify various polymers based on their composition and properties for given applications.
ii. Compare of nano and smart materials with composites.
iii. Identify at least 5 Nonmetallic components for a given machine / assembly. Also list the material of identified machine / assembly.
iv. Identify and list nonmetallic Materials used for construction of common home appliances like mixer grinder, washing machine, refrigerator, electric iron, etc.
v. Write composition, properties and industrial applications of important plastics.

b. Mini Project:

i. Collect at least 10 machine parts made of non metals and identify its properties, its structure and its application and prepare a report.
ii. Select five different plastics samples and then categorize them by performing experiments based on burning test.

CO-6 Select relevant heat treatment processes.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.1 Interpret TTT curves. SO6.2 Explain Pearlitic, Bainitic and Martensitic Transformation for the given material SO6.3 Select relevant heat treatment processes for the given material or application with justification.	LE6.1 Operate heat treatment furnace. LE6.2 Use muffle /box type furnace to Determine the effect of following quenching media on the hardness of mild steel -Oil, Water Brine.	**Unit-6.0 Heat treatment of Steels** 6.1 Introduction, purpose and advantage of heat treatment 6.2 TTT Curve: Significance and construction of TTT curve for eutectoid steel 6.3 Introduction to Pearlitic, Bainitic and Martensitic Transformation 6.4 Heat treatment processes: Annealing, Normalizing, Hardening, Tempering, Surface and Case hardening 6.5 Heat treatment furnaces: Muffle furnace, Box type furnace	• Heat treatment of tool steel and high speed steel

SW-6 Suggested Sessional Work (SW) :

a. Assignments:

i. Explain the importance of TTT curves.
ii. Can heat treatment improves the material properties, justify?
iii. Compare the different heat treatment processes
iv. Select appropriate heat treatment process for given application with justification.
v. Explain the effect of cooling rate in hardening.

b. Mini Project:

i. Visit at least two industry which has specifically heat treatment facilities and prepare a report consisting of:
   a. Types of heat treatment process
   b. Types of furnaces
   c. Types of quenching mediums used
   d. Types of Testing equipments
   e. Safety precautions observed.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

CO-7 Select relevant material testing method.

(Approx. Hrs: L+P+T=11)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO7.1 Select a hardness testing method for a given material. SO7.2 Select a non destructive material testing method for the given component.	LE7.1 Use Brinell, hardness tester to determine the hardness of a given material. LE7.2 Use Rockwell hardness tester to determine the hardness of a given material. LE7.3 Use Vickers hardness tester to determine the hardness of a given material. LE7.4 Use Magnetic particle crack detector to detect internal crack in a given part/material. LE7.5 Use Dye penetration method to detect surface crack in a given part/material. LE7.6 Use Ultrasonic crack detector to identify internal crack in a given part/material.	**Unit-7.0 Testing of Materials** 7.1 Destructive and non-destructive testing 7.2 Destructive testing - Hardness test (Brinell, Rockwell and Vickers) 7.3 Non-destructive testing – Magnetic particle crack detection test, Dye penetration test, Ultrasonic test, Radiography test, Eddy current testing	

SW-7 Suggested Sessional Work (SW) :

a. Assignments:

i. Compare the different methods of hardness testing.

ii. List the advantages of non destructive testing of materials over destructive testing of materials.

b. Mini Project:

i. Determine the hardness of different metallic components and compare hardness and plot a bar chart to show the hardest and softest material.

ii. Conduct hardness tests on: an amorphous ceramic (glass); 2 ductile metals, an alloy (brass) and a pure metal (copper); 2 polymers and justify that the microstructure and mechanical properties vary as a function of distance from the surface.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Properties and Structure of Engineering Materials	2	4	4	10
II	Plastic Deformation	2	4	6	12
III	Phase Diagrams	2	2	6	10
IV	Metallic Materials	2	2	4	8
V	Non-metallic materials	2	2	4	8
VI	Heat treatment of Steels	2	4	6	12
VII	Testing of Materials	2	2	6	10
Total		**14**	**20**	**36**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Operate metallurgical microscope to examine the given specimen.	15	10	5
LE1.2	Macroscopy examination of constitution of a metal or an alloy in relation to its physical and mechanical properties.	15	10	5
LE1.3	Microscopy examination of constitution of a metal or an alloy in relation to its physical and mechanical properties.	15	10	5
LE1.4	Measure particle size and size distribution of powder using metallographic technique	15	10	5
LE2.1	Determine the tensile behavior of the given material	15	10	5
LE3.1	Prepare micro-specimen of the given material	15	10	5
LE3.2	Use Metallurgical Microscope to identify different phases of the given material.	15	10	5
LE3.3	Determine the lead-tin (Pb-Sn) equilibrium phase diagram to demonstrate phase equilibrium in a binary system.	15	10	5
LE3.4	Polish and etch low-carbon steel samples to reveal the equilibrium phase distribution	15	10	5
LE3.5	Identify the effect of non-equilibrium cooling rates on microstructure	15	10	5
LE3.6	Measure cooling curve of a Pb-Sn eutectic alloy using thermocouple	15	10	5
LE4.1	Use Metallurgical Microscope to determine the Micro structure of given alloy.	15	10	5
LE4.2	Use Metallurgical Microscope to determine Micro structure of given steel.	15	10	5
LE4.1	Use Metallurgical Microscope to identify different phases of the given material.	15	10	5
LE5.1	Use burning test to identify the different types of plastics.	15	10	5
LE5.2	Characterize the mechanical behavior of Teflon, a polymer, and identify its special characteristics as	15	10	5

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	compared with metals			
LE6.1	Operate heat treatment furnace.	15	10	5
LE6.2	Use muffle /box type furnace to Determine the effect of following quenching media on the hardness of mild steel • Oil, • Water • Brine	15	10	5
LE7.1	Use Brinell, hardness tester to determine the hardness of a given material.	15	10	5
LE7.2	Use Rockwell hardness tester to determine the hardness of a given material.	15	10	5
LE7.3	Use Vickers hardness tester to determine the hardness of a given material.	15	10	5
LE7.4	Use Magnetic particle crack detector to detect internal crack in a given part/material.	15	10	5
LE7.5	Use Dye penetration method to detect surface crack in a given part/material.	15	10	5
LE7.6	Use Ultrasonic crack detector to identify internal crack in a given part/material.	15	10	5

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend: PRA: Process Assessment, PDA : Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1.	Material Science and Metallurgy	O. P. Khanna	Dhanpat Rai & Sons	ISBN: 9788189928315

S. No.	Title	Author	Publisher	Edition & Year
2.	Materials Science and Metallurgy	R. K. Rajput	S. K. Kataria & Sons	ISBN: 9789350144183
3.	Materials Science & Engineering	V. Raghvan	PHI	ISBN: 8120324552
4.	Materials Science	R. S. Khurmi	S Chand	ISBN: 9788121901468
5.	Materials Science	G. K. Narula, K. S. Narula, V. K. Gupta	TMH	ISBN: 0074517961
6.	Material Science & Metallurgy	U. C. Jindal	Pearson	ISBN: 9788131759110
7.	Fundamentals of Materials Science & Engineering	William D. Callister David G Rethwisch	Jhon Wiley & Sons	ISBN : 13 9781118287989

(b) Open source software and website address:

1. NPTEL Course- http://nptel.ac.in/courses/113106032/
2. Plastic deformation -https://www.youtube.com/watch?v=Oz8fW68RY6I
3. Properties and Structure of Engineering Materials- https://www.youtube.com/watch?v=uG35D_euM-0
4. Plastic deformation- https://www.youtube.com/watch?v=Oz8fW68RY6I
5. Phase diagrams- https://www.youtube.com/watch?v=m9O2LzwnxsY
6. Metallic Materials https://www.youtube.com/watch?v=uh4obOPltpw&list=PL8bFJyqxQ9otr7r3gGoZ2Hvl-3c8q6Q8A
7. Non-metallic Materials- https://www.youtube.com/watch?v=ssLOujezkxo
8. Heat treatment of Steels- https://www.youtube.com/watch?v=Jt8pYX4nVSo
9. Testing of Materials https://www.youtube.com/watch?v=tpGhqQvftAo&list=PL1XvQlloG76jRFOxUiWAcmYrMUf4BsnSX

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Metallurgical Microscope	6V, 30 W Halogen light, 200x magnification, wide field eyepiece, trinocular head, mechanical stage.	LE3.1, LE3.3, LE3.4, LE3.5
2	Grinding machine for rough polishing	Single phase, belt driven, ½ HP, manually operated	LE3.2
3	Double disc variable speed polishing machine (Automatic Polishing Machine can also be considered)	Digital, double disc, variable speed 50 – 1400 rpm control by potentiometer	LE3.2
4	Standard steel specimens for microscopic examination	Standard specimens of different types of steel	LE3.3
5	Standard Cast Iron specimens	Standard specimens of different types of	LE3.4

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
	for microscopic examination	cast iron	
6	Heat treatment furnace (Muffle/Box type)	Max temperature 1400^{o}C, digital temperature control, 220V with necessary accessories like gloves, tongs etc.	LE6.1, LE6.2
7	Brinell Hardness tester	Digital Brinell Hardness tester with standard accessories and conforming to Indian standards	LE7.1
8	Rockwell Hardness tester	Digital Rockwell Hardness tester with standard accessories and conforming to Indian standards	LE7.2
9	Vickers Hardness tester	Vickers Hardness tester with standard accessories and conforming to Indian standards	LE7.3
10	Magnetic particle crack detector	Operating on single phase 230V supply suitable for laboratory use with all standard accessories and consumables	LE7.4
11	Dye penetration test kit	Suitable for laboratory purposes with all standard accessories and consumables	LE7.5
12	Ultrasonic crack detector	Digital Ultrasonic crack detector comprising of ultrasonic pulser/receiver, hardware and software, LCD display	LE7.6

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Interpret properties and structure of various engineering materials.	2	3	3	2	-	1	-	1	1	1	-	-	3
CO-2 Analyze the plastic deformation of metals.	2	3	3	2	-	-	-	1	1	1	-	-	3
CO-3 Interpret the phase diagrams.	2	3	3	2	-	-	-	1	1	1	-	-	3
CO-4 Select ferrous and non ferrous materials as per the requirement.	2	3	3	2	-	1	-	1	1	2	-	-	3
CO-5 Select non-metallic materials as per the requirement	2	3	3	2	-	1	-	1	1	2	-	-	3
CO-6 Select heat treatment process as per the requirement	2	3	3	2	-	1	-	1	1	2	-	-	3
CO-7 Select relevant material testing method.	2	3	3	2	-	1	-	1	1	2	-	-	3

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,6, 8,9,10 PSO-3	CO-1 Interpret properties and structure of various engineering materials.	SO1.1, SO1.2 SO1.3, SO1.4 SO1.5	LE1.1 LE1.2 LE1.3 LE1.4	Unit 1.0 Properties and Structure of Engineering Materials 1.1, 1.2, 1.3. 1.4,1.5,1.6	As mentioned in relevant page numbers.
PO-1,2,3,4,8,9,10 PSO-3	CO-2 Analyze the plastic deformation of metals.	SO2.1, SO2.2 SO2.3, SO2.4 SO2.5,SO2.6	LE2.1	Unit 2.0 Plastic Deformation 2.1, 2.2, 2.3, 2.4, 2.5,2.6	
PO-1,2,3,4,8,9,10 PSO-3	CO-3 Interpret the phase diagrams.	SO3.1, SO3.2 SO3.3, SO3.4 SO3.5, SO3.6	LE3.1, LE3.2 LE3.3, LE3.4 LE3.5, LE3.6	Unit 3.0 Phase Diagrams 3.1, 3.2, 3.3, 3.4, 3.5, 3.6,3.7	
PO-1,2,3,4,6, 8,9,10 PSO-3	CO-4 Select ferrous and non ferrous materials as per the requirement.	SO4.1 SO4.2 SO4.3	LE4.1 LE4.2	Unit 4.0 Metallic Materials 4.1, 4.2, 4.3	
PO-1,2,3,4,6, 8,9,10 PSO-3	CO-5 Select non-metallic materials as per the requirement	SO5.1, SO5.2 SO5.3, SO5.4	LE5.1 LE5.2	Unit 5.0 Non-metallic materials 5.1, 5.2, 5.3, 5.4	
PO-1,2,3,4,6, 8,9,10 PSO-3	CO-6 Select heat treatment process as per the requirement	SO6.1 SO6.2 SO6.3	LE6.1 LE6.2	Unit 6.0 Heat treatment of steels 6.1, 6.2, 6.3,6.4,6.5	
PO-1,2,3,4,6, 8,9,10 PSO-3	CO-7 Select relevant material testing method.	SO7.1 SO7.2	LE7.1, LE7.2 LE7.3, LE7.4 LE7.5, LE7.6	Unit 7.0 Testing of Materials 7.1, 7.2,7.3	

Name of program: Diploma in Engineering **Semester: III**
Branch : Mechanical Engineering **Code: NIL**
Subject : Health, Hygiene & Yoga **Total Tutorial Periods: NIL**
No. Of Periods : 2 Periods/Week

Course Objectives:

1 To provide understanding the importance of health.
2 To provide insight into the hygiene aspect & quality of life.
3 To study the concepts of various medical therapy.
4 To practice the various yogasans.
5 To provide knowledge about common diseases and its cure through yagasans and pranayam.
6 To develop concentration through various methods.

UNIT- I **HEALTH & HYGIENE:** Concept of health, Physical health and mental health and wellbeing and how to achieve these, longevity and how to achieve it, concept and common rules of hygiene, cleanliness and its relation with hygiene; Overeating and underrating, amount of food intake required, intermittent fasting; adequate physical labour, sleep; consumption of junk fast food vs nutritious food; fruits, vegetables cereals and qualities of each of these.

UNIT-II **INTRODUCTORY KNOWLEDGE OF COMMON STREAMS OF MEDICINAL CURE:** History, development, basic concepts, modes of operation of Alopathy, Ayurved, Homoeopathy, Biochemic, Unani, Siddha, Accurpressure, Accupunture, Naturopathy, Yogic and Herbal system of medicines, Introduction of Anatomy and Physiology concerned.

UNIT- III **YOGASANS:** Meaning and concept of Yoga, Yogasans and its mode of operation, How to perform Yogasans, Common Yogasans with their benefits, such as, Padahastasan, Sarvangasan, Dhanurasan, Chakrasan, Bhujangasan, Paschimottasan, Gomukhasan, Mayurasan, Matsyasan, Matsyendrasan, Pawanmuktasan, Vajrasan, Shalabhasan, Sinhasan, Shashankasan, Surya Namaskar, Halasan, Janushirasan, Utshep Mudra.

UNIT-IV **YOGASANS FOR COMMON DISEASES:** From Yogic Materia Medica with symptoms, causes, asans and herbal treatment.

- **Modern silent killers:** High blood pressure, diabetes and cancer, causes and cure; Common health problems due to stomache disorders, such as, indigestion, acidity, dycentry, piles and fissures, artheritis, its causes, prevention and cure.
- **Asans for relaxation:** Shavasan, Makarasan, Matsyakridasan, Shashankasan.
- **Asans to increase memory and blood supply to brain:** Shirsh padasan, Shashankasan.
- **Asans for eye sight:** Tratak, Neti Kriya .
- **Pranayam:** Definition and types: Nadi Shodhan, Bhastrik, Shitakari, Bhramari useful for students.

UNIT-V **CONCENTRATION:** Concentration Of Mind And How To Achieve It. Tratak (त्राटक), Concentration On Breath, Japa (जप), Ajapajap (अजपाजप), Internal silence(, Visualization In Mental Sky (, Concentration On Point Of Light(, Concentration On Feeling (, Concentration On Figure (

Text Books:

Health, Hygiene & Yoga, Dr P B Deshmukh, Gyan Book Pvt Ltd. New Delhi.

Reference Books:

(1) Yogic Materia Medica
(2) Asan, Pranayam and Bandh