BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Programme Name/s	**: Automobile Engineering./ Agricultural Engineering/ Chemical Engineering/ Mechanical Engineering/ Production Engineering/ Polymer Technology**
Programme Code	**: AE/ AL/ CH/ ME/ PG/ PO**
Semester	**: Second / Third / Fourth**
Course Title	**: BASIC ELECTRICAL AND ELECTRONICS**
Course Code	**: 312020**

I. RATIONALE

Modern engineering systems, irrespective of the field, are increasingly incorporating smart technologies that rely on electrical and electronics components. Many engineering projects involve the integration of mechanical, electrical and electronic components. A well-rounded education in electrical and electronics principles enables engineers to work seamlessly across disciplines. In Chemical Engineering, Agricultural Engineering and Polymer Technology, precise measurement and control of variables are crucial. The fourth industrial revolution emphasizes the integration of digital technologies into manufacturing and engineering processes. Electrical and electronics knowledge is fundamental for implementing Industry 4.0 concepts in Engineering fields .This course will develop skills in handling tools and equipment related electrical and electronics engineering and provide the necessary foundation for understanding, maintaining and implementing advanced systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified outcomes through various teaching learning experiences: Use Electrical and Electronics equipment safely in mechanical engineering applications

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use Principles of electrical and magnetic circuits to solve mechanical engineering broadly defined problems.
- CO2 - Use of Transformer and Electric motors for given applications.
- CO3 - Suggest suitable electronic component for given mechanical engineering application.
- CO4 - Use of diodes and transistors as a relevant component in given electric circuits of . mechanical engineering application

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312020	BASIC ELECTRICAL AND ELECTRONICS	BEE	AEC	2	-	4	-	6	3	-	-	-	-	-	50	20	50@	20	-	-	100

BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the given technical terms related to Electric and Magnetic circuits . TLO 1.2 Identify analogy between Electric and Magnetic Circuits. TLO 1.3 Apply Fleming's right hand rule and Lenz's law for determination of direction of induced emf in the given situation. TLO 1.4 Explain attributes of the given AC quantities. TLO 1.5 Find currents and voltages in the given series and parallel AC circuits.	**Unit - I Electric and Magnetic Circuit** 1.1 1 Electric circuits E.M.F, Potential difference, power, Magnetic circuits M.M.F, magnetic force, permeability. 1.2 Electromagnetic induction, Faraday's laws of electromagnetic induction, Lenz's law, dynamically induced emf. 1.3 Statically induced emf. (a) Self induced emf (b) Mutually induced emf; Equations of self and mutual inductance. 1.4 A .C. Signal terms: Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor, Peak Factor, impedance, phase angle, and power factor. 1.5 Voltage and Current relationship in Star and Delta connections. Working of Batteries, wiring specifications and IS electrical standards for safety and appliances.	Chalk-Board Presentations Videos on Flemings Right hand rule and Lenz Law
2	TLO 2.1 Explain with sketches the construction and working principle of the given type of single phase transformer. TLO 2.2 Explain with sketches the working principle of the given autotransformer. TLO 2.3 Describe with sketches the construction of the given single phase motor. TLO 2.4 Explain with the sketches the working principle of the given single phase induction motors.	**Unit - II Transformer and single phase induction motor** 2.1 General construction and principle of different type of transformers, EMF equation and transformation ratio of transformers. 2.2 Auto transformers. Working Principle and applications 2.3 Construction and Working principle of single phase AC. motor. Types of single phase motors, applications of single phase motors. 2.4 Applications of Induction motors	Chalk-Board Demonstration Hands-on

BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Differentiate between the given active and passive components. TLO 3.2 Determine the value of given resistor and capacitor using color code and printed information on components . TLO 3.3 Explain the given signal parameters with sketches. TLO 3.4 Identify the given type of ICs based on the IC number	**Unit - III Electronic Components and Signals** 3.1 Electronic Components : Passive and Active components: Resistor, Capacitor, Inductor, symbols color codes, specifications. 3.2 Voltage and current sources, signals: Waveform (Sinusoidal, triangular and square). 3.3 Time and frequency domain representation of signals.Amplitude, frequency, phase, wavelength. 3.4 Integrated circuits - Analog and Digital.	Chalk-Board Demonstration of components Hands-on
4	TLO 4.1 Explain with the sketches the working of given type of diode using its V-I characteristics. TLO 4.2 .Explain with the sketches the working of given type of rectifier using circuit diagram. TLO 4.3 Justify the given selection of power supply and LEDs for the given circuit. TLO 4.4 Explain with the sketches the application of the given type of transistor as a switch. TLO 4.5 Compare the performances of the given transistor configurations.	**Unit - IV Diodes and Bipolar Junction Transistor** 4.1 Diodes and its Applications: P-N junction diode: symbol, construction working and applications ,Zener diode: working, symbol, voltage regulator. 4.2 Rectifiers: Half wave, Full wave, Bridge rectifier Performance parameters: PIV, ripple factor, efficiency. 4.3 Light Emitting Diodes: symbol, construction, working principle and applications. 4.4 BJT Symbol, construction, working principle Transistor as switch and amplifier. 4.5 Input and Output characteristics: CE configurations, Operating regions: Cut-off, saturation Active Region.	Chalk-Board Demonstration Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure voltage and current in single phase circuits with resistive load using appriopriate meters	1	* Voltage and Current measurement	2	CO1
LLO 2.1 Measure power required by single phase circuit with resistive load.	2	* Power measurement of single phase circuit	2	CO1
LLO 3.1 Measure Energy consumed by given equipment using energy meter.	3	Energy measurement	2	CO1
LLO 4.1 Measure average value, peak value and RMS value of AC waveform using CRO./ DSO LLO 4.2 Measure time and frequency of AC waveform using CRO./ DSO	4	AC signal parameters	2	CO1
LLO 5.1 Make a star and delta connection to measure line and phase voltage	5	* Line and Phase voltage measurement of star - delta connection circuit	2	CO1
LLO 6.1 Test given battery using digital multimeter.	6	* Battery Testing	2	CO1
LLO 7.1 Connect Single phase transformer for measuring input and output quantities LLO 7.2 Determine its turns ratio	7	* Input and output quantities of Single phase transformer	2	CO2
LLO 8.1 Test primary and secondary winding to measure continuity of transformer.	8	Continuity test of transformer-primary and secondary windings	2	CO2

BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Measure output voltage of auto transformer	9	Auto transformer	2	CO2
LLO 10.1 Identify parts of single phase induction motor.	10	* Single phase induction motor	2	CO2
LLO 11.1 Select the suitable gauge of wire for given electrical application.	11	* Electrical wire specifications	2	CO2
LLO 12.1 Build the switch board for given requirement by connecting suitable coloured wire to respective terminals .	12	* Electrical Swichboard assembly	2	CO2
LLO 13.1 Identify Passive electronic components on given electronics circuit	13	* Passive electronic components	2	CO3
LLO 14.1 Connect the capacitors in series combination on bread board to measure its value using multimeter. LLO 14.2 Connect the capacitors in parallel combination on bread board to measure its value using multimeter.	14	* Resistors in series and parallel connections	2	CO3
LLO 15.1 Connect the capacitors in series combination on bread board to measure its value using multimeter. LLO 15.2 Connect the capacitors in parallel combination on bread board to measure its value using multimeter.	15	Capacitors in series and Parallel connections	2	CO3
LLO 16.1 Use LCR-Q meter for measuring the value of given Inductor and Capacitors.	16	* LCR-Q meter	2	CO3
LLO 17.1 Identify various active electronic components in given circuit.	17	* Active electronic components	2	CO3
LLO 18.1 Test the given P N junction diode using multi meter	18	* P N Junction diode	2	CO4
LLO 19.1 Multi colour LEDs.	19	Multi colour LEDs	2	CO4
LLO 20.1 Identify type of seven segment display (Common anode / Common cathode)) LLO 20.2 Testing of seven- segment display.	20	* Seven- segment display	2	CO4
LLO 21.1 Built/ Test Half Wave Rectifier.	21	Half Wave Rectifier	2	CO4
LLO 22.1 Test Full Wave Rectifier using virtual Lab.	22	Full Wave Rectifier	2	CO4
LLO 23.1 Build/Test Bridge Rectifier constructed using four diodes LLO 23.2 Test bridge rectifier package	23	Bridge Rectifier	2	CO4
LLO 24.1 Identify three terminals of transistors using multimeter.	24	Three terminals of transistors	2	CO4
LLO 25.1 Test the performance of NPN transistor.	25	Testing of NPN transistor	2	CO4
LLO 26.1 Soldering and de- soldering given passive active components on PCB	26	* Soldering and De soldering	2	CO4
LLO 27.1 Test the performance of zener diode	27	Zener diode	2	CO4
LLO 28.1 Identify components of flasher circuits	28	Electronic flasher circuit	2	CO4
LLO 29.1 Identify terminals of three terminal positive and negative voltage regulator	29	* Three terminal voltage regulators	2	CO4
LLO 30.1 Build and test + 5 V regulated D C power supply using three terminal voltage regulator .	30	Regulated Power Supply	2	CO4

BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Single Phase Autotransformer: Single phase, Input 0-230,10 A, Output:0-270 Volts	1,2
2	Clamp on Meter: 750 V, 2000 Counts	1,2
3	Single Phase Induction Motor - 230 V 50 Hz AC supply	11
4	LCR Q Meter: Parameter L-Q, C-D, R-Q and Z-Q Frequency 00 Hz, 120 Hz and 1 KHz Accuracy Basic Accuracy : 0.3% Display 5 digits display for both primary and secondary parameters L 100 Hz, 120 Hz 1 mH - 9999 H 1 KHz 0.1 mH - 999.9 H Measurement C 100 Hz, 120Hz 1 pF – 9999 mF Range 1 KHz 0.1 pF - 999.9 mF R, |Z| 0.0001V- 999.9 MV D, Q 0.0001 – 9999 D% 0.0001% - 9999% Test Level 120 Hz 0.3 Vrms (1 ±15%) (Range Auto 1 KHz and Open 100 Hz 0.42 Vrms (1±15%) Circuit) Ranging Mod Auto and Hold Equ	15
5	Function Generator: Frequency range 0.1Hz to 30 MHz sine, square, triangular, ramp and pulse generator, Output amplitude 20V open circuited, Output impedance 50 ohms. Facility to indicate output frequency and amplitude on display	22,23,24,29
6	Simulation software: Multisim, Proteus	23
7	CRO: Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Readout , USB interface or CRO with higher specifications	26,27,28,30
8	Digital Storage Oscilloscope: 25MHz/60MHz/70MHz/100MHz Dual Channel, 4 Trace TFT based X10 magnification 20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out, USB interface. Any other Oscilloscope with additional features is also suitable with magnifying probe at least two probes, if possible isolated probe	27,28,30
9	Single Phase Direct Measuring Energy Meter :100A 176 to 276V AC	3
10	Measurement Digital Multimeter: Minimum 3 ½ digit 4 ½ digit display, multimeter measures Vac, Vdc (1000V max), Adc, Aac (10-amp max), Resistance (0-100 Mohm), diode and transistor testing mode	4,6,12,14,17,18,19,20,21,25,13,9
11	Lamp Bank - 230 V 0-20 A	5
12	Single phase auto transformer-Single Phase Input 0-230,10A,output: 0-270Volts	7,8

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Electric and Magnetic Circuit	CO1	7	0	0	0	0

BASIC ELECTRICAL AND ELECTRONICS **Course Code : 312020**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Transformer and single phase induction motor	CO2	8	0	0	0	0
3	III	Electronic Components and Signals	CO3	7	0	0	0	0
4	IV	Diodes and Bipolar Junction Transistor	CO4	8	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For FA PR ,Formative (Continuous) assessment shall be based on process and product related performance indicators. Course teacher may assign 60%, weightage for process and 40% weightage for product related LL work .

Summative Assessment (Assessment of Learning)

- For SA PR At the end of semester PR examination will be conducted by course teacher and based on PR exam performance marks out of 50 will be allocated

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	-	1	-	-	1			
CO2	2	-	-	2	-	-	1			
CO3	1	-	-	1	-	-	1			
CO4	1	1	1	1	-	-	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mittle and Mittal	Basic Electrical Engineering	McGraw Education, New Delhi, edition 2017, ISBN-13 978-0070593572
2	Jegathesan, V	Basic Electrical and Electronics Engineering	Wiley India, New Delhi, edition-2015 ISBN 978-8126529513
3	Sedha, R.S.	A Text book of Applied Electronics	S.Chand New Delhi, edition-2008 ISBN-13: 978-8121927833
4	Mehta, V.K. Mehta, Rohit	Principles of Electronics	S. Chand and Company, New Delhi, edition-2014, ISBN-13-9788121924504
5	Bell Devid	Fundamental of Electronic Devices and Circuits	Oxford University Press, New Delhi edition-2015 ISBN 978-0195425239
6	Susan S Mathew Saji T Chacko	Fundamental of Electrical and Electronics Engineering	Khanna Book Publishing Co (P) Ltd. New Delhi 978-93-91505-59-2

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://fossee.in/ (Open Source Electronics Simulation software) https://cloud.scilab.in/ (Open Source Scilab Cloud for Electronics Simulation)	Smulation
2	https://www.electrical4u.com/fleming-left-hand-rule-and-flem ing-right-hand-rule/	Flemings Right hand and left hand rule
3	https://www.electrical4u.com/lenz-law-of-electromagnetic-ind uction/	Lenz's Law
4	https://www.animations.physics.unsw.edu.au/jw/	Electronic components, A.C. circuits, transformer, Electric motors.
5	https://en.wikipedia.org/wiki/Transformer	Transformer
6	http://www.alpharubicon.com/altenergy/understandingAC.htm	A.C. Current
7	https://www.learningaboutelectronics.com/Articles/	Electronic components
8	https://learn.sparkfun.com/tutorials/transistors	Transistors
9	https://www.technologystudent.com/elec1/transis1.htm	Transistors
10	https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/get_i s_list_by_category_id/5	IS standards for electrical safety and appliances

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

STRENGTH OF MATERIALS **Course Code : 313308**

Programme Name/s	**: Automobile Engineering./ Agricultural Engineering/ Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Production Engineering/**
Programme Code	**: AE/ AL/ CE/ CR/ CS/ LE/ ME/ PG**
Semester	**: Third**
Course Title	**: STRENGTH OF MATERIALS**
Course Code	**: 313308**

I. RATIONALE

All civil & mechanical engineering components are subjected to different types of loads and behave in a specific way. Students can able to understand & analyze various types of loads, stresses & strains with regards to the structural behavior of components and materials. This course is a prerequisite for understanding elastic behavior of different engineering materials, structural analysis, machine design, principles and the strengths of various structural elements used in civil & mechanical industries.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Analyze the stresses & strains in the given structural elements using relevant methods.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Calculate the M.I. of the given object using relevant formulae & methods.
- CO2 - Analyze the structural behavior of the given structural components under various loading conditions.
- CO3 - Draw SFD and BMD for the given structural element under given loading conditions.
- CO4 - Determine the bending and shear stresses in beams under different loading conditions
- CO5 - Analyze the direct & bending stresses in the structural members under eccentric loading conditions.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313308	STRENGTH OF MATERIALS	SOM	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

STRENGTH OF MATERIALS **Course Code : 313308**

Total IKS Hrs for Sem. : 1 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Calculate Centroid, Moment of Inertia of Plane lamina and radius of gyration of a given lamina. TLO 1.2 Explain Parallel and Perpendicular axes theorems. TLO 1.3 Calculate Moment of inertia of standard solid shapes and hollow shapes. TLO 1.4 Calculate Moment of inertia of composite plane figures such as I, C, T & L sections. TLO 1.5 Understand Moment of inertia for built-up section.	**Unit - I Moment of Inertia** 1.1 Concept of Moment of Inertia, M.I. of plane lamina and radius of gyration of a given lamina. 1.2 Parallel and perpendicular axes theorems (without derivation). 1.3 M.I. of standard basic figures like square, rectangle, triangle, circle, semi-circle, quarter-circle and Hollow Rectangular & Circular sections. (without derivation). 1.4 M.I. of Composite plane figures such as symmetrical and unsymmetrical I-section, channel section, T-section, angle section. Numerical on composite figure consisting of maximum 03 standard shapes. 1.5 Introduction to M.I. for built-up sections. (No numerical). (IKS* Concept of Centre of Gravity & M.I.used in ancient constructions like temples, forts etc.)	Chalk-Board Hands-on Collaborative learning Video Demonstrations Presentations

STRENGTH OF MATERIALS **Course Code : 313308**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Understand concept of stresses and strains in deformable bodies. TLO 2.2 Understand Hook's law, elastic limit, Linear and lateral strain, Poisson's ratio. TLO 2.3 Determine modulus of elasticity, modulus of rigidity and bulk modulus for given material. TLO 2.4 Articulate practical significance of stress- strain curve for given material under given loading conditions for their relevant use. TLO 2.5 Concept of single shear, double shear & punching shear. TLO 2.6 Compute the total deformation for given homogeneous (compound) sections under axial load. TLO 2.7 Determine the stresses in each material for given composite section. TLO 2.8 Compute strain along x, y and z-direction for a given bi-axial or tri-axial stress system. TLO 2.9 Determine volumetric strain & change in volume for given cube or cuboid.	**Unit - II Simple Stresses, Strains & Elastic Constants** 2.1 Concept of elastic body ,definition of stress, strain, Type of stresses & strains. 2.2 Hook's law, elastic limit, Linear and lateral strain, Poisson's ratio. 2.3 Young's Modulus, Shear Modulus, Bulk Modulus & Relation between these three moduli. 2.4 Standard stress strain curve for mild steel bar and Tor steel bar under tension test, Yield stress, proof stress, ultimate stress, breaking stress, and working stress, strain at various critical points, percentage elongation and Factor of safety. 2.5 Shear stress and shear strain, Single shear, Double shear, Punching shear. 2.6 Deformation of body subjected to axial force for uniformed and stepped sections .Deformation of uniform body subjected to forces at its intermediate sections. 2.7 Concept of composite section, stresses induced and load shared by each material under axial loading only.(No numerical on stepped sections). 2.8 Uni-axial, Bi-axial and Tri-axial stress systems. 2.9 Strain in each direction, volumetric strain, change in volume.	- Chalk-Board - Hands-on Collaborative learning - Video - Demonstrations - Presentations
3	TLO 3.1 Enlist Types of Supports & Types of Beams TLO 3.2 Enlist types of loads acting on a beam. TLO 3.3 Understand the relation between SF, BM and rate of loading. TLO 3.4 Draw SFD and BMD for Simply supported beams ,Cantilever beams & overhanging beams. TLO 3.5 Locate point of maximum BM and point of contra-flexure.	**Unit - III Shear Force & Bending Moment** 3.1 Types of Supports: Simple, Hinge, Roller & Fixed and Beams: Cantilever, Simply supported, Roller, Hinge & overhanging beams. 3.2 Types of loads: Concentrated or Point load, Inclined point load & Uniformly Distributed load. 3.3 Meaning of SF and BM, Relation between them, Sign conventions. 3.4 SFD & BMD for Simply Supported, Cantilever and overhanging beams subjected to Vertical point load & UDL only. 3.5 Drawing SFD and BMD, Location of Point of Contra-Shear, maximum BM, Location of Point of Contra-flexure.	Chalk-Board Hands-on Collaborative learning Video Demonstrations Presentations

STRENGTH OF MATERIALS **Course Code : 313308**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Understand concept of pure bending , Neutral Axis and radius of gyration of a given lamina and section modulus. TLO 4.2 Determine Moment of Resistance (M.R.) & section modulus (Z) using Flexural Formula. TLO 4.3 Determine the Bending stresses at given location in simply supported & cantilever beams subjected to standard loading cases (Point load & UDL only). TLO 4.4 Compute & draw maximum and average shear stress for rectangular and circular section. TLO 4.5 Draw shear stress distribution diagram for given section across its depth. TLO 4.6 Determine shear stresses in hollow rectangular section.	**Unit - IV Bending and Shear Stresses in beams** 4.1 Theory of pure bending, assumptions in pure bending, Concept of Neutral Axis and section modulus. 4.2 Flexural Equation (without derivation) with meaning of each term used in equation, bending stresses and their nature, bending stress distribution diagram. 4.3 Bending stress variation diagram across depth of given cross section for cantilever and simply supported beams for symmetrical sections only. 4.4 Shear stress equation (without derivation), meaning of each term used in equation, relation between maximum and average shear stress for square, rectangular and circular section (numerical), shear stress distribution diagram. 4.5 Shear stress distribution diagram for square, rectangular, circle, hollow square, hollow rectangular, hollow circle, T- section & symmetrical I- section only. (no numericals) 4.6 Use of shear stress equation for determination of shear stresses in hollow rectangular section.	Chalk-Board Hands-on Collaborative Learning Demonstration Video Presentations
5	TLO 5.1 Explain effect of direct and eccentric loads on columns. TLO 5.2 Draw resultant stress distribution diagram for a compression member subjected to eccentric load about one of its principal axis. TLO 5.3 Write No tension condition for columns, Core of the section for rectangular & circular column. TLO 5.4 Identify the terms radius of gyration, slenderness ratio & effective length for given column with different end conditions. TLO 5.5 Understand the concept of buckling load in columns using Euler's Formula & Rankine's Formula.	**Unit - V Direct and Bending Stresses** 5.1 Introduction to direct and eccentric loads, Eccentricity about one principal axis, nature of stresses. 5.2 Maximum and minimum stresses, resultant stress distribution diagram. Condition for 'No tension' condition(Problems on Column subjected to Eccentric load about one axis only.) 5.3 Limit of eccentricity, core of section for circular cross sections, middle third rule for rectangular section. 5.4 Introduction to compression members, effective length, radius of gyration, slenderness ratio, type of end conditions for columns. 5.5 Buckling (or Crippling) load for columns by Euler's Formula & Rankine's Formula with meaning of each term in it.(No numericals.)	Chalk-Board Collaborative learning Presentations Demonstration Videos

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different components of UTM .	1	*Conduct sample compressive and tensile tests on metal using Universal Testing Machine along with introduction to machine & other tests to be conducted on UTM.	2	CO2
LLO 2.1 Perform Tension test on mild steel as per IS:432(1) .	2	*Tension test on mild steel as per IS:432(1) .	2	CO2
LLO 3.1 Perform tension test on Tor steel as per IS:1608, IS:1139 .	3	Tension test on Tor steel as per IS:1608, IS:1139 .	2	CO2

STRENGTH OF MATERIALS **Course Code : 313308**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Conduct compression test on sample test piece using Compression Testing Machine .	4	*Compression test on any two metals like Mild Steel, Brass, Al etc. using Compression Testing Machine .	2	CO2
LLO 5.1 Conduct Izod Impact test on given metals as per IS:1598 .	5	*Izod Impact test on any two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1598 .	2	CO2
LLO 6.1 Conduct Charpy Impact test on given metals as per IS:1598 .	6	Charpy Impact test on two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1757 .	2	CO2
LLO 7.1 Determine Compressive strength of dry and wet bricks .	7	Compressive strength of dry and wet bricks as per IS:3495 (part I), IS:1077 .	2	CO2
LLO 8.1 Perform Single Shear and double shear test on given metals as per IS:5242 .	8	*Single Shear and double shear test on any two metals like Mild steel/ brass/ Al / copper / cast iron etc. as per IS:5242 .	2	CO2 CO4
LLO 9.1 Conduct Compression test on timber section along the grain and across the grain .	9	Compression test on timber section along the grain and across the grain as per IS:2408 .	2	CO1 CO2
LLO 10.1 Plot Shear force and Bending Moment diagrams of beams subjected to different types of loads.	10	*Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loading . (02 problems on each type of beam) .	4	CO3
LLO 11.1 Conduct Flexural test on timber beam on rectangular section.	11	*Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408 .	2	CO1 CO4
LLO 12.1 Prepare PPT on Strain Energy. LLO 12.2 Prepare PPT on Thermal Stresses & Thermal Strains.	12	a) Prepare PPT of minimum 05 slides on the concept of Strain Energy & instantaneous stress induced in a material due to gradual, Sudden & impact load. b) Prepare PPT of minimum 04 slides on Thermal Stresses & Thermal Strains.	2	CO2
LLO 13.1 Conduct Flexure test on floor tiles/roofing tiles.	13	Flexure test on floor tiles IS:1237, IS:13630 or roofing tiles as per IS:654, IS:2690 .	2	CO4
LLO 14.1 Determine hardness no. for given metal using Rockwell Hardness Tester.	14	Rockwell Hardness Test on any two Metals like Mild Steel, Brass Copper, Aluminum etc.	2	CO2
LLO 15.1 Determine hardness no for given metals using Brinell Hardness Tester.	15	Brinell hardens test on any two metals like Mild Steel, Brass Copper, Aluminum etc.	2	CO2

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Collect the information of Indian Knowledge System (IKS) given in different units.
- Prepare charts of maximum bending moment and shear force values in standard beams.
- Two Numericals on Chimneys (of rectangular and circular cross section) subjected to wind pressure & also draw stress distribution diagram at base of it.

- Draw & identify difference between Bending stress distribution & Shear stress distribution diagrams for square, rectangular, circle, hollow square, rectangular, circle, T- section, & symmetrical I- section.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Extensometer with least count 0.01mm, maximum extension 25 mm with dial gauge/ digital display suitable for various gauge length.	1,2,3
2	Accessories: Vernier caliper, meter scale, weighing balance, weights, punch, file, hammer, screw driver, pliers, etc.	1,2,3,4,5,6,7,8,9,11,13
3	Universal Testing Machine of capacity 1000kN, 600 kN / 400 kN, analog type/digital type with all attachments and accessories.	1,2,3,8,11,13
4	Tile flexural testing machine confirming to IS:654, capacity 200 Kg with uniform loading rate of 45 to 55 Kg/minute provided with lead shots .	13
5	Brinell and Rockwell Hardness Test machine .	14,15
6	Compression Testing Machine of capacity 2000 kN / 1000 kN, analog / digital type with all attachments and accessories.	4,7,9
7	Izod/Charpy impact testing machine confirming to IS: 1757.	5,6
8	Hot Air Oven with thermostatic control having temp. range 100 to 105 degree celsius .	7

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Moment of Inertia	CO1	10	2	4	6	12
2	II	Simple Stresses, Strains & Elastic Constants	CO2	16	6	8	4	18
3	III	Shear Force & Bending Moment	CO3	14	2	4	10	16
4	IV	Bending and Shear Stresses in beams	CO4	10	2	4	6	12
5	V	Direct and Bending Stresses	CO5	10	2	4	6	12
Grand Total				**60**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks each will be conducted and average of two-unit tests considered. • For formative assessment of laboratory learning 25 marks • Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

STRENGTH OF MATERIALS **Course Code : 313308**

Summative Assessment (Assessment of Learning)

- Pen and Paper Test (Written Test)

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	3	2	2	1	--	2			
CO2	3	3	3	3	1	--	3			
CO3	3	3	2	1	1	--	2			
CO4	3	3	2	1	1	---	2			
CO5	3	3	2	1	1	--	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Khurmi R.S., Khurmi N.	A Textbook of Strength of Materials	S. Chand and Co. Ltd. New Delhi, 2019, ISBN 9789352833979
2	Ramamrutham S.	Strength of Materials	Dhanpat Rai and sons, New Delhi, 2015, ISBN 9788187433545
3	Punmia B. C., Ashok Kumar Jain , Arun Kumar Jain .	Mechanics of Materials	Laxmi Publications (p) Ltd. New Delhi, 2017, ISBN-13: 978-8131806463
4	Rattan S.S.	Strength of Materials	McGraw Hill Education; New Delhi 2017, ISBN-13: 978-9385965517
5	Rajput R. K .	A Textbook of Strength of Materials	S. Chand Publishing 9789352533695, 9352533690

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/DzyIEz3dKXQ?si=beGDRqJ1olZ70LUe	Concept of Stress and Strain .
2	https://youtu.be/RSlmDKHDMUY?si=FHCxXE1QSaa0FqBn	Standard stress-strain curve for mild steel bar and Tor steel bar .
3	https://www.youtube.com/watch?v=MFZ18Ed4HI8	Field Test on TMT .
4	https://www.youtube.com/watch?v=C-FEVzI8oe8	Concept of SFD and BMD .
5	https://www.youtube.com/watch?v=yvbA4mk36Kk	Practical examples of SFD and BMD.
6	https://www.youtube.com/watch?v=f2eGwNUopws	Concept & Numerical on Point of Contraflexure .
7	https://www.youtube.com/watch?v=f08Y39UiC-o	Bending Stresses & Shear Stresses in Beams .
8	https://skyciv.com/structural-software/beam-analysis-softwar e	Calculation & Drawing of SFD & BMD freeware Software .

STRENGTH OF MATERIALS **Course Code : 313308**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**

FUNDAMENTALS OF AUTOMOBILE ENGINES **Course Code : 313312**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Third**
Course Title : **FUNDAMENTALS OF AUTOMOBILE ENGINES**
Course Code : **313312**

I. RATIONALE

Internal combustion (IC) engines find extensive application in a various range of vehicles, including cars, motorcycles, trucks, and airplanes, as well as in industrial and power generation contexts. This course is designed to cultivate proficiency in identifying and locating engine parts, understanding their functions, managing minor settings, and executing the procedures for the disassembly and assembly of systems and components related to automobile engines. Successful completion of this course is a prerequisite for advancing into more advanced engine technology studies.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Check the functioning of engine components in both two-wheeler and passenger car.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the given engine specifications.
- CO2 - Identify engine components and their respective locations.
- CO3 - Perform minor adjustments to the fuel feed system
- CO4 - Inspect the ignition system to ensure proper functioning
- CO5 - Maintain cooling and lubrication systems of the vehicle.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313312	FUNDAMENTALS OF AUTOMOBILE ENGINES	FAE	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State the advantages and disadvantages of the IC engines TLO 1.2 Describe valve timing diagram for SI and CI Engines TLO 1.3 Define engine terminology TLO 1.4 Describe working principle of given engine TLO 1.5 Differentiate between SI and CI engines on the basis of given parameters TLO 1.6 Compare engine working cycles on the basis of given parameters.	**Unit - I Basics of Automobile Engines** 1.1 Basic engine terminology- Cylinder bore, Stroke, TDC, BDC, Clearance volume, swept volume, Total volume, Cubic Capacity, Compression ratio, Power and Torque. Classification of I.C. Engines. Engine specifications, Limitation and Applications of IC engines. 1.2 Cycle of operations in four strokes and two-stroke SI and CI engines, valve timing diagrams & their comparative study; Scavenging. 1.3 Air standard and Fuel air cycles, Actual cycles, Deviation of actual engine cycle from ideal cycle 1.4 Comparison of otto, diesel and dual cycle.	Chalk Board/ White Board Presentations Model demonstration Video demonstration
2	TLO 2.1 List the different components of the given automobile engine TLO 2.2 Describe constructional features of the given engine components TLO 2.3 Sketch the valve arrangement used in the automobile engine. TLO 2.4 Describe functions of the given engine components. TLO 2.5 Suggest suitable material for given component with relevant justification	**Unit - II Constructional Features of Engine Components** 2.1 Engine subsystems and components-location, functions, specific features and materials- Cylinder block, Cylinder liner, Cylinder head, Gaskets, Piston, Piston rings, Piston pin, Crank shaft, Camshaft, Connecting rod, Oil sump. 2.2 Valves and Valve operating mechanisms- types, valve material, Valve springs, Valve guides, Cam and followers. Push rods, rocker arm. OHV and OHC system, Valve cooling 2.3 Camshaft drives: Timing Gears, Chain and Belt drive.	Model Demonstration Presentations Demonstration Presentations
3	TLO 3.1 Describe construction and working of the given type of carburetion system with sketches. TLO 3.2 Explain with sketches the construction and working of the given type of fuel injection system. TLO 3.3 Describe with sketch the working of mechanical governor TLO 3.4 List different types of nozzles used in diesel fuel injection system.	**Unit - III Fuel and Air feed system** 3.1 Petrol fuel supply system- Types, Layout, location and functions of components, Fuel Tank, Fuel Filter, S. U. Electrical Fuel Pump. 3.2 Principle of carburetion, Air fuel ratio requirements, Simple carburetor, limitations of simple carburetor, Types of carburetors (Carter, Solex & SU) 3.3 Need and requirements of Fuel Injection Systems; layout and types-Individual pump, Unit injector system, Distributor system and Common rail system. 3.4 Fuel Injector and types of nozzles. Fuel metering in Fuel Injection Pump (Inline pump and Distributor pump) 3.5 Working of Mechanical Governor in Fuel Injection Pump. 3.6 Air cleaners and Filters.	Demonstration Model Demonstration Video Demonstrations Presentations

FUNDAMENTALS OF AUTOMOBILE ENGINES **Course Code : 313312**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain with sketch the working of the given type of ignition system. TLO 4.2 Explain the firing order of the given engine with relevant justification TLO 4.3 Explain with sketch the construction and working of exhaust system TLO 4.4 Select the relevant type of silencer/Mufflers for the given engine.	**Unit - IV Ignition and Exhaust System** 4.1 Requirements of ignition system 4.2 Magneto and Battery Ignition system-layout, construction and working 4.3 Engine firing order-Necessity, Firing order of 3,4 and 6 cylinder engines 4.4 Function of Exhaust manifold. 4.5 Types of silencer / Mufflers (Construction and Working).	Model Demonstration Video Demonstrations Presentations Demonstration
5	TLO 5.1 Describe the need and functions of cooling system TLO 5.2 Describe the need and functions of lubrication system TLO 5.3 Explain with the sketch construction and working of the cooling system. TLO 5.4 Describe various properties of coolant and their effects on cooling performance TLO 5.5 Describe properties of the given type of engine oil and their effects TLO 5.6 Select the relevant coolant and engine oil for given operating condition.	**Unit - V Engine Cooling and Lubrication system** 5.1 Need of cooling system and limitations of cooling system. 5.2 Types: Air, Water/ Liquid cooling system (Layout and Function of Components) 5.3 Engine Coolants and additives-Types and Characteristics and their effect on performance of engine cooling 5.4 Cooling system components- Construction and working of Thermostat valve, Water expansion tank, Temperature Indicators, Pressure cap, Water pump, Fan and fan belt, electrically driven Fan circuit. 5.5 Radiator: Construction and type of radiator cores 5.6 Need, Properties and additives used in lubricating oil, Parts to be lubricated 5.7 Classification of Lubricating Oils on the basis of Viscosity (SAE) and Load (API) Severity rating; Types of lubrication system-Mist, Splash, Pressure – wet sump and dry sump 5.8 Functions of Components: Oil filters, Oil pump and its drive, pressure regulators, oil pressure gauge.	Model Demonstration Video Demonstrations Presentations Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Observe different engine Components /sub assembly LLO 1.2 Identify location of various engine subassemblies/ components of given engine and their interconnectivity	1	*Identify the components in the given cut section/working models of 2/4 stroke engines (petrol/ diesel)	2	CO1
LLO 2.1 Use suitable tools to dismantle the engine as per service manual LLO 2.2 Identify major components LLO 2.3 Follow safety precautions for dismantling the engine	2	*Dismantle two/four-wheeler engine	2	CO2

FUNDAMENTALS OF AUTOMOBILE ENGINES **Course Code : 313312**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Identify the different components of a given engine LLO 3.2 Enlist the specification and function of each component of the given engine with sketches LLO 3.3 Prepare a report on the following aspects: Constructional details, materials and manufacturing process, Working principles and operation of components	3	Examine the major engine components (Minimum Five)	2	CO2
LLO 4.1 Measure dimensional parameters of Engine components (eg. crank throw in crankshaft, dimeters of main journal and crankpin journals) LLO 4.2 Record the dimensions of each component and compare with the service/ workshop manual LLO 4.3 Prepare report with relevant data and sketches	4	*Measure dimensional parameters of Engine components (Eg. crank throw in crankshaft, dimeters of main journal and crankpin journals)	2	CO2
LLO 5.1 Use suitable tools for checking the valve and valve guide LLO 5.2 Replace the valve if necessary LLO 5.3 Check valve seats leakage LLO 5.4 Dismantle rocker shaft assembly LLO 5.5 Clean and check rocker shaft and levers for wear and cracks and reassemble	5	Inspection of valve seats and valve guide	2	CO2
LLO 6.1 Use suitable tools for dismantling cylinder head assembly LLO 6.2 Check the flatness of the cylinder head with a feeler Gauge LLO 6.3 Reassemble removable parts in sequence LLO 6.4 Refit cylinder head and manifold and other assembly	6	Examine the cylinder head assembly	2	CO2
LLO 7.1 Use appropriate tools for dismantling the carburetor from two-wheeler/ four-wheeler engine. LLO 7.2 Follow standard procedure / service manual to check the different components LLO 7.3 Reassemble it accurately.	7	*Carburetor Dismantling and Refitting (Two-Wheeler/Four-Wheeler)	2	CO3
LLO 8.1 Dismantle the reciprocating /rotary plunger type fuel injection pump as per service manual LLO 8.2 Identify and check various components LLO 8.3 Reassemble the rotary plunger type fuel injection pump accurately	8	Fuel Injection Pump	2	CO3
LLO 9.1 Identify the different components of the fuel supply systems LLO 9.2 Describe the function of each component of the given system with sketches LLO 9.3 Prepare report with referring to workshop manual process	9	*Diesel fuel injection system	2	CO3

FUNDAMENTALS OF AUTOMOBILE ENGINES **Course Code : 313312**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Check the given fuel filter LLO 10.2 Replace the faulty fuel filter in an engine LLO 10.3 Use proper techniques for handling and installing fuel filters in both two-wheelers and four-wheelers.	10	Replacement of Fuel Filter (Two-wheelers / four-wheelers)	2	CO3
LLO 11.1 Identify the different ignition components including spark plugs, ignition coils, and High-Tension (HT) cords. LLO 11.2 Describe the function of each component of Ignition system with sketches LLO 11.3 Perform cleaning, inspection of critical ignition components as per service manual	11	*Maintenance of Spark Plug, Ignition Coil, and HT Cords	2	CO4
LLO 12.1 Identify the suitable grade of engine oil LLO 12.2 Unscrew the drain plug for removing the used oil LLO 12.3 Plug in screw and Refill the engine oil up to the desired level LLO 12.4 Check the oil level and any leakages	12	Practice on change of Engine oil	2	CO5
LLO 13.1 Recognize the role of oil pump, oil filter, and pressure relief valve in engine protection LLO 13.2 Dismantle the given oil pump, oil filter, and pressure relief valve LLO 13.3 Reassemble the components after thoroughly checked	13	*Dismantling and Assembly of Oil Pump, Oil Filter, and Pressure Relief Valve	2	CO5
LLO 14.1 Check proper functioning of different parts such as radiator, radiator fan, Thermostat, water pump etc. LLO 14.2 Check the engine oil pressure, coolant level, radiator cap etc.	14	*Service engine cooling system its parts and check functionality	2	CO5
LLO 15.1 Select suitable coolant LLO 15.2 Follow service manual procedure to drain and refill the coolant LLO 15.3 Check for any leakage from coolant hosepipe	15	Practice on Checking and Top up coolant	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Comparison of Engines: - Collect data on three engines of the same category and compare them based on various parameters such as performance, fuel efficiency, and emissions.
- Ignition System Model: - Develop a working model of a battery ignition system, showcasing its components and the ignition process.

- Coolant and Lubricant Market Report: - Collect data on available coolants and lubricants in the market, preparing a comprehensive report on their specifications, applications, and market trends.
- Cut-Section Model of Cooling System Component: - Prepare a cut-section model of a used cooling system component or assembly, visually demonstrating its internal structure and functioning.
- Engine Components Comparison: - Collect engine components from various engines and compare them on aspects like material, design, and functionality.
- Cut-Section Model of Lubrication System Component: - Create a cut-section model of a used lubrication system component or assembly, highlighting its internal mechanisms and the flow of lubricants.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	General purpose tools (Spanners, ring spanner and socket)- 6mm to 32 mm	11
2	Engine dismantling and assembly tools	12
3	Fuel Supply system (Petrol)- including carburettor, fuel pump and fuel filter of two wheeler/ four wheeler	2
4	Four stroke engine cut-section model- single cylinder (motorized/ manual)	2
5	Two stroke engine cut-section model- single cylinder (motorized/ manual)	2
6	Fuel Supply system (Diesel) - Fuel Injection pump, primary filter, secondary filter, Injectors. - Single cylinder/ multi-cylinder engine FIP unit.	4
7	Distributor, ignition system demonstration model	4
8	Four stroke multi-cylinder diesel/ petrol engine with water cooling system	5
9	Special purpose tools (Piston ring expander, Piston ring compressor, Valve lifter, Torque wrench)- Torque wrench range- 10 Nm to 200Nm.	8
10	Four stroke diesel / petrol engine with lubrication system	8
11	Consumables (cotton waste, fuel and lubricants), Water supply provision, Electrical supply provision, Exhaust gas outlet, Wooden blocks, safety equipment, fire extinguisher	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Automobile Engines	CO1	10	4	6	4	14
2	II	Constructional Features of Engine Components	CO2	16	2	8	6	16
3	III	Fuel and Air feed system	CO3	16	2	8	6	16
4	IV	Ignition and Exhaust System	CO4	8	4	2	4	10
5	V	Engine Cooling and Lubrication system	CO5	10	2	8	4	14
Grand Total				**60**	**14**	**32**	**24**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Tests Seminar/Presentation Term Work

Summative Assessment (Assessment of Learning)

- Practical Theory

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	3	2	-	3			
CO2	3	-	-	3	2	-	3			
CO3	3	-	-	3	2	3	3			
CO4	3	3	3	3	2	-	3			
CO5	3	3	3	3	2	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	V. A. W Hiller	Hiller's Fundamentals of Motor Vehicle Technology -Book 1	Nelson Thrones Ltd UK Sixth Edition 16/10987654321
2	H N Gupta	Fundamentals of Internal Combustion Engines 2nd Edition	Prentice Hall India ISBN 978-8120346802
3	Jain and Asthana	Automobile Engineering	McGraw Hill Education ISBN 978-0070445291
4	M.L.Mathur and S.C.Sharma	Internal Combustion Engines	Dhanpat rai Publications ISBN 978-9383182428
5	V. Ganesan	Internal Combustion Engines	McGraw Hill Education ISBN 978-1259006197

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=bZUoLo5t7kg	Petrol (Gasoline) Engine vs Diesel Engine
2	https://www.youtube.com/watch?v=BXQ27pU3_7E	Assembly of four stroke engines
3	https://www.youtube.com/watch?v=ASSsg8hcQjM	Engine: structure and name of parts / Gradual engine disassembly in 3D animation
4	https://www.youtube.com/watch?v=0VDIV-A-Y7A	Carburetor working visualization

FUNDAMENTALS OF AUTOMOBILE ENGINES **Course Code : 313312**

Sr.No	Link / Portal	Description
5	https://www.youtube.com/watch?v=TqQE0xkCJ8c	Ignition system working
6	https://www.youtube.com/watch?v=g7LNA4w6wOI	Silencer working
7	https://www.youtube.com/watch?v=vRZu3-64yo0	Cooling system
8	https://www.youtube.com/watch?v=9lse1SfDq7M	Lubrication system

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**

THEORY OF MACHINES **Course Code : 313313**

Programme Name/s	**: Automobile Engineering./ Mechanical Engineering/ Mechatronics/ Production Engineering/**
Programme Code	**: AE/ ME/ MK/ PG**
Semester	**: Third / Fourth**
Course Title	**: THEORY OF MACHINES**
Course Code	**: 313313**

I. RATIONALE

Diploma Engineer should be able to identify and interpret various elements of machines in day-to-day life when they come across various machines in practice. In maintaining various machines, a Diploma Engineer should have sound knowledge of fundamentals of machine and mechanism. TOM subject imparts the kinematics involved in different machine elements and mechanisms like I.C. engine, cam-follower, belt-pulley, gear, flywheel etc. This course serves as a prerequisite for other courses such as Machine Design of higher semester etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course will enable the students to: Apply the knowledge & skills related to machine, mechanism & motions according to field applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply knowledge and skill related to different mechanisms and its motion in given situation.
- CO2 - Determine velocity and acceleration for given mechanism.
- CO3 - Develop a Cam profile for given type of Follower and its motions in given situation.
- CO4 - Select the suitable power transmission devices for the given field/industrial application.
- CO5 - Use knowledge and skills related to balancing of masses and vibration for various applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313313	THEORY OF MACHINES	TOM	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

THEORY OF MACHINES **Course Code : 313313**

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Identify various links and pairs in the given mechanism. TLO 1.2 Identify various type motion in the given pair. TLO 1.3 Identify various kinematic chain in the given configuration. TLO 1.4 Estimate degree of freedom for given configuration. TLO 1.5 Explain different inversion of mechanism. TLO 1.6 Select suitable inversion of mechanism for different application.	**Unit - I Fundamentals and Types of Mechanism** 1.1 Kinematics of Machines: - Definition of statics, Dynamics, Kinematics, Kinetics, Kinematic link and its types, Kinematic pair and its types, constrained motion and its types 1.2 Kinematic chain (locked chain, constrained chain and unconstrained chain with equation), Degree of freedom (Kutzbach equation) 1.3 Mechanism and Inversion: Mechanism and Inversion of Mechanism, Difference between machine and structure. 1.4 Inversion of Kinematic Chain a) Inversion of four bar chain: Beam engine, Coupling rod of Locomotive, Watt's indicator mechanism. b) Inversion of single slider Crank chain: Reciprocating I.C. engine, Whitworth quick return mechanism, Rotary Engine, Oscillating cylinder engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism c) Inversion of Double Slider Crank Chain: Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling	Classroom Lecture Model Demonstration Video Demonstrations Hands-on Presentations
2	TLO 2.1 Describe velocity and acceleration in mechanism. TLO 2.2 Draw velocity and acceleration diagram/polygon by relative velocity/ Klein's construction method following standard procedure . TLO 2.3 Determine linear and angular velocity of links in the given mechanism. TLO 2.4 Determine linear and angular acceleration of links in the given mechanism.	**Unit - II Velocity and Acceleration in Mechanism** 2.1 Concept of relative velocity and acceleration of a point on a link, Inter-relation between linear and angular velocity and acceleration. 2.2 Drawing of velocity and acceleration diagram of a given configuration, diagrams of simple Mechanisms: four bar chain and single slider crank chain (Limited up to 4 Links). 2.3 Determination of velocity and acceleration of point on link by relative velocity method (Excluding Coriolis component of acceleration) . 2.4 Klein's construction to identify velocity and acceleration of different links in single slider crank mechanism (When crank rotates with uniform velocity only).	Lecture Using Chalk-Board Video Demonstrations
3	TLO 3.1 Explain Cam and its terminology with field application. TLO 3.2 Identify the type of motion of Follower. TLO 3.3 Classify Cams and Followers. TLO 3.4 Draw Cam profile as per the given condition of Follower.	**Unit - III Cam and Follower** 3.1 Introduction to Cams and Followers, definition and applications of Cams and Followers, Cam terminology. 3.2 Classification of Cams and Followers. 3.3 Different follower motions and their displacement diagrams - Uniform velocity, simple harmonic motion, uniform acceleration and retardation. 3.4 Drawing of profile of radial Cam with knife-edge and roller Follower with and without offset (reciprocating motion only).	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Presentations

THEORY OF MACHINES **Course Code : 313313**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Identify the different drives for power transmission. TLO 4.2 Select suitable drive for a particular application. TLO 4.3 Calculate various quantities like velocity ratio, belt tensions, angle of contact, power transmitted in belt drives. TLO 4.4 Enlist advantages and disadvantages of chain drive. TLO 4.5 Identify the different types of gear trains. TLO 4.6 Compare belt drive, chain drive and gear drive for given parameters.	**Unit - IV Power transmission (Belt, Chain and Gear)** 4.1 Belt Drive: a) Type of belts, flat belt, V-belt & its applications, material for flat and V-belt, Selection of belts b) Angle of lap, length of belt (No derivation), Slip and creep, Determination of velocity ratio of tight side and slack side tension, Power transmitted by belt. (numerical on power transmission by belt) 4.2 Chain Drives: Types of chains and sprockets, Advantages & Disadvantages of chain drive over other drives (No numerical on Chain drive). 4.3 Gear Drives: a) Classification of gears, Law of gearing, Concept of Conjugate profile (Involute only) Spur gear terminology. b) Types of gear trains, Train value & velocity ratio for simple, compound, reverted and epicyclic gear trains. (No numerical on Gear drive). Comparison between Belt drive, Chain drive and Gear drive	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration
5	TLO 5.1 Explain the concept of balancing. TLO 5.2 Find balancing mass and position of plane analytically and graphically in single plane. TLO 5.3 Explain the basic vibrating system with causes and remedies.	**Unit - V Balancing of Masses and Vibration** 5.1 Balancing of Rotating Masses: Concept of balancing: Need and types of balancing, Balancing of single rotating mass. 5.2 Analytical and Graphical methods for balancing of several masses revolving in same plane and different plane (Numerical on single plane only). 5.3 Vibration: Fundamentals of Vibration: Definition and concept of Free, Forced, Undamped, Damped vibrations. (no numerical) 5.4 Advantages and Disadvantages of Vibration, Causes and remedies of Vibration, Vibration isolators. Forced vibrations of longitudinal and torsional systems (Concepts only, No numerical and No derivation on vibration).	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different mechanisms available in laboratories/institute premises LLO 1.2 Sketch the identified mechanism.	1	Identification of Mechanisms in the different laboratory and institute premises.	2	CO1 CO3 CO4

THEORY OF MACHINES **Course Code : 313313**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Identify number of links and pairs of given mechanism LLO 2.2 Identify input link and its motion. LLO 2.3 Identify output link and its motion	2	*Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B) Group A: i) Beam Engine ii) Coupling rod of Locomotive, iii) Watt's indicator mechanism. Group B: i) Reciprocating engine ii) Whitworth quick return mechanism. iii) Rotary Engine iv) Crank and slotted lever quick return Mechanism v) Hand Pump mechanism	2	CO1
LLO 3.1 Identify number of links and pairs of given mechanism. LLO 3.2 Identify input link and its motion. LLO 3.3 Identify Output link and its motion.	3	Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B) Group A: i) Elliptical trammel, ii) Scotch Yoke Mechanism, iii) Oldham's Coupling Group B: i) Bicycle free wheel sprocket mechanism ii) Geneva mechanism iii) Ackerman's steering gear mechanism iv) Foot operated air pump mechanism	2	CO1
LLO 4.1 Determine degree of freedom of given mechanism	4	*Degree of Freedom of given mechanism by using Kutzbach equation. (Any five mechanisms available in the Laboratory)	2	CO1

THEORY OF MACHINES **Course Code : 313313**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Measure the ratio of time of cutting stroke to the return stroke in shaping operation.	5	*Quick return mechanism used in a shaper machine	2	CO1
LLO 6.1 Draw velocity and acceleration polygon of four bar chain. LLO 6.2 Calculate angular velocity and linear velocity of a link using given data.	6	Velocity and Acceleration of four bar chain by relative velocity method. (Two Problem on A2 size Sheet.)	2	CO2
LLO 7.1 Draw velocity and acceleration polygon of single slider crank chain. LLO 7.2 Calculate angular velocity and linear velocity of a link using given data.	7	*Velocity and Acceleration of single slider crank chain by relative velocity method. (Two Problem on A2 size Sheet.)	2	CO2
LLO 8.1 Draw a space diagram of a single slider crank mechanism LLO 8.2 Measure the velocity and acceleration of links using Klien's construction method.	8	Velocity and Acceleration of Slider crank chain by Klien's Construction Method.	2	CO2
LLO 9.1 Generate cam profile for given follower to obtain desired follower motion	9	Cam profile for knife edge Follower. (Two problem on A2 size sheet, at least one problem on offset follower)	2	CO3
LLO 10.1 Generate cam profile for given follower to obtain desired follower motion	10	Cam Profile for roller follower. (Two Problem on A2 size sheet, at least one problem on offset follower)	2	CO3
LLO 11.1 Identify displacement of follower with cam rotation	11	*Measurement of follower displacement with Cam rotation for knife edge follower and roller follower	2	CO3
LLO 12.1 Measure the angular speed using tachometer. LLO 12.2 Compute the length of belt and slip	12	*Estimation of slip, length of belt, angle of contact in an open and cross belt drive.	2	CO4
LLO 13.1 Identify the type of gears and gear train.	13	Identification of gears and gear train in Lab and Machine shop.	2	CO4
LLO 14.1 Identify the type of gears and gear train. LLO 14.2 Construct gear train for desirable velocity ratio	14	*Preparation of different Gear trains from the given gears.	2	CO4
LLO 15.1 Construct balanced system for rotating masses.	15	*Balancing of rotating unbalanced system	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

NA

- NA

THEORY OF MACHINES **Course Code : 313313**

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Working Model of Beam Engine, Coupling rod of Locomotive, Watt's indicator mechanism, Reciprocating engine, Whitworth quick return mechanism, Rotary Engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism	1,2,4
2	Shaper machine available in institute workshop	1,2,4,5
3	Working Models of Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling, Bicycle free wheel sprocket Mechanism, Geneva mechanism, Ackerman's steering gear Mechanism, Foot operated air pump mechanism	1,3,4
4	Working models of Flat belt and V belt arrangement for demonstration	1,4,12
5	Experimental cam follower set up: Machine consist of a cam shaft driven by a D.C. motor/Manual operated. The shaft runs in a double ball bearing. At the free end of the cam shaft a cam can be easily mounted. The follower is properly guided in bushes and the type of the follower can be changed to suit the cam under test. A graduated circular protractor is fitted coaxial with the shaft and a dial gauge can be fitted to note the follower displacement for the angle of cam rotation. A spring is used to provide controlling force to the follower system.	11
6	Tachometer: optical type of tachometer (digital Tachometer) Range speed minimum 0 to 2000RPM or more	12
7	Belt drive test benchA test bench comprising of following pulleys, belts, electrical motor, arrangement for adjusting belt tensions and regulating speed of the driving motor and a suitable mounting frame	12
8	Working Model of Gear Trains: i) Simple Gear Train ii) Compound Gear train iii) Reverted Gear Train iv) epicyclic Gear Train	13
9	Different types of Gears with different modules : al least 5 quantity of each gear Spur gearHelical gear (Single /double)Spiral gearBevel gear	13
10	Experimental set up to arrange gears and shaft such that desired gear train can be obtained for given velocity ratio.	14
11	Static & Dynamic Balancing MachineSingle phase motor connected to a shaft, containing 4 rotating masses. Each rotating masshas a facility to insert. Pulley is provided to add weights to balance the unbalance shaft	15
12	Working models of various Cam follower arrangements for demonstration (Radial cam with knife edge and Roller follower models are mandatory)	4,9,10,11

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals and Types of Mechanism	CO1	16	6	8	4	18

THEORY OF MACHINES **Course Code : 313313**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Velocity and Acceleration in Mechanism	CO2	10	2	4	6	12
3	III	Cam and Follower	CO3	10	4	4	6	14
4	IV	Power transmission (Belt, Chain and Gear)	CO4	16	4	8	4	16
5	V	Balancing of Masses and Vibration	CO5	8	4	4	2	10
Grand Total				**60**	**20**	**28**	**22**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Laboratory Performance and Term work, Class Test I & II
- Term work (Lab Manual and drawing sheet), Question and Answers in class room as well as at the time of Practical. Note: Each practical will be assessed considering 60% and 40 % weightage.

Summative Assessment (Assessment of Learning)

- End Semester Board exam- Theory

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	2	-	-	2			
CO2	3	2	1	-	-	-	-			
CO3	3	2	3	2	-	-	1			
CO4	3	2	1	2	1	-	2			
CO5	3	2	1	2	2	-	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. Ghosh, A. K. Malik	Theory Of Mechanisms and Machines	Affiliated East west press ISBN: 978-8185938936
2	S. S. Rattan	Theory Of Machines	Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-9353166281
3	R.S. Khurmi, J. K. Gupta	Theory of Machines	S. Chand and Company New Delhi, ISBN: 978-8121925242
4	J. E. Shigely, J. J. Uicker	Theory Of Machines and Mechanisms	Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-0198062325
5	R. K. Bansal, Brar J. S.	A text book of Theory of Machine	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 9788170084181

THEORY OF MACHINES **Course Code : 313313**

Sr.No	Author	Title	Publisher with ISBN Number
6	P. L. Ballaney	Theory Of Machines	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 978-8174091222
7	Sadhu Singh	Theory of Machines	Pearson Education ISBN: 978-8131760697
8	S.S. Rao	Mechanical Vibrations	Pearson Education 2018 ISBN: 978-9353062569
9	G.K. Grover	Mechanical Vibration	978-8185240565

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mechanalyzer.com/downloads.html	Mech Analyzer is a free software developed to simulate and analyze the mechanisms
2	https://www.youtube.com/watch?v=oTcC_xXfdrA	Coupling Rod Locomotive
3	https://www.youtube.com/watch?v=8shK6kbu7Xk	Piston cylinder animation showing application of cam and gear train
4	https://www.youtube.com/watch?v=yHHeicPbEzg	Simple Beam Engine
5	https://www.youtube.com/watch?v=yHHeicPbEzg	Knife edge follower and Radial Cam
6	https://www.youtube.com/watch?v=Rib-_ZK8KfE	Roller follower with Radial Cam
7	https://www.youtube.com/watch?v=AODiJYtxuSw	Grear train animation
8	https://www.youtube.com/watch?v=klVYeSlxucU	Types of Belt drives
9	https://www.udemy.com/course/theory-of-machines-determine-degrees-of-freedom-in-a-system/	Degree of freedom
10	https://archive.nptel.ac.in/courses/112/106/112106270/	Online NPTL lectures of Theory of machine
11	https://play.google.com/store/apps/details?id=com.pinjara_imran5290.Belt_Length_Calculator&hl=en&gl=US&pli=1	Belt length calculator Application (play store app)
12	https://psmotion.com/mechdesigner/feature/cam-design-analysis	Design of Cam software
13	https://www.vlab.co.in/broad-area-mechanical-engineering	Virtual Lab
14	https://opac.library.iitb.ac.in/	Digital Central Library

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AUTOMOBILE TRANSMISSION SYSTEMS **Course Code : 313314**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Third**
Course Title : **AUTOMOBILE TRANSMISSION SYSTEMS**
Course Code : **313314**

I. RATIONALE

This course provides knowledge about the various components of Automotive power transmission. It will help the students during inspection, installation, operation and maintenance of transmission system of automobile. Therefore, this course has been developed provide the relevant knowledge and associated skills

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Inspect automobile power transmission system components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select vehicle layout and chassis for specific purpose.
- CO2 - Identify Clutch system of an automobile
- CO3 - Dismantle/ Assemble different automobile transmission system components
- CO4 - Maintain automobile transmission system components
- CO5 - Select wheels and tyres for given automobiles.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313314	AUTOMOBILE TRANSMISSION SYSTEMS	ATS	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

AUTOMOBILE TRANSMISSION SYSTEMS **Course Code : 313314**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 List different types of vehicle layout TLO 1.2 Classify vehicle layout TLO 1.3 Draw different types of vehicle layout TLO 1.4 Classify chassis frame TLO 1.5 Select the relevant frame for the given capacity of vehicle with justification	**Unit - I Vehicle Structure** 1.1 Vehicle layout and its types: (a) Introduction of related terms- an automobile, Chassis, Body, Vehicle layout (b) Types of vehicles (c) Classification of vehicle layout with respect to- i) Location of engine, ii) No of live axles, iii) Arrangement of Engine, Passenger and Luggage section, iv) Application (d) Layout of the front engine rear wheel drive vehicle- Location and functions of major components of transmission system 1.2 Chassis Frames: Necessity of frame. (a) Loads acting on frame. (b) Types of frames- conventional (ladder and x-member type), semi integral and integral types. Sub frames. (c) Frame sections-channel, box and tubular sections. (d) Materials for frames.	Model Demonstration Lecture Using Chalk-Board
2	TLO 2.1 State principle of Clutch of automobile TLO 2.2 Explain the construction and working of different types of clutch used in automobile with neat sketch TLO 2.3 List different types of cutch operating mechanisms. TLO 2.4 State functions of different clutch components. TLO 2.5 Select relevent clutch for given application with justification	**Unit - II Automobile Clutches** 2.1 Necessity ,Requirements of Clutch, Principle of friction Clutch, 2.2 Types of Clutch - construction and working of Single plate Clutch (Coil and Diaphragm), Multi plate clutch , Centrifugal Clutch 2.3 Clutch Operating Mechanism -Mechanical operation, Electro magnetic Operation, Hydraulic Operation, Clutch by wire. 2.4 Constructions of Clutch Components- Clutch Plate, Pressure Plate, Release lever, Straps , springs and throw-out bearings 2.5 Types of Materials used for clutch facing, desirable properties of clutch material	Model Demonstration Lecture Using Chalk-Board
3	TLO 3.1 State functions of Gear box TLO 3.2 Explain construction and working of different types of Gearbox with neat sketch TLO 3.3 Draw constructional details of gear shift and Gear selector Mechanism TLO 3.4 Explain working of automatic transmission system with neat sketch TLO 3.5 State the necessity of CVT . TLO 3.6 List different faults occurred in the gearbox with their causes and remedies	**Unit - III Automobile Gear Box** 3.1 Necessity of Gear box in Automobile Transmission System, Functions of Gear box, 3.2 Types of Gear box, Construction and Working - a) Sliding mesh Gearbox, b) Constant mesh Gearbox, c) Synchro- mesh Gear box 3.3 Construction and working of 1. Gear shift Mechanism, 2. Gear selector Operating Mechanism 3.4 Automatic Transmission- necessity of automatic transmission, Construction and working of a) Torque Converter b) Overdrive c) dual clutch system 3.5 Continuously Variable Transmission (CVT) - Principle, construction and working , advantages and disadvantages 3.6 Transfer case- Purpose , Construction and working	Model Demonstration Video Demonstrations Lecture Using Chalk-Board

AUTOMOBILE TRANSMISSION SYSTEMS **Course Code : 313314**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain constructional feature of propeller shaft and universal joint TLO 4.2 Classify rear axle drive TLO 4.3 Explain working principle of differential with neat sketch TLO 4.4 State the necessity of rear axle TLO 4.5 List different faults occurred in the drive line with their causes and remedies	**Unit - IV Drive Line** 4.1 A) Propeller shaft - Necessity and Types. Constructional details of Hollow and solid propeller shaft. B) Universal Joint – Functions, Types, Construction and Operation of simple Hooke's joint, Constant velocity joints – Inboard Tripod Joint and outboard Rezappa joint. C) Function and construction of Slip Joint 4.2 Types of rear axle drives – construction, working and applications of Torque tube drive and Hotchkiss drive. 4.3 Final drive and Differential - a. Necessity, types, construction and working of final drive . b. Necessity, types, construction and working of differential. 4.4 Rear Axle- a. Necessity of Rear Axle. b. Loads acting on the rear axle c. Types of rear axles- semi floating, Three quarter floating and full floating type. d. Rear axle casing- split and banjo type 4.5 Front wheel drive shaft- construction and working	Lecture Using Chalk-Board Demonstration
5	TLO 5.1 Compare different types of automobile wheels TLO 5.2 List desirable properties for Tyre material TLO 5.3 Explain construction of different types of Tyre with neat sketch TLO 5.4 Select suitable tyre for given vehicle according to application by using tyre coding system TLO 5.5 List different causes of tyre wear wear with justification	**Unit - V Wheels and Tyres** 5.1 Wheels and rims-Requirements for Automobile Wheels, Types of Wheels- construction and comparison of Disc wheel, wire wheel, Cast wheel, types of rims 5.2 Tyre- Functions, Desirable Tyre characteristics , Tyre Materials, 5.3 Types of Tyres - Constructional details of a) Tubed tyre b) Tubeless tyres. c) Radial ply tyre , d) Cross ply, e) Belted bias tyre, Comparison between tubed and tubeless tyre, types of treads 5.4 A) Selection of Tyre on the basis of Ply rating, Aspect ratio, Load index, speed rating, B) Tyre Designation and tyre coding system 5.5 Tyre life and factors influencing on it.	Model Demonstration Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use appropriate hand tools and measuring devices in given situation	1	* Use of Hand tools and measuring devices available in the Laboratory	2	CO1 CO4
LLO 2.1 Draw layout of given automobile Chassis LLO 2.2 Identify different components of given automobile Chassis	2	* Observation of Automobile Chassis	2	CO1
LLO 3.1 Identify differnt components of Single plate clutch LLO 3.2 Measure various parameters of given single plate clutch	3	*Single Plate dry type Clutch dismantling and assembly	2	CO2
LLO 4.1 Dismantle Multi plate clutch. LLO 4.2 Measure different parameters of given multi plate clutch	4	Multi plate clutch dismantling and assembly	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Dismantle and assemble Synchromesh gear box. LLO 5.2 Calculate gear ratio of given gear box LLO 5.3 Name different components of Syncromesh gear box.	5	*Synchromesh Gear Box dismantle and assembly	4	CO3 CO4
LLO 6.1 Dismantle and assemble Vario Drive LLO 6.2 List different components of Vario Drive	6	Vario Drive of Two wheeler Dismantling and Assembly	2	CO3 CO4
LLO 7.1 Identify different parts of Torque converter LLO 7.2 Dismantle and assemble given Torque converter	7	*Dismantling and assembly of Torque converter	4	CO3 CO4
LLO 8.1 Identify different components of CVT LLO 8.2 Calculate drive ratio of CVT	8	Dismantling and Assembly of CVT	2	CO3 CO4
LLO 9.1 Identify different components of Propeller shaft Universal joint assembly LLO 9.2 Dismantle propeller shaft Universal joint assembly	9	*Dismantling and assembly of Propeller shaft - Universal Joint assembly	2	CO4
LLO 10.1 Identify different parts of Differential LLO 10.2 Calculate differential gear ratio .	10	*Disentailing and assembly of Differential	4	CO3
LLO 11.1 Identify different components of rear axle assembly	11	Disentailing and Assembly of Rear axle assembly	2	CO4
LLO 12.1 Identify different components of Wheel assembly	12	*Dismantling and Assembly of a Wheel assembly.	2	CO5
LLO 13.1 Interpret designation of given tyre according to tyre code LLO 13.2 Identify differnt parts of Tyre	13	Automobile Tyre designation	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Compare clutches used in a two wheeler, four wheeler and moped.- Collect clutch of two and four wheeler vehicle, Observe ,Compare and Write a report.
- Observe transmission system of your bike - read service manual, Type of Transmission, purpose of transmission, .maintenance procedure as per manufacturers catalog, Write report
- Collect information catalog of tires from different manufacturers and compare on the basis of material used, aspect ratio, speed rating and load rating, prepare report

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Vehicles -Two Wheeler, Three wheeler, Four wheeler vehicle.	1,2,3,4
2	Cut – section working model of Single Plate dry type clutch.	2
3	Cut – section working model of simple Pulley based vario-drive used in mopeds.	3
4	Cut – section working model of four wheeler transmission system.	4
5	Cut – section working model of Sequential automatic transmission system.	5,6,7
6	Cut – section working model of Final drive and differential	8,9,10
7	Four wheeler chassis – Front Engine Rear wheel drive/Four wheel drive	All
8	Four wheeler chassis – Front Engine Front wheel drive	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Vehicle Structure	CO1	8	4	4	4	12
2	II	Automobile Clutches	CO2	8	2	6	4	12
3	III	Automobile Gear Box	CO3	11	4	6	8	18
4	IV	Drive Line	CO3,CO4	12	4	6	10	20
5	V	Wheels and Tyres	CO5	6	2	2	4	8
Grand Total				**45**	**16**	**24**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work, Laboratory work

Summative Assessment (Assessment of Learning)

- End semester practical Examination

XI. SUGGESTED COS - POS MATRIX FORM

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	-	3	2	2	3			
CO2	2	-	-	3	2	2	3			
CO3	2	-	-	3	2	2	3			
CO4	2		-	3	2	2	3			
CO5		3	-	2	2	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr.Kripal Singh	Automobile Engineering Vol.1	Standard Publisher Distributers, New Delhi Edition 3 ISBN Number-978-81-8014-196-6
2	S.K.Gupta	A Text book of Automobile Engineering	S.Chand and Co.Pvt.Ltd., New Delhi Edition 13 ISBN Number- 978-93-83746-91-0
3	A.K.Babu and A.P.Singh	Automobile Engineering	S.Chand and Co.Pvt.Ltd., New Delhi Edition 13 ISBN Number- 81-219-9770-4
4	Narang, G.B.S	Automobile Engineering	Khanna Publishers, New Delhi, Edition 2009, ISBN-13: 1234567144518
5	Schwaller, Anthony E.	Motor Automotive Technology	Delmar Publishers Inc. New Delhi, Edition 2009, ISBN-13: 978-0827351004
6	G.K.Awari,V.S.Kumbhar, R.B.Tirpude	Automobile Systems:Principles and Practice	CRC Press , Taylor and Francis, London Edition 2020 978-0367498429

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=devo3kdSPQY	Demonstration of clutch working
2	https://www.youtube.com/watch?v=TcYsV063lk8	Multiple clutch
3	https://www.youtube.com/watch?v=Pv7wlv-Oe9s	Sliding mesh gear box demonstartion
4	https://www.youtube.com/watch?v=K2IfBlea9cc	constant mesh gear box
5	https://www.youtube.com/watch?v=z5G2zQ_3xTc	basic working of torque converter
6	https://www.youtube.com/watch?v=Tkdx0Gc-_tc	Torque converter working
7	https://www.youtube.com/watch?v=PEq5_b4LWNY	CVT working
8	https://www.youtube.com/watch?v=nC6fsNXdcMQ	Differential working
9	https://www.youtube.com/watch?v=dLwsoM3WnuQ	components of tyre

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students