Curriculum of Diploma Programme

in

Automobile Engineering

Department of Science,
Technology and Technical Education (DSTTE),
Govt. of Bihar

State Board of Technical Education
(SBTE), Bihar

Semester – III
Teaching & Learning Scheme

CourseCodes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2433301	**PCC**	**Automobile Maintenance Engg.**	03	-	04	02	09	06
2433302	**PCC**	**Automobile Transmission System**	03	-	04	02	09	06
2425303	**PCC**	**Strength of Materials for Mechanical Engg.** (ME, ME (Auto))	03	-	04	02	09	06
2425304	**PCC**	**Basic Thermodynamics** (ME, ME (Auto))	02	01	04	02	09	06
2425305	**PCC**	**Computer Aided Drafting and Modeling** (ME, ME (Auto))	-	-	04	02	06	03
2433306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	02	02	04	02
2400207	**NRC**	**Indian Constitution** (Common for All Programmes)	01	-	-	-	01	01
Total			**12**	**1**	**22**	**12**	**47**	**30**

Note: Prefix will be added to Course Code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - III
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2433301	**PCC**	**Automobile Maintenance Engg.**	30	70	20	30	20	30	200
2433202	**PCC**	**Automobile Transmission System**	30	70	20	30	20	30	200
2425303	**PCC**	**Strength of Materials for Mechanical Engg.** (ME, ME (Auto))	30	70	20	30	20	30	200
2425304	**PCC**	**Basic Thermodynamics** (ME, ME (Auto))	30	70	20	30	20	30	200
2425305	**PCC**	**Computer Aided Drafting and Modeling** (ME, ME (Auto))	-	-	20	30	20	30	100
2433306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
2400207	**NRC**	**Indian Constitution** (Common for All Programmes)	25	-	25		-	-	50
Total			**145**	**280**	**135**	**165**	**110**	**165**	**1000**

Note: Prefix will be added to Course Code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

A) Course Code : **2433301(T2433301/P2433301/S2433301)**

B) Course Title : Automobile Maintenance Engineering

C) Pre- requisite Course(s) :

D) Rationale

Automobile Maintenance Engineering is a technical course dealing with automobile workshop, trouble-shooting, servicing and repair of engine and related system such as transmission system, brake system, steering and suspension system, wheels and tire. This course provides knowledge about fault detection, cause and their remedies in various components of vehicle. This course will also help the students during inspection, installation, operation and maintenance of automobile systems. This course is therefore a core course for automobile engineers and they should develop desired knowledge and practical skills.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Use relevant tools and equipment required for maintenance of vehicle.
CO-2 Maintain different engine components.
CO-3 Diagnose troubles in brake and Antilock braking systems
CO-4 Inspect and replace components of steering and suspension systems
CO-5 Maintain automobile HVAC system.

F) Suggested Course Articulation Matrix (CAM):

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, Sustainabilityand Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	1	1	3	-	1	2		
CO-2	3	3	2	2	2	1	1		
CO-3	3	3	2	2	2	1	-		
CO-4	3	3	2	2	1	1	1		
CO-5	3	3	2	2	3	1	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	CourseTitle	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2433301	Automobile Maintenance Engineering	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Casemethod, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop,field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedbackof teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2433301	Automobile Maintenance Engineering	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars,micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** aswell as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/
  Presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria ofinternal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment,the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2433301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Identify relevant tools and equipment. *TSO 1b.* Select relevant tools for a given application. *TSO 1c.* Explain the use of the given tools/equipment with justification. *TSO 1d.* Explain the safety precautions to be taken while using the given tool/equipment with justification. *TSO 1e.* Select relevant maintenance procedure for the given automobile component. *TSO 1f.* Explain the given type of workshop record with relevant justification.	**Unit-1.0 Automobile Workshop Tools, Equipment and Maintenance Management** 1.1 General safety precautions in automobile workshop. 1.2 Functions of major automobile workshop tools and equipment with safety precautions- wheel aligner, wheel balancer, engine analyzer, hydraulic lift, compressor, injector tester. 1.3 Safety procedure for using power tools and equipment (electrically, hydraulically, pneumatically operated) 1.4 Necessity and types of maintenance- Preventive maintenance, scheduled maintenance, breakdown maintenance. 1.5 Decision to repair or replace the components during maintenance. 1.6 Record keeping: Necessity and types of workshop records – History sheet, work orders/job cards, Activity file, service manual, spare part register and spare procurement register.	**CO1**
TSO 2a. State causes and relevant remedies for the given fault in the engine systems. *TSO 2b.* Explain with sketch the procedure of engine compression test with justification. *TSO 2c.* Explain the working of specified injection pump with justification. *TSO 2d.* Describe with sketch servicing of the given engine component. *TSO 2e.* Describe engine tune up procedure for the given engine with diagram.	**Unit-2.0 Engine Maintenance** 2.1 Engine troubleshoot- Engine smoke, oil level and condition, coolant level and condition, oil pressure testing, compression test, vacuum test, cylinder leakage test. 2.2 Lubrication system service: Change oil filter, check oil pump, diagnose causes for excessive oil consumption, external oil leakage and low oil pressure in an engine. 2.3 Fuel feed system service- Injector cleaning and testing, FIP phasing and calibration, MPFI injector testing and cleaning. 2.4 Cooling system servicing- refilling of radiator, pressure testing, thermostat checking, leakage testing, fan belt tension checking and adjusting. 2.5 Engine servicing- Checking and servicing of engine components-cylinder head, cylinder block, cylinder liners, piston, piston ring, crank shaft, connecting rod, valves and tuning of engine.	**CO1, CO2**
TSO 3a. State the cause and relevant remedies for the given fault in vehicle control system. *TSO 3b.* Explain servicing procedure for brakes of the given vehicle with justification. *TSO 3c.* Describe the routine maintenance procedure of the given ABS -Brake system. *TSO 3d.* Diagnose simple problems in Antilock - braking systems (ABS)	**Unit-3.0 Maintenance of Brake System** 3.1 Maintenance of brakes- Inspection of master cylinder, wheel cylinder, brake drum, brake linings, brake disc and brake pads. 3.2 Adjustment of hydraulic brakes-shoe clearance, brake pedal free travel, pedal to floor clearance, parking brake adjustment. 3.3 Brake bleeding and procedure for bleeding of hydraulic brakes. 3.4 Trouble, causes and remedies of hydraulic and air brake system.	**CO1, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.5 Diagnosis of Antilock -braking systems	
TSO 4a. Locate and correct causes for the given fault in Suspension components *TSO 4b.* Explain the servicing procedure for the given suspension system with justification. *TSO 4c.* Service of the given Shock absorber *TSO 4d.* Describe the servicing procedure for the given steering system with justification. *TSO 4e* Service the steering gear box assembly	**Unit-4.0 Maintenance of Steering and Suspension System** 4.1 Inspection and Servicing of Suspension components 4.2 Inspection and Servicing of Shock absorber 4.3 Troubleshooting of Suspension system. 4.4 Inspection and Servicing of Steering Gears 4.5 Troubleshooting of steering system.	**CO1, CO4**
TSO 5a. Explain safety rules for servicing of the given air conditioner component. *TSO 5b.* State causes and remedies for the given fault in car air conditioning system. *TSO 5c.* Describe with sketch procedure for leakage testing of refrigerant for the given vehicle. *TSO 5d.* Describe the troubleshooting procedure of the given part of the air conditioner.	**Unit-5.0 Maintenance of HVAC System** 5.1 Air conditioner service safety rules. 5.2 Troubleshooting of the air conditioning compressor. 5.3 Troubleshooting of the air conditioning blower and condenser. 5.4 Troubleshooting of the air conditioning evaporator, valves and filters. 5.5 Refrigerant leakage testing. 5.6 Evacuation and charging of air conditioner.	**CO1, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2433301

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Follow standard practices while handling tools and measuring devices LSO 1.2 Measure the given assembly using suitable measuring devices	1.	Use of various hand tools and measuring devices.	CO-1
LSO 2.1 Identify location of various engine components of petrol/diesel engine. LSO 2.2 Use compression test rig	2.	Perform the compression test on petrol/diesel engine.	CO-2
LSO 3.1 Identify the location of fuel injectors LSO 3.2 Follow service manual procedure for checking fuel injectors LSO 3.3 Re-correcting or installing the fuel injector	3.	Testing of mechanical fuel injector for efficient delivery.	CO-2
LSO 4.1 Inspect fan belt and pulleys LSO 4.2 Service an assembly after replacing the faulty or broken parts	4.	Service engine cooling system for broken fan belt.	CO-2
LSO 5.1 Check for any external oil leakage LSO 5.2 Compare oil consumption with manufacturer recommended value LSO 5.3 Ratify engine lubrication problem	5.	Service engine lubrication system for excessive oil consumption.	CO-2
LSO 6.1 Diagnose faults LSO 6.2 Use special tools for tuning of various engine components or parts	6.	Perform tune-up procedure on petrol/diesel engine	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 7.1 Diagnose faulty braking action in drum and disc brakes LSO 7.2 Use suitable tools to service drum And disc brakes	7.	Servicing of Drum and Disc Brakes	CO-3
LSO 8.1 Identify causes for brake bleeding LSO 8.2 Ratify problems such as remove air bubbles from the brake system or replace with new brake fluid.	8.	Perform hydraulic brake bleeding	CO-3
LSO 9.1 Diagnose faulty action in antilock braking systems LSO 9.2 Ratify problems such as remove air bubbles from the brake system or replace with new brake fluid.	9.	Diagnose trouble in antilock braking systems	CO-3
LSO 10.1 Use suitable tools in dismantling the given suspension system LSO 10.2 Check and reassemble the Suspension System	10.	Servicing the components of Suspension systems	CO-4
LSO 11.1 Check the given shock absorber for any faulty action LSO 11.2 Use suitable tools in dismantling the given faulty shock absorber LSO 11.2 Service the given shock absorber	11.	Insect and Replace Shock absorber	CO-4
LSO 12.1 Use special tools in dismantling steering gear box assembly LSO 12.2 Check and reassemble the assembly	12.	Service the steering gear box assembly of LMV/HMV.	CO-4
LSO 13.1 Use suitable tools in dismantling auto air conditioning system LSO 13.2 Identify problems in HVAC system LSO 13.3 Service the system after replacing the faulty or broken parts	13.	Troubleshoot HVAC system of a car	CO-5
LSO 14.1 Recharge suitable refrigerant in the given auto air condoning system.	14.	Perform testing of refrigerant leakage for the given auto air condoning system	CO-5

L) **Suggested Term Work and Self Learning: S2433301** Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. List tools and equipment used in workshop and write their specification.
2. Procedure of belt tension checking and adjusting.
3. Explain the cause of wear of clutch lining material.
4. Procedure and importance of hydraulic brake bleeding.
5. Importance of lubrication used in various moving parts of transmission system

b. Micro Projects:

1. Identify tools and equipment required for automobile workshop and collect specification of the identified tools and equipment.
2. Prepare the report for manufacturer/supplier and procurement of identified tools and equipment.
3. Identify the infrastructural facilities, tools and equipment required for roadside garage and modern workshop for specialized work.
4. Visit nearby automobile workshop and prepare the report on inventory control system used in automobile workshop.
5. Collect samples and compare the specifications, properties, application and cost of different lubricants.

c. Other Activities:

1. Seminar Topics:

   - Safety precautions to be taken while working in automobile workshop.
   - Working of fuel injection and its importance.
   - Fault, cause and remedies of differential.
   - Importance of maintenance and record keeping in automotive service center.
   - Environmental aspects of refrigerant used in car air-conditioning system.

2. Visits: Visit nearby automobile service center with all the modern facilities. Prepare report of visit with special comments of servicing of engine and important components of transmission system. Also observe and prepare a report on maintenance of HVAC system.

3. Self-Learning Topics:

   - Selection relevant maintenance procedure for wheel alignment, battery testing and cylinder bore.
   - Lifting mechanism used in four wheeler service center.
   - Function of each component used in power transmission system.
   - List any four refrigerant used in air-conditioning system and their write their properties.
   - Procedure of evacuation and charging of air-conditioner

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	10%	10%
CO-2	30%	30%	30%	25%	20%	25%	25%
CO-3	20%	20%	20%	25%	30%	20%	20%
CO-4	20%	20%	20%	25%	25%	25%	25%
CO-5	15%	15%	15%	25%	25%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (S)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above(A)
Unit-1.0 Automobile Workshop Tools, Equipment and Maintenance Management	8	CO1	11	5	4	2
Unit-2.0 Engine maintenance	12	CO1, CO2	21	4	10	7
Unit-3.0 Maintenance of Brake System	10	CO1, CO3	14	4	6	4
Unit-4.0 Maintenance of Steering and Suspension System	12	CO1, CO4	14	4	6	4
Unit-5.0 Maintenance of HVAC system	6	CO1, CO5	10	3	4	3
Total	**48**	**-**	**70**	**20**	**30**	**20**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment

O) Suggested Specification Table for Laboratory (Practical) Assessment:

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce
			PRA*	PDA**	
1.	Make use of various hand tools and measuring devices.	CO-1	60	30	10
2.	Perform the compression test on petrol/diesel engine.	CO-2	40	50	10
3.	Test mechanical fuel injector for efficient delivery.	CO-2	30	60	10
4.	Service engine cooling system for broken fan belt.	CO-2	40	50	10
5.	Service engine lubrication system for excessive oil consumption.	CO-2	40	50	10
6.	Perform tune-up procedure on petrol/diesel engine	CO-2	30	60	10
7.	Servicing of Drum and Disc Brakes	CO-3	30	60	10
8.	Perform hydraulic brake bleeding	CO-3	30	60	10
9.	Diagnose trouble in antilock braking systems	CO-3	30	60	10
10	Servicing the components of Suspension systems	CO-4	30	60	10
11	Insect and Replace Shock absorber	CO-4	40	50	10
12	Service the steering gear box assembly of LMV/HMV.	CO-4	40	50	10
13	Troubleshoot HVAC system of a car	CO-5	40	50	10
14	Perform testing of refrigerant leakage for the given auto air condoning system	CO-5	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment
Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1	General purpose tools (Spanners, ring spanner and socket)-	6mm to 32 mm	All
2	Special purpose tools (Piston ring expander, Piston ring compressor, Valve lifter, Torque wrench)	Torque wrench range- 10 Nm to 200Nm.	All
3	Air Compressor	1.5 HP, 24 lt, 1300w	2
4	Compression tester	MT-6565	2
5	Injector tester	pressure range 0-60Mpa, fuel tank volume=1L	3
6	Working model of four stroke S.I. and C.I. engine	Actual working engine (multi cylinder four stroke S.I. and C.I. engine above 1000cc) set up with all accessories.	4,5& 6
7	Brake system	working model of (i)Drum and Disc brake (ii)hydraulic brake system (iii) antilock- braking systems	7,8 &9
8	Suspension systems	Actual model of suspension systems	10&11
9	Steering Assembly	Actual steering gear boxes of LMV/HMV in good working condition: Rack and pinion type, Recirculating ball and Nut type, Worm and roller type.	12
10	HVAC system	Working model of HVAC system of Light Motor Vehicles	13 & 14
11	A modern Car and Jeep of any make and model	Light Motor Vehicles: A modern Car and Jeep of any make and model like Maruti, Mahindra, TATA, Force Motors along with all relevant accessories and systems.	All
12	Hydraulic lift	Capacity-2 Ton	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher with ISBN
1.	Automotive service	Gills, Tim	Delmar Publisher Inc ISBN-13: 9781401812355
2.	Automotive mechanics	Crouse, William, H Anglin, Donald L	McGrawhill Education, New Delhi, ISBN-13: 978-0071125994
3.	Automotive engine theory and servicing	Halderman, James	Pearson Education, New Delhi, ISBN-13:9780133515008
4.	Motor Automotive technology	Schwaller, Anthony	Delmar Publisher Inc. ISBN-13:978-0827351004
5.	Automotive engine performance	Layne, Ken	Prentice Hall Career Technology ISBN 13:9780471829911
6.	Automobile Engineering	Gupta, R. B.	Satya prakashan, New delhi, ISBN-9788176843799

(b) Online Educational Resources:

1. http://www.youtube.com/watch?v=LGXfWdAZ0N4
2. http://www.youtube.com/watch?v=-mhhDiz3bwk
3. http://www.youtube.com/watch?v=5Efh-Y35Lcs
4. http://www.youtube.com/watch?v=Yz-zh3N6AOo
5. http://www.youtube.com/watch?v=h7wotCaA6kg
6. http://www.youtube.com/watch?v=8q6QP0PmHlg
7. http://www.youtube.com/watch?v=O1jwgVhdMso
8. http://www.youtube.com/watch?v=s73JEX6HG78
9. http://www.youtube.com/watch?v=h7-WXFKZiXM
10. http://www.youtube.com/watch?v=qEyhsk0JTOo
11. http://www.youtube.com/watch?v=wGD0Wm7Smrw
12. http://www.youtube.com/watch?v=32wnnTgCJn8
13. http://www.youtube.com/watch?v=QUSIEYfx5DM
14. http://www.youtube.com/watch?v=_atSLfBlAOI
15. http://www.youtube.com/watch?v=D69Echdj2EU
16. http://www.youtube.com/watch?v=osnT0QqGP61
17. http://www.youtube.com/watch?v=JePOTERmApw
18. http://www.youtube.com/watch?v=oponMtCv-BU
19. http://www.youtube.com/watch?v=BXTZURC5iQ0
20. http://www.youtube.com/watch?v=REHQXqzdoa8
21. http://www.youtube.com/watch?v=RKp946w-_SQ
22. http://www.youtube.com/watch?v=qcWNgdlVkh
23. Howstuffworks.com
24. Wikipedia.com

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

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A) Course Code : 2433302(T2433302/P2433302/S2433302)

B) Course Title : Automobile Transmission System

C) Pre- requisite Course(s) :

D) Rationale :

Any automobile apart from engine is made of transmission system and other systems like brakes, steering and suspension systems. The transmission is a device that is connected to the back of the engine and sends the power from the engine to the drive wheels. An automobile engine runs at its best at a certain RPM (Revolutions per Minute) range and it is the transmission's job to make sure that the power is delivered to the wheels while keeping the engine within that range. Hence this course is essential for an automobile technician. This course will enable the students to understand the concept of manual and automatic transmission system based on operating parameter, components of transmission system and its requirements.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Identify the components and maintenance requirements for the manual and automatic transmission system of vehicle.

CO-2 Diagnose clutch troubles and adjust clutch linkages

CO-3 Use service manual to find out the components and maintenance requirements for the different transmission control system and Gear boxes used in the given vehicle.

CO-4 Service and replace propeller shafts, universal joints, drive and axle to transmit power effectively.

CO-5 Dismantle/assemble final drive, differential and rear axle components to transmit power effectively.

CO-6 Perform wheel alignment of the given vehicle.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	-	2	-	-	2		
CO-2	3	3	2	2	3	-	-		
CO-3	3	2	-	2	-	-	-		
CO-4	3	3	2	2	2	-	-		
CO-5	3	3	2	2	2	-	-		
CO-6	3	2	-	2	2	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs isoptional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2433302	Automobile Transmission System	03	-	04	02	09	06

Legend:

CI: Classroom instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, fieldorotherlocationsusingdifferentinstructional/Implementationsstrategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2433302	Automobile Transmission System	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating scales and rubrics)

TWA: Term work &Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty, but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2433302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe power transmission systems. *TSO 1b*. Identify major assemblies and its function. *TSO 1c.* Draw power flow lines in front wheel, rear wheel and four-wheel drive. *TSO 1d.* Draw and explain different layout of chassis. *TSO 1e.* Explain advantages and disadvantages of various chassis layout. *TSO 1f.* Explain construction of frames. *TSO 1g.* Select frame material and identify loads acting on frame.	**Unit-1.0 Introduction to Automobile Transmission System** 1.1 Major assemblies – their locations and functions 1.2 Flow of power transmitted in front wheel drive, rear wheel drive and four wheel drive. 1.3 Different layout of chassis. 1.4 Advantages and disadvantages of various chassis layout. 1.5 Different types of frame. 1.6 Frame construction and material. 1.7 Loads acting on frame.	**CO1, CO2**
TSO 2a. List different types of clutches. *TSO 2b.* Explain operation of Clutch, Clutch actuating Mechanism. *TSO 2c.* Describe various types of clutches used in Automobiles *TSO 2d.* Identify materials used for clutch lining. *TSO 2e.* Describe Construction and working of fluid coupling.	**Unit-2.0 Clutch** 2.1 Principle, function and requirements of Clutch. 2.2 Construction and functions of different types of clutches– single plate, multi-plate clutches dry & wet clutches, centrifugal clutch and diaphragm clutch. 2.3 Clutch actuating mechanism- Hydraulic & mechanical clutch linkage 2.4 Materials used for clutch lining. 2.5 Fluid coupling- principle, construction and working. 2.6 Maintenance of clutch: checking clutch plate for thickness, run out, Check pressure plate for wear, scoring and warpage, free and seated height of pressure springs, Check clutch shaft for bent and distorted splines, procedure of clutch adjustment. 2.7 Cause and remedies for clutch slip, clutch noise, clutch grab and chatter.	**CO1, CO3**
TSO 3a. Describe different types of gears and gear boxes. *TSO 3b.* Differentiate between sliding, mesh and synchromesh gear box arrangements. *TSO 3c.* Describe with sketches the method of lubrication for the given type of gearbox *TSO 3d.* Describe the operation of Gear shifting mechanism *TSO 3e.* Explain function and working of transmission control systems *TSO 3f.* Explain construction & working of overdrive & torque convertor. *TSO 3g*. Describe the servicing procedure for the given gear box with justification *TSO 3h.* Diagnose the faults /causes in the given gear	**Unit-3.0 Gear Box** 3.1 Function and necessity of Gear Box. 3.2 Construction and functions of Sliding mesh, Constant mesh, Synchromesh, Epicyclical train & automatic transmission. 3.3 Lubrication of gear box. 3.4 Operation of Gear shifting mechanisms with line diagram of motion flow. 3.5 Concept of semiautomatic and automatic transmission 3.6 Transmission control system: • Automatic transmission control • Continuously Variable Transmission (CVT) control	**CO1, CO3**

box	• Dual-clutch transmission (DCT) control 3.7 Torque converter and overdrive- construction & working. 3.8 Maintenance of gearbox 3.9 Cause and remedies for gear box noise, hard gear shifting.	
TSO 4a. Explain need & construction of various types of propeller shafts. *TSO 4b.* Explain construction & functions of various types of universal joints and slip joints. *TSO 4c.* Describe Hotchkiss drive and torque tube drive.	**Unit-4.0 Propeller Shaft and Universal Joint** 4.1 Need of propeller shaft, universal joint and slip joint. 4.2 Construction & functions of various types of propeller shafts. 4.3 Construction & functions of various types of universal joints-Constant velocity Joints- Rzeppa Joint, Tripod Joint. 4.4 Function and construction of slip joint. 4.5 Construction of Hotchkiss drive and torque tube drive. 4.6 Maintenance of propeller shaft and universal joint assembly.	**CO1, CO4**
TSO 5a. Explain with sketches the construction and working of the given type of final drive and differential. *TSO 5b.* Compare with sketches the given types of rear axles used in the given four wheeler based on construction, working and application.	**Unit-5.0 Final Drive, Differential and Rear Axle** 5.1 Principle, Necessity and function of final drive and differential. 5.2 Construction & functions of final drive. 5.3 Types of rear axles- semi - floating, three quarter floating and full floating type. 5.4 Loads acting on rear axle. 5.5 Maintenance of Final drive, Differential and rear axle	**CO1, CO4**
TSO 6a. Describe construction of various types of wheels and tires. *TSO 6b.* Factors affecting life of tire & Tire rotation. *TSO 6c.* Describe tire rating & specifications. *TSO 6d.* Explain tire retreading procedures. *TSO 6e.* Describe wheel alignment/ balancing procedure for the given vehicle.	**Unit-6.0 Wheels and Tires** 6.1 Various types of wheels. 6.2 Salient features of wheels. 6.3 Salient features of different types of rims. 6.4 Types of tires. 6.5 Constructional details of tube and tubeless tires. 6.6 Tire retreading procedure. 6.7 Rating of tire. 6.8 Factors affecting life of tire. 6.9 Tire rotation and Tire specification. 6.10 General Maintenance of wheel assembly and Greasing of wheel hub, Care of wheels and tires, procedure of wheel alignment, procedure of wheel balancing.	**CO1, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2433302

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Identify suitable tools for dismantling of single plate dry type clutch assembly LSO 1.2 Make an assembly after replacing the faulty or broken parts	1.	Assemble a single plate dry type clutch assembly	CO-2
LSO 2.1 Choose suitable tools for dismantling Multi plate clutch assembly LSO 2.2 Check and reassemble the assembly	2.	Service Multi plate clutch assembly with relevant clutch adjustments	CO-2
LSO 3.1 Use special tools in dismantling gear box of two wheeler LSO 3.2 Check and reassemble the gear box assembly after replacing the faulty or broken parts	3.	Servicing of two wheeler gear box	CO-3
LSO 4.1 Use special tools in dismantling a given gear box LSO 4.2 Check and reassemble the gear box assembly after replacing the faulty or broken parts	4.	Dismantle and assemble a three speed sliding type gear box	CO-3
LSO 5.1 Use special tools in dismantling a given gear box LSO 5.2 Check and reassemble the gear box assembly after replacing the faulty or broken parts	5.	Servicing a five speed gear box	CO-3
LSO 6.1 Use special tools in dismantling a Propeller shaft - Universal Joint assembly LSO 6.2 Check and reassemble the given assembly	6.	Assemble a Propeller shaft - Universal Joint assembly.	CO-4
LSO 7.1 Use special tools in dismantling the Differential and Rear axle assembly LSO 7.2 Check and reassemble the given assembly	7.	Assemble the Differential and Rear axle assembly	CO-5
LSO 8.1 Use appropriate tools in dismantling the Wheel assembly LSO 8.2 Use grease gun for wheel hub greasing LSO 8.2 Check and reassemble the given wheel assembly	8.	Dismantle/ Assemble a Wheel assembly	CO-6
LSO 9.1 Determine the reasons for misalignment of wheel LSO 9.2 Check tire Camber, Caster and Toe angle using wheel alignment tools	9.	Perform wheel alignment of vehicle.	CO-6

L) Suggested Term Work and Self Learning: S2433302 Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in linewith the targeted COs.

b. Micro Projects:

1. Collect the data of different types of clutches commonly used in vehicles and compare it.
2. Collect the different types of universal joints from scrap/garage and write report with their comparison.
3. Prepare display boards or charts for clutch, gear box, propeller shaft, universal joints, differential, rear axle, wheels and tires.
4. Collect the data of different types of tires from market and compare it.
5. Identify the advance systems used in modern vehicle and prepare report on it
6. Collect the data of Indian Motor vehicle manufacturers and their products and write a report on it.

c. Other Activities:

1. Seminar Topics:
   - Power Transmission mechanism in four wheel drive vehicle.
   - Working of centrifugal clutch and friction lining material.
   - Automatic gear shifting mechanism.
   - Effect of tire rotation and tire retreading on tire life.

2. Visits: Visit nearby automobile service center with all the modern facilities. Prepare report of visit with special comments of servicing of gear box, differential and all other important components of transmission system. Also observe and prepare a report on tire rotation pattern and its effect on tire life.

3. Self-Learning Topics:
   - Assembly and disassembly of clutch plate.
   - Servicing of differential and assembly.
   - 3D scanning process.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	-	-	-	-
CO-2	20%	20%	20%	20%	20%	20%	20%
CO-3	20%	20%	20%	25%	25%	25%	25%
CO-4	20%	20%	20%	15%	15%	20%	20%
CO-5	15%	15%	15%	15%	15%	15%	15%
CO-6	15%	15%	15%	25%	25%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above(A)
Unit-1.0 Introduction to Automobile Transmission System	6	CO1, CO2	7	3	2	2
Unit-2.0 Clutch	8	CO1, CO3	14	3	7	4
Unit-3.0 Gear Box	12	CO1, CO3	15	4	6	5
Unit-4.0 Propeller Shaft and Universal Joint	8	CO1, CO4	14	3	8	3
Unit-5.0 Final Drive, Differential and Rear Axle	8	CO1, CO4	10	4	4	2
Unit 6.0 Wheels and Tires	6	CO1, CO5	10	3	5	2
Total	**48**	**-**	**70**	**20**	**32**	**18**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce
			PRA*	PDA**	
1.	Assemble a single plate dry type clutch assembly	CO-2	40	50	10
2.	Service Multi plate clutch assembly with relevant clutch adjustments	CO-2	40	50	10
3.	Servicing of two wheeler gear box	CO-3	40	50	10
4.	Dismantle and assemble a three speed sliding type gear box	CO-3	40	50	10
5.	Servicing a five speed gear box	CO-3	40	50	10
6.	Assemble a Propeller shaft - Universal Joint assembly.	CO-4	30	60	10
7.	Assemble the Differential and Rear axle assembly	CO-5	30	60	10
8.	Dismantle/ Assemble a Wheel assembly	CO-6	30	60	10
9.	Perform wheel alignment of vehicle.	**CO-6**	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies maybe appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1	General purpose tools (Spanners, ring spanner and socket)-	6mm to 32 mm	All
2	A modern Car and Jeep of any make and model	Light Motor Vehicles: A modern Car and Jeep of any make and model like Maruti, Mahindra, TATA, Force Motors along with all relevant accessories and systems.	All
3	Working model of four stroke C.I. engine	Actual working engine (multi cylinder four stroke C.I. engine above 1000cc) set up with all accessories.	All
4	Cut – section working model of LMV/HMV Clutches	Single plate clutch and Multi-Plate wet type clutch of LMV/HMV	1&2
5	Two wheeler Gear box Assembly	Gear box Assembly of any two wheeler in good running condition	3
6	Gear box Assembly	Sliding mesh/Constant mesh/Synchromesh gearbox of LMV/HMV in good running condition.	4& 5
7	Cut – section working model of Propeller shaft and universal joint	Four wheeler chassis with cut section of Propeller shaft and universal joint	6
8	Cut – section working model of Final drive and differential.	Four wheeler chassis with cut section of Final drive and differential.	7
9	Wheel aligner Equipped with variable height camera support, vehicle orientation directional indicator, located on camera beam, individual camber, caster & toe.	Parameter, Range, Accuracy: Camber: ±10º, ± 2’; Caster: ±20º, ±6’; Kingpin Inclination: ±20º, ±6’; Toe-in & Toe-out: ±20º, ±2’; Set back: ±5º, ±2’; Thrust angle: ±5º, ±2’.	8 & 9

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Automobile Engineering	R. B. Gupta	Satya Prakashan, New Delhi ISBN-13: 9788176843799
2.	Automobile Engineering vol-II	Anil Chhikara	SatyaPrakashan, New Delhi ASIN : B0BW9TWWBN
3.	Automobile Engineering	K. M. Gupta	Umesh Publication ISBN-13: 5551234002614
4.	Automobile Engineering	Jain K. K., Asthana R. B.	Tata Mc-Graw Hill Publishing Co. Ltd. ISBN-13 : 978-0070445291
5.	Transmission and power train	W. H. Crouse & D.L. Anglin	Tata Mc-Graw Hill Publishing Co. Ltd. ISBN-13 : 978-0070146372

(b) Online Educational Resources:

1. http://www.youtube.com/watch?v=H7Iay0Ke_t4
2. http://www.youtube.com/watch?v=OQ9eI7mEmxw
3. http://www.youtube.com/watch?v=FfjGohWy-OU
4. http://www.youtube.com/watch?v=IKywZ730JFs
5. http://www.youtube.com/watch?v=eKKfJAaVBjE
6. http://www.youtube.com/watch?v=aUlS25r3XY0
7. http://www.youtube.com/watch?v=VcFQZ8NiF4o
8. http://www.youtube.com/watch?v=17FG-GzVJyI
9. http://www.youtube.com/watch?v=1-ksUrWmBo4
10. http://www.ehow.com/video_2327738_overview-shocks-suspension-system.html
11. Howstuffworks.com
12. Wikipedia.com

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, onlineeducational recourses before use by the students.

*****

A) Course Code **:2425303(T2425303/P2425303/S2425303)**

B) Course Title **:** Strength of Materials for Mechanical Engg. (ME, ME (Auto))

C) Pre- requisite Course(s) **:** Physics, Engineering Mechanics

D) Rationale **:**

The effects due to action of force system on a body have already been studied in Physics/Mechanics in previous Semester/Class. Generally, Mechanical/Automobile Engineering components and members are subjected to different loading conditions, resulting into different types of stresses and strains. In this course, estimation of induced stresses and strains of determinate structures/components under action of these transverse, axial, thermal, shear loads, pressure, bending and torsion moment are performed. Moreover, this course will lay sound foundation for analysis and design of mechanical components going to be discussed in latter semesters.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Calculate direct stresses and strains in Mechanical members/components in single load situations.
- **CO-2** Determine bending moment, shear force, slope and deflection in different types of beams/components subjected to transverse loading
- **CO-3** Calculate bending and shear stresses in different types of beams/components.
- **CO-4** Estimate shear stresses in shafts subjected to twisting moment.
- **CO-5** Calculate Stresses and deflection in helical springs.
- **CO-6** Calculate various stresses in thin pressure vessels.
- **CO-7** Calculate principal stress and strain in machine members subjected to multi-load situations.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	2	-	3	2	-	1		
CO-2	3	2	-	2	-	-	1		
CO-3	3	2	-	2	-	-	1		
CO-4	3	2	-	2	-	-	1		
CO-5	3	2	-	2	-	-	1		
CO-6	3	2	-	-	-		1		
CO-7	3	2	-	-	-		1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2425303	Strength of Materials for Mechanical Engg.	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425303	Strength of Materials for Mechanical Engg.	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
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I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2425303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Identify various types of loadings in the given component/member with justification. *TSO 1b.* Identify mechanical components subjected to single load situations. *TSO 1c.* Calculate various elastic moduli in the given situation. *TSO 1d.* Calculate direct stresses and strains in the given determinate component/member subjected to single static longitudinal, shear and thermal loads.	**Unit-1.0 Direct Stresses and Strains in Components** 1.1 Different types of Loads. 1.2 Mechanical properties of materials like Strength, Stiffness, Hardness, Toughness, Ductility, Malleability, Elasticity, Plasticity. 1.3 Statically Determinate structures. 1.4 Direct Stress, Linear Strain, Hook's Law, Stress-Strain curve of ferrous and non ferrous materials, Modulus of Elasticity, Yield, Proof, Breaking and Ultimate Stress and Factor of safety. 1.5 Lateral Strain and Poisson's ratio, Relations between different Moduli. 1.6 Temperature Stresses and Strain with and without yielding. 1.7 Shear Stress, Shear Strain and Shear Modulus. 1.8 Bulk Modulus and Volumetric Strain	**CO1**
TSO2.a. Identify Mechanical components subjected to bending moment. TSO2.b. Draw Shear Force and Bending Moment Diagram for the given Statically Determinate Beam. TSO2.c. Identify location of point of contra flexure in the given situation with justification. TSO2.d. Determine deflection and slope in a given Statically determinate Beam using given method.	**Unit-2.0 Shear Force, Bending Moment, Slope and Deflection in Beam type Components** 2.1 Types of Beams like Cantilever, Simply Supported and Over Hang Beams. 2.2 Relation between Shear Force and Bending Moment. 2.3 Sagging and Hogging Bending Moment and its importance. 2.4 Point of Contra flexure and its importance. 2.5 S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams. 2.6 Slope and Deflection in Cantilever and Simply Supported beams.	**CO2**
TSO 3a. Calculate the bending stress in the given beam. *TSO 3b.* Calculate Slope and Deflection in the given beam. *TSO 3c.* Calulate the shear stress behavior in the given beam.	**Unit-3.0 Bending and Shear Stresses in Beam type Components** 3.1 Bending Theory, Flexural equation, Bending stress, Bending strain, Sectional Modulus 3.2 Neutral Axis, application of Bending theory to Statically determinate beams. 3.3 Shear stress: Average and Maximum shear stress for rectangular and circular section beams. 3.4 Short members subjected to eccentric loading.	**CO3**
TSO 4a. Calculate the shear stresses in the given shaft which is subjected to pure twisting moment. *TSO 4b.* Calculate angle of twist and shear train in given solid shaft. *TSO 4c.* Calculate the power transmitted by the given solid and hollow shafts. *TSO 4d.* Select solid and hollow shaft for the given application with justification.	**Unit-4.0 Torsion of Shaft** 4.1 Torsion/Twisting Moment, Torsional Equation, Angle of Twist, Polar Moment of Inertia, Torsional Rigidity. 4.2 Torsional Stress and Strain in solid and hollow shafts. Comparison between Solid and Hollow Shafts subjected to pure torsion. 4.3 Power Transmitted /Consumed for shaft, spindle and axle of solid and hollow sections subjected to Twisting Moment.	**CO4**
TSO 5a. Calculate Stiffness, deflection and maximum stress in the given spring.	**Unit-5.0 Stresses and Deflection in Helical Springs**	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5b. Estimate strain energy for the given axially loaded helical spring.	5.1 Definition, types and application of springs. 5.2 Spring classification based on size, shape and load-leaf spring, helical and spiral spring. 5.3 Stiffness, deflection and maximum stress in helical open and closed coil springs only.	
TSO 6a. Identify mechanical components subjected to internal/external pressure loading. *TSO 6b.* Find out various stresses induced in the given thin pressure vessel due to internal/external pressure.	**Unit-6.0 Thin Cylindrical and Spherical Pressure Vessels** 6.1 Pressure Vessels. 6.2 Thin cylinders and spheres subjected to internal pressure; Hoop stresses, longitudinal stress and change in volume. 6.3 Wire bound thin Cylindrical pressure vessels.	**CO6**
TSO 7a. Identify multi-load situations with justifications. *TSO 7b.* Estimate principal stresses and maximum shear stress for a given combined loading by analytical Approach. *TSO 7c.* Estimate principal stresses and maximum shear stress for a given combined loading by Mohr's circle method.	**Unit-7.0 Principal Stresses** 7.1 Multi load situations and need of estimating principal stresses. 7.2 Definition of principal plane and principal stresses. 7.3 Expression for normal and tangential stress, maximum shear stress. 7.4 Stresses on inclined planes. 7.5 Position of principal planes and planes of maximum shear. 7.6 Graphical solution using Mohr's circle of Stresses.	**CO7**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use UTM to perform Tensile test. *LSO 1.2.* Plot stress-strain curve for a given material under tensile loading. *LSO 1.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area. *LSO 1.4.* Use related IS Code	1.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	CO1
LSO 2.1. Use UTM to perform Compression test. *LSO 2.2.* Plot stress-strain curve for a given material under compressive loading. *LSO 2.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area. *LSO 2.4.* Use related IS Code	2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	CO1
LSO 3.1. Use UTM to perform Shear test. *LSO 3.2.* Plot stress-strain curve for a given material under shear loading. *LSO 3.3.* Estimate corresponding yield strength, proof stress, and ultimate strength. *LSO 3.4.* Use related IS Code	3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 4.1. Identify simply supported end conditions *LSO 4.2.* Correlate Young's Modulus of beam material with deflection and area moment of inertia.	4.	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	CO1, CO2
LSO 5.1. Use Impact machine under Izod and Charpy test situations *LSO 5.2.* Identify way to apply impact loading *LSO 5.3.* Estimate Toughness of the specimen material. *LSO 5.4.* Use related IS Code	5.	Calculate Impact Value/Toughness of Mild Steel and Aluminium using Izod and Charpy Impact Test Apparatus as per IS 1757.	CO1
LSO 6.1. Use Brinell, Rockwell and Vicker's hardness testers. *LSO 6.2.* Perform hardness test. *LSO 6.3.* Correlation of different hardness values from different tests.	6.	Perform Brinell, Rockwell and Vicker's hardness test on different metals.	CO1
LSO 7.1. Use Combined Shear Force and Bending Moment apparatus. *LSO 7.2.* Estimate Bending moment and shear force in beams. *LSO 7.3.* Estimate the point of contraflexure.	7.	Estimate Maximum Bending moment and Shear force for simply supported and cantilever beams under point load and UDL using 'Combined Shear Force and Bending Moment' apparatus.	CO2
LSO 8.1. Use using 'Slope and Deflection' apparatus *LSO 8.2.* Find out Measure flexural rigidity (EI) for a given beam *LSO 8.3.* Correlate experimental and analytical values	8.	Measure flexural rigidity (EI) for beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	CO2
LSO 9.1. Use using 'Slope and Deflection' apparatus *LSO 9.2.* Investigate the effect of beam length and width on deflection of beam *LSO 9.3.* Correlate experimental and analytical values	9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	CO2
LSO 10.1. 'Torsion of Bar' apparatus *LSO 10.2.* Correlate the angle of twist, length and modulus of Rigidity of a shaft. *LSO 10.3.* Use related IS Code	10.	Perform the torsion test on wire/ Rod of different materials using 'Torsion of Bar' apparatus. (Part I) as per IS 1717	CO4
LSO 11.1. Use 'Extension and compression of Spring 'apparatus *LSO 11.2.* Estimate Stiffness of the given spring. *LSO 11.3.* Correlate the effect of spring deflection and load on strain energy stored.	11.	Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring 'apparatus.	CO5

L) Suggested Term Work and Self Learning: S2433303 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Collect information about the values of different engineering properties of five standard mechanical engineering materials and present in tabular form.
- Identify simple mechanical components where single load situation exist.
- Solve numerical problems related to direct stresses and strains.
- List out different types of test that can be performed on a UTM.
- Solve numerical problems related to S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams type components.

- Collect information comprising of different mechanical components subjected to bending stresses.
- Prepare a list of machine components where deflection is desirable and non desirable for the functioning.
- Solve problems related to deflection of components under transverse loading.
- Solve numerical problems on simple multi load situations.

b. Micro Projects:

1. Prepare a model showing the effects of thermal stresses on prismatic components.
2. Prepare an excel sheet to calculate SF and BM in a simply supported beam and cantilever beam.
3. Prepare a working model to measure deflection in digital form using sensors/potentiometer/transducers of a cantilever beam with facility to vary the position of a point load.
4. Perform internet search to prepare a list of software used to draw and estimate shear force, bending moment and deflection of beams.
5. Prepare a model of a shaft to demonstrate relation between length and angle of twist.
6. Collect data of three shafts of three different electric motors available in your college like length, diameter and material. Note down the power and speed of the motor and comment on the shaft diameters used.

c. Other Activities:

1. Seminar Topics:
    - Different mechanical property testing methods used in industry
    - Different types of beams with examples
    - Relation between Load, SF, BM, Slope and Deflection
    - Application of solid and hollow shafts.
    - Different types of Helical springs
    - Domestic and industrial Thin and Thick pressure vessels

2. Visits:
    - Visit a nearby industry/workshop to identify and list the various failures in machine components due to direct stresses.
    - Visit to automobile service center and tabulate the usage of helical/leaf spring in various automotives Cars/Trucks/Buses.
    - Visit institute mechanical workshop and list shafts and their applications in different machines and equipment.

3. Self-Learning Topics:
    - Relations between different elastic moduli
    - Spherical Pressure vessels
    - Deflection in Cantilever beams with point and Uniform Distributed Loads
    - Power transmitted by a hollow shaft.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	-	17%	50%	20%
CO-2	10%	10%	10%	33%	17%	20%	20%
CO-3	15%	15%	15%	33%	17%	-	20%
CO-4	15%	15%	15%	34%	17%	15%	20%
CO-5	10%	10%	10%	-	17%	15%	20%
CO-6	10%	10%	10%	-	15%	-	-
CO-7	20%	20%	20%	-	-	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Direct Stresses and Strains in components	10	CO1	14	3	5	6
Unit-2.0 Shear Force, Bending Moment, Slope and Deflection in Beam type components	10	CO2	12	3	3	6
Unit-3.0 Bending and Shear stresses in beam type components	08	CO3	10	3	2	5
Unit-4.0 Torsion of Shaft	06	CO4	10	3	2	5
Unit-5.0 Stresses and Deflection in Helical Springs	04	CO5	08	3	0	5
Unit-6.0 Thin Cylindrical and Spherical Pressure Vessels	04	CO6	08	3	0	5
Unit-7.0 Principal Stresses	06	CO7	08	2	0	6
Total	**48**	**-**	**70**	**20**	**12**	**38**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	CO1	40	50	10
2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	CO1	40	50	10
3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	CO1	40	50	10
4.	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	CO1, CO2	40	50	10
5.	Calculate Impact Value/Toughness of Mild Steel and Aluminium using Izod and Charpy Impact Test Apparatus as per IS 1757.	CO1	40	50	10
6.	Perform Brinell, Rockwell and Vicker's hardness test on different metals.	CO1	40	50	10
7.	Estimate Maximum Bending moment and Shear force for simply supported and cantilever beams under point load and UDL using 'Combined Shear Force and Bending Moment' apparatus.	CO2	40	50	10
8.	Measure flexural rigidity (EI) for beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	CO2	40	50	10
9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	CO2	40	50	10
10.	Perform the torsion test on wire/ Rod of different materials using 'Torsion of Bar' apparatus. (Part I) as per IS 1717	CO4	40	50	10
11.	Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring 'apparatus.	CO5	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Universal Testing Machine	**Universal Testing Machine:** Capacity - 40 tones. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to32 mm. (2) Compression test attachment(3)Shear test attachment with sizes of bushes (3) Shear test attachment (4) Two point and three pont bending attachment etc.	1,2,3,4,5
2.	Impact Testing Machine (Izod Test)	**IZOD Impact Test Apparatus:** Pendulum dropangle:90°-120; Pendulum effective Wt:20-25kg; Striking velocity of pendulum:3-4 m/sec; Pendulum impact energy:168 joule; Min scale graduation:2 Joule.	5
3.	Impact Testing Machine (Charpy Test)	**CHARPY Test Apparatus:** Pendulum drop angle140°; Pendulum effective Wt 20-25 kg; Strikingvelocityofpendulum5-6m/sec; Pendulum impact energy 300 j; Min scale graduation 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum 815mm.	5
4.	Perform Brinell, Rockwell and Vicker's hardness testers	-	6
5.	Combined Shear Force and Bending Moment apparatus	Combined Shear Force and Bending Moment apparatus	7
6.	Slope and Deflection of Beam Apparatus	A bench mounted apparatus with a steel base with support at ends. The supports can be fitted with knife edges or clamp plates.A steel beam and two load hangers are together with two dial gauges for measuring beam deflections and slopes, Micrometer, Calipers, Scale, Weights and hanger.	8, 9
7.	Torsion Testing Machine	**Torsion Testing Machine:** Fixed with auto torque select or to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy +1% of the true torque Suitable for: Torsion and Twist test on diverse metal rods and flats, Torque Measurement by pendulum dynamometer system	10
8.	Torsions of bars apparatus	**Torsions of bars apparatus:** To understand and investigate directly the relationship between the torsional load applied to a round bar and the angular twist produced and how this relationship varies with the beam material and its cross-sectional polar moment of area. Specimens are rigidly held in a clamp fixed to one end of the bench top base frame of the apparatus.	10
9.	Extension and compression of Springs apparatus	The apparatus should be designed to be mounted on a rigid vertical support approximately 1.5 metres above floor level. It is used to test tension springs up to 200 mm in length. The maximum spring diameter is 38mm, Micrometer, Calipers, Scale, Weights and hanger.	11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Strength of Materials	R.K. Rajput	S. Chand Publishing (6th Edition, 2015, ISBN-13: 978-9385401367
2.	Strength of Materials	Rattan S.S.	McGraw Hill Education; Third edition, 2016, ISBN-13: 978-9385965517
3.	Strength of Material and Mechanics of Structures	B.C. Punamia	Laxmi Publications (p) Ltd. New Delhi, 10/e, 2015, ISBN-13:978-8131809259
4.	Strength of Material	S. Ramamurutham	Dhanpat Rai Publishing Company Private Limited-New Delhi; Eighth edition, 2014, ISBN-13:978- 9384378264

(b) Online Educational Resources:

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. https://onlinecourses.nptel.ac.in/noc19_ce18/preview
3. https://www.coursera.org/learn/mechanics-1
4. https://www.coursera.org/courses?query=mechanics%20of%20materials
5. en.wikipedia.org/wiki/Shear_and_moment_diagram
6. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
7. www.engineerstudent.co.uk/stress_and_strain.html
8. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

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

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A) Course Code **: 2425304(T2425304/P2425304/S2425304)**

B) Course Title **:** Basics Thermodynamics (ME, ME (Auto))

C) Pre- requisite Course(s) **:**

D) Rationale **:**

Thermodynamics is a branch of science that deals with energy transformations and are primarily concerned with the two forms of energy heat and work. The energy transformations are governed by the various laws of thermodynamics known as zero, first, second and third laws. Applications of thermodynamics can be found in fields of refrigeration and air-conditioning to automobile. Its principles are used to design automobile engines, steam turbines, power plants, HVAC, aircraft and rockets, etc. Thus, every student of Diploma Mechanical Engineering should have a fundamental knowledge of this course.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Asses' thermodynamic properties and systems.
CO-2 Apply the laws of thermodynamics to the given systems**.**
CO-3 Analyze thermodynamics cycles
CO-4 Quantify the behavior of boiler based on the thermodynamic cycle**.**
CO-5 Analyze processes involving ideal gases and real substances

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Developmentof 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**
CO-1	3	2	3	-	-	-	-		
CO-2	3	3	2	2	1	2	2		
CO-3	3	3	2	2	2	-	2		
CO-4	3	2	2	2	-	-	-		
CO-5	3	3	2	2	2	2	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2425304	Basics Thermodynamics	02	01	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425304	Basics Thermodynamic	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2425304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain thermodynamics & various thermodynamics processes. *TSO 1b.* Analyze heat and work. *TSO 1c.* Draw P-V and T-S diagram of different process. *TSO 1d.* Calculate internal energy and enthalpy. *TSO 1e.* Identify state through properties. *TSO 1f.* Calculate the work done by a closed system *TSO 1g.* Calculate changes in entropy using thermodynamic tables *TSO 1h.* Calculate changes in entropy for ideal gases *TSO 1i.* calculate absolute and gage pressure, and absolute temperature. *TSO 1j.* calculate changes in kinetic, potential, enthalpy and internal energy.	**Unit-1.0 Fundamental Concepts of Thermodynamics** 1.1 Thermodynamics: Terminology, definition and scope, microscopic and macroscopic approaches, Basic concepts of – State, state point, System, Boundary and Surroundings, 1.2 Identification of a state through properties Thermodynamic properties, their units and classifications. intensive and extensive various property diagrams 1.2 Mechanics definition of work and its limitations, Heat and work, Work done, sign convention, change in internal energy, change in enthalpy and entropy, Specific heats at constant volume and at constant pressure. 1.3 Thermodynamic processes of ideal gases. Isobaric, Isochoric, Isothermal, Adiabatic and polytropic with representation on P-V and T-S diagram. 1.4 General gas equation, Characteristics of gas constant, Mol of gas, Universal gas constant, specific heats of ideal gases. 1.5 Thermodynamic equilibrium, Reversibility and irreversibility, Quasi-static process	**CO1**
TSO 2a. Apply zeroth law of thermodynamics to a given thermodynamic system. *TSO 2b.* Apply first law of thermodynamics to a given thermodynamic system. *TSO 2c.* Calculate thermal efficiency & C.O.P. for a given thermodynamic cycle *TSO 2d.* Apply third law of thermodynamics to a given thermodynamic system *TSO 2e.* Explain Steady flow energy equation and their application *TSO 2f.* Apply second law of thermodynamics to a given thermodynamic system *TSO 2g.* Analyze systems and control volumes through the application of the second law	**Unit-2.0 Law of Thermodynamics** 2.1 Zeroth and first law of thermodynamics, Statement of the First law of thermodynamics for a cycle Steady flow energy equation and their application. 2.2 Derivation of the First law of processes, energy, internal energy as a property 2.3 Concept of heat source and heat sink, heat reservoir, heat engine, heat pump and refrigerator 2.4 Statement of the second law of thermodynamics: - Kelvin Planck Statement, Clausius Statement and their equivalence, heat engine, heat pump, refrigerator and simple numerical on thermal efficiency and COP. 2.5 Statement of the third law of thermodynamic	**CO2**
TSO 3a. Describe types of thermodynamics cycle. *TSO 3b.* Draw P-V and T-S diagram of Carnot cycle *TSO 3c.* Calculate thermal efficiency of Carnot cycle. *TSO 3d.* Draw P-V and T-S diagram of cycle and Brayton cycle. *TSO 3e.* Calculate air standard efficiency of different cycle	**Unit-3.0 Thermodynamic Cycles** 3.1 Classifications of thermodynamic cycle. 3.2 Carnot cycle and its representation on P-V and T-S diagram. 3.3 Derivation of thermal efficiency of Carnot cycle and simple numerical based on it. 3.4 Concept of air standard efficiency of Otto, Diesel, and Brayton cycle (Without derivation), representation on P-V & T-S diagram.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3f. Analyze the Carnot, Otto, and Rankine thermodynamic cycles.		
TSO 4a. Describe steam and their phases. *TSO 4b.* Calculate dryness fraction and degree of superheat. *TSO 4c.* Calculate enthalpy of steam using steam table. *TSO 4d.* Explain given type of boiler, mountings and their accessories. *TSO 4e.* Identify different components of given boiler	**Unit-4.0 Properties of Steam and Steam Power** 4.1 Formation of steam, various phases like wet steam, dry saturated Steam, superheated steam. 4.2 Dryness fraction, degree of superheat, sensible heat, Latent heat, calculation of enthalpy of wet, dry saturated & superheated steam using steam table. 4.3 Steam boilers: Classification, Construction and working of Cochran, Babcock and Wilcox, Lamont and Loeffler boiler. Mountings – Bourdon Pressure Gauge, Safety valves, Water level Indicator and fusible Plug. Accessories – Economizer, super heater and air pre-heater.	**CO4**
TSO.5a Sketch P-v, T-v, and P-T plots for steam, R-134a, and ideal gases. *TSO.5b* Locate data states on P-v, T-v, and P-T plots for steam, R-134a, and ideal gases *TSO.5c* Apply the concept of the generalized compressibility factor to determine the state of a gas *TSO.5d* Apply the ideal gas equation to solve problems involving pressure, temperature, and volume of ideal gases *TSO.5e* Analyze processes involving ideal gases and real substances as working fluids in both closed systems and open systems *TSO.5f* Determine the properties of pure substances using thermodynamic tables *TSO.5g* Calculate changes in entropy using thermodynamic tables. *TSO.5h* Calculate changes in entropy for ideal gases	**Unit-5.0 Pure Substances, Ideal & Real Gases** **Ideal and perfect gases** 5.1 Differences between perfect, ideal and real gases, equation of state, evaluation of properties of perfect and ideal gases. 5.2 Real Gases: Introduction. Vander Waal's Equation of state, Van der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor, compressibility chart **Pure Substances** 5.3 Definition of a pure substance, phase of a substance, triple point and critical points, sub-cooled liquid, saturated liquid, vapor pressure, two-phase mixture of liquid and vapor, saturated vapor and superheated vapor states of a pure substance 5.4 Representation of pure substance properties on p-T and p-V diagrams, detailed treatment of properties of steam for industrial and scientific use	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use of thermometer and pressure gauge.	1.	Calibrate thermometers and pressure gauges	CO1
	2.	Compare the accuracy and characteristics response of the different types of thermometers.	CO1
	3.	Determine the pressure with a bourdon tube pressure gauge	CO1
	4.	Determine the pressure with different pressure measuring devices and then compare the measured values	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1. Use working models of petrol engine/ diesel engine	5.	Use model of cross-sectional view of given petrol engine to identify different parts and components of the engine	CO2
	6.	Use model of cross-sectional view of given diesel engine to identify different parts and components of the engine	CO2
LSO 2.2. Use heat pump	7.	Determine the power input, power output as well coefficient of performance of heat pump	CO2
LSO 2.3. Use steam turbine	8.	Operate impulse and reaction steam turbines.	CO2
	9.	Determine power output & efficiency of a steam turbine	CO2
	10.	Determination of steam flow rate of a steam turbine	CO2
LSO 2.4. Use condenser	11.	Find the efficiency of the given condenser	CO2
LSO 3.1. Use steam engine	12.	Determine the brake power of a single cylinder steam engine with varying load	CO3
LSO 3.2. Use heat Engine	13.	Investigate the first law and Second law of thermodynamic using heat Engine	CO3
LSO 4.1. Use separating and throttling calorimeter	14.	Find dryness fraction of steam by separating and throttling calorimeter.	CO4
LSO 4.2. Use working models of different types of boilers.	15.	Identify low pressure boilers and their accessories and mountings.	CO4
	16.	Identify high pressure boilers and their accessories and mountings.	CO4
	17.	Prepare heat balance sheet for given boiler.	CO4
	18.	Investigate the relationship between pressure and temperature of saturated steam.	CO4
	19.	Carry out fault finding on Boiler control demonstration unit.	CO4
LSO5.1 Use air-Water-Steam Heat Exchanger	20.	Determine the mean temperature difference between two mediums in both contra and parallel flow using air-Water-Steam Heat Exchanger	CO5
	21.	Plot the temperature difference curves for a variety of flow conditions using air-Water-Steam Heat Exchanger	CO5
LSO5.2 Use indicator unit	22.	Use indicator unit to draw the PV diagram of a piston side and piston rod side.	CO5

L) Suggested Term Work and Self Learning: S2425304 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

i. Draw P-V and T-S diagram of dual cycle.
ii. Derive formula of thermal efficiency of otto cycle.
iii. Differentiate between diesel cycle and otto cycle on the basis of compression ratio and same higher pressure.

iv. Differentiate between water tube boiler and fire tube boiler on basis of pressure.

b. Micro project:

i. Prepare report on different thermal equipment in your home where law of thermodynamics is applicable.
ii. Prepare report on application of boiler principle equipment like pressure cooker, geyser etc.
iii. Prepare report on effect of compression ratio on Otto and Diesel cycle.
iv. Prepare model of boiler mounting and accessories.

c. Other Activities:

1. Seminar Topics:
   - Heat engine
   - Steam Boiler
   - Heat exchanger

2. Visits:
   - Visit nearby thermal power plant and prepare a detail report on the basis of given criteria
   - Visit nearby automobile service station and prepare a detail report on the basis of given criteria.

3. Self-Learning Topics:
   - Properties of a System
   - Heat pumps
   - Entropy
   - Enthalpy

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	15%	20%
CO-2	20%	20%	20%	25%	-	20%	20%
CO-3	25%	25%	25%	25%	33%	25%	20%
CO-4	20%	20%	20%	25%	33%	20%	20%
CO-5	20%	20%	20%	25%	34%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:
- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Fundamental Concepts of Thermodynamics	8	CO1	12	4	4	4
Unit-2.0 Law of Thermodynamics	9	CO2	15	4	5	6
Unit-3.0 Thermodynamic cycles	10	CO3	15	4	5	6
Unit-4.0 Properties of Steam and Steam Power	12	CO4	15	4	5	6
Unit-5.0 Pure Substances, Ideal & Real Gases	9	CO5	13	4	4	5
Total	**48**	**-**	**70**	**20**	**23**	**27**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Calibrate of Thermometers and pressure gauges	CO1	30	60	10
2.	Compare the accuracy and characteristics response of the different types of thermometers.	CO1	40	50	10
3.	Determine the pressure with a bourdon tube pressure gauge	CO1	40	50	10
4.	Determine the pressure with different pressure measuring devices and then compare the measured values	CO1	40	50	10
5.	Use model of cross-sectional view of given petrol engine to identify different parts and components of the engine	CO2	30	60	10
6.	Use model of cross-sectional view of given diesel engine to identify different parts and components of the engine	CO2	40	50	10
7.	Determine the power input, power output as well coefficient of performance of heat pump	CO2	40	50	10
8.	Operate impulse and reaction steam turbines.	CO2	40	50	10
9.	Determine power output & efficiency of a steam turbine	CO2	40	50	10
10.	Determination of steam flow rate of a steam turbine	CO2	40	50	10
11.	Find the efficiency of the given condenser	CO2	40	50	10
12.	Determine the brake power of a single cylinder steam engine with varying load	CO3	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
13.	Investigate the first law and Second law of thermodynamic using heat Engine	CO3	40	50	10
14.	Find dryness fraction of steam by using separating and throttling calorimeter.	CO4	40	50	10
15.	Identify low pressure boilers and their accessories and mountings.	CO4	40	50	10
16.	Identify high pressure boilers and their accessories and mountings.	CO4	40	50	10
17.	Prepare heat balance sheet for given boiler.	CO4	40	50	10
18.	Investigate the relationship between pressure and temperature of saturated steam.	CO4	40	50	10
19.	Carry out fault finding on Boiler control demonstration unit.	CO4	40	50	10
20.	Determine the mean temperature difference between two mediums in both contra and parallel flow using air-Water-Steam Heat Exchanger	CO5	40	50	10
21.	Plot the temperature difference curves for a variety of flow conditions using air-Water-Steam Heat Exchanger	CO5	40	50	10
22.	Use indicator unit to draw the PV diagram of a piston side and piston rod side.	CO5	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Thermometer and pressure gauges of different types	300 mm (+10% variation is acceptable). Length of main scale: 180mm±10% Scale smallest division: shall not be more than 0.5 degree centigrade. Bulb length: Shall not be less than 10mm and shall not greater than 25mm. Stem diameter: Shall not be less than 5.5mm and shall not greater than 8mm.	1-4
2.	Petrol engine	Single cylinder, 4 stroke, air cooled ,110 cc, fuel-petrol Computerized Engine Test Rigs	5
3.	Diesel engine	Single cylinder, 4 stroke, air cooled ,110 cc, fuel-diesel Computerized Engine Test Rigs	6

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Heat pump	Heat pump should have 60° C to 70° C hot water COP of at least 3.6 at 15°C wet bulb ambient, air to water type to heat water to a constant 60°C at condensing temperature at or below 55°C, robust casing manufactured from 304 or 316 stainless steel, The heat pump unit shall be complete with independent compressor circuit where more than one (1) compressor is utilized, evaporation coil shall be aluminum on copper tube, axial fans, primary water circulation pump, check valves, gate valves, gauges and automatic control system Heat pump should be a 3PH, 380V, 36KW	7
5.	Steam turbine	Steam Turbine Test Rig	8,9,10
6.	Condenser	Working models of Jet condenser, Surface condenser	11
7.	Steam engine	Working models Steam engine	12
8.	Heat Engine	Working models Heat Engine	13
9.	Separating and throttling calorimeter	Separating Calorimeter: lagged with glass wool and cladded with aluminum and should have gauge column, pressure gauge, stop cock & needle valve Throttling Calorimeter: lagged with glass wool and cladded with aluminum, brass orifice and should have cased thermometer, manometer, valve, etc. Boiler Unit- mini boiler unit approx. 5ltr capacity producing steam of 2 -4 kg max. fitted with 2kW heater, Pressure gauge, safety valve and glass tube water level indicator.	14
10.	Different types of Boilers	Working model of Cochran, Lancashire Boiler, Babcock & Wilcox Boiler	15-19
11.	Boiler mounting and accessories	Working models of water level indicator, safety valve Fusible plug, pressure gauge, stop valve, feed check valve, 7. blow off cock, manhole and mud box Accessories- super heater, economizer, air preheater	15-19
12.	Heat Exchanger	Shell & tube heat exchanger, Fin tube heat exchanger	20-21
13.	Indicator unit	Piston indicator, Balanced diaphragm type indicator, Electronic indicator, Optical indicator	22

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Thermodynamics	James Ambrose Moyer	Maxwell Press,2022 ISBN-10: **9355282001** ISBN-13: **9355282002-978**
2.	Engineering Thermodynamics	R.K. Singal Mridul Singal Rishi Singal	Dreamtech Press, 2020 ISBN-10: **9389698669** , ISBN-13: **9389698664-978**
3.	Heat and Mass Transfer - Fundamentals and Applications	Yunus A. Cengel Afshin J. Ghajar	McGraw Hill, Ed.6th ISBN-10: **9390185289** ISBN-13: **9390185283-978**

4.	Thermodynamics an engineering approach	Yunus A. Cengel Michael A. Boles Mehmet Kanoglu	McGraw Hill Education India, 2019 ISBN: 9789353165741, 9353165741
5.	Applications of Thermodynamics	V. Kadambi T. R. Seetharam K. B. Subramanya Kumar	Wiley, 2019 ISBN-10 : 8126571241 ISBN-13 : 978-8126571246
6.	Basic and applied thermodynamics	P.K. Nag	McGraw Hill Education india, Ed.2nd 2017, ISBN: 9780070151314,9780070151314
7.	Thermal Engineering	R.S. Khurmi	S Chand, 2020 ISBN-10 : 9788121925730 ISBN-13 : 978-8121925730
8.	A course in Thermal Engineering	Domkundwar, Kothandaraman	Dhanpat Rai and company, 2017 ASIN : B0B5KRKDHS

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=gG9mzVV9FYA&list=PL9RcWoqXmzaK6AHCCyL_J6gqc02RN-w-D
2. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
3. https://www.youtube.com/watch?v=ZTpnJZu1IQw&list=PLiSPNzs4fD9snxh0jHSuk3HuqoMhW24VO
4. https://archive.nptel.ac.in/courses/112/108/112108148/
5. https://archive.nptel.ac.in/courses/112/108/112108149/

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Conference paper
2. Journal paper
3. Lab Manuals

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A) Course Code **:2425305(P2425305/S2425305)**

B) Course Title **:** Computer Aided Drafting and Modelling (ME, ME (Auto))

C) Pre- requisite Course(s) **:** Engineering Drawing

D) Rationale **:**

With the emergence of computer-aided drafting and design (CAD) tools the traditional engineering drawing practices has undergone significant change as the emphasis has shifted from drawing board based engineering practices to Computer aided based drafting and modeling which has the advantages of speed, modification, storage and convenience of drawing complex 2D and 3D entities. This course makes them able to use computer aided drafting and design software for developing 2D & 3D digital entities, Digital engineering drawings and Assemblies related to different fields. The goal of this course is to make the student proficient in the most up-to-date drafting, solid modeling and assembly practices through providing them with hands-on experience.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Use Computer Aided Drafting software to draw simple and complex 2D geometric entities.
- **CO-2** Use Computer Aided Drafting software to draw orthographic and isometric projections.
- **CO-3** Use Computer Aided Design Software to model 3D components and assemblies.
- **CO-4** Use Computer Aided Design Software to create engineering drawings of machine components and assemblies.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	-	3	1	1	2		
CO-2	3	-	1	3	1	1	2		
CO-3	3	1	1	3	-	1	2		
CO-4	3	-	-	3	-	1	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2425305	Computer Aided Drafting and Modelling	-	-	04	02	06	03

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits= (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425305	Computer Aided Drafting and Modelling	-	-	20	30	20	30	100

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Use the given computer aided drafting software for creating the institute Drawing Template. *TSO 1b.* Use drawing commands to create the given simple 2D geometry. *TSO 1c.* Apply drawing aids, coordinate system, selection methods, and templates to create the given drawing quickly and precisely. *TSO 1d.* Use the given computer aided drafting software for creating the given simple 2D entity.	**Unit-1.0 Basic Computer Aided Drafting** 1.1 Various Software for Computer Aided Drafting and Computer Aided Design. 1.2 Basics of AutoCAD or any other drafting software–interface, screen layout, starting commands from menus, command line. 1.3 Coordinate system, Angular measurements, Point specification. 1.4 Drawing aids - Grid, Snap, Ortho, Osnap, Units, Limits, Layers, Linetype. 1.5 Opening and Saving drawing files. 1.6 Creating User Defined Templates. 1.7 Methods of Selecting and deleting Objects. 1.8 Undo and Redo. 1.9 Creating basic drawings objects - lines, arc, circles, ellipses, polyline and polygons.	**CO1**
TSO 2a. Use modifying commands to create the given complex 2D entity. *TSO 2b.* Use hatching, text and dimensioning, tolerance and formatting commands to make the given complex 2D drawings. *TSO 2c.* Use layers and blocks to handle complex 2D drawings. *TSO 2d.* Use the given computer aided drafting software for creating the given complex 2D entity. *TSO 2e.* Print the given drawing (using institute template) on A4/A3 sheet.	**Unit-2.0 Advanced Computer Aided Drafting** 2.1 Modify 2D entities: Erase, Trim, Extend, Copy, Move, Mirror, Offset, Fillet, Chamfer, Array, Rotate, Scale, Lengthen, Stretch, Break, Divide, Exploded and Block, Hatch etc. 2.2 Text and Dimensioning, Dimensional tolerances and Geometrical tolerances. 2.3 Formatting commands- Line weight, Color, Line type, Dimension style. 2.4 Controlling Drawing display. 2.5 Layers: concept and application. 2.6 Printing and plotting of drawings- Paper space, Model space, creating table, Plot commands.	**CO1**
TSO 3a. Use the given computer aided drafting software for creating orthographic views of the given object. *TSO 3b.* Use the given computer aided drafting software for creating isometric views of the given object.	**Unit-3.0 Application of Computer Aided Drafting** 3.1 Drawing orthographic views using drafting software with principles mentioned in 'Engineering Drawing' Course. 3.2 Drawing isometric views using drafting software with principles mentioned in 'Engineering Drawing' Course.	**CO1, CO2**
TSO 4a. Explain solid modeling, surface modeling and assembly operation in the available CAD software. *TSO 4b.* Use the given computer aided Design software to create 2D entities with constraints and parametric relations.	**Unit-4.0 Computer Aided Design Software-Working in 2D Environment** 4.1 Introduction, features, and applications of different software packages used for solid modeling. System requirement & compatibility with other software. 4.2 Working in Sketcher mode - Line, Profile, Circle, Arc, curves, Rectangle, and their sub options. 4.3 Constraints-Dimensioning constraint, Geometrical constraint.	**CO3**
TSO 5a. Create the given 3D model (part) using the given commands and parametric relations. *TSO 5b.* Describe the procedure to use 3D modify commands to edit the given 3D Model.	**Unit-5.0 Computer Aided Design Software-Solid Modeling and Assembly** 5.1 Introduction to Computer Aided Design Software and different modules.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5c. Create assembly of the given 3D solid (Part) models using the CAD software. *TSO 5d.* Modify the given assembly using the CAD software. *TSO 5e.* Describe the procedure to use explode command for the given assembly.	5.2 Working in 3D environment 5.3 Creating 3D Solid Models of simple and complex machine parts using Extrude, Revolve, Sweep, variable section sweep, Draft, loft, Blend, creating reference planes, points and lines, and similar 3D commands. 5.4 Part editing tool: Trim, Extend, Erase, Mirror, Chamfer, Round, Copy, Move, Draft, Boolean operations, Patterns, etc. 5.5 Parametric and non parametric modeling-concept, differences and illustration. 5.6 Preparation of assemblies using assembly commands. Introduction to Top down and Bottom up approach of assembly 5.7 Exploded view: Explode the assembly.	
TSO 6a. Describe the procedure to generate 2D drawings of the given part models and assembly using the CAD software. *TSO 6b.* Plot production drawing as per the given dimensions, parts and assemblies.	**Unit-6.0 Drafting and Plotting using Computer Aided Design Software** 6.1 Generate orthographic projections from already available Part Models and Assemblies. All types of views – front view, top view, side view, sectional views, isometric views, auxiliary views. 6.2 Dimensioning Commands – Apply dimensions, dimensional and geometrical tolerances. 6.3 Preparation of Assembly drawing using assembly features. 6.4 Working in Drafting Mode. 6.5 Bill of material – Prepare part list table and name plate. 6.6 Page set up, Plot command.	**CO4**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use the given Computer aided Drafting software. *LSO 1.2.* Draw standard 2D entities using Draw commands.	1.	Use the Computer Aided Drafting software to draw following simple 2-D entities using Draw commands • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1
LSO 2.1. Customize the given Computer aided drafting software as per requirements. *LSO 2.2.* Use readymade templates to draw 2D entities.	2.	• Use customization tool bar of CADr software to customize main window and to do interfacing. • Use existing standard 2D drawing templates.	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.1. Use the given Computer aided Drafting software to create template as per requirement. *LSO 3.2.* Insert already prepared 2D entities in the template using modify commands	3.	Prepare a template for your institute of A-4 size with title block and institute logo using the Computer Aided Drafting software.	CO1
LSO 4.1. Estimate areas and perimeters of regular and complex 2D entities using software.	4.	Use the Computer Aided Drafting software to estimate Area, Perimeter, and Centroid for the given 2D entities like Circle, Pentagon, Trapezium, hexagon and 2D entity with arcs and spline curves using 'Enquiry' and 'List' commands.	CO1
LSO 5.1. Draw conic sections using software. *LSO 5.2.* Draw popular engineering curves for engineering applications.	5.	Use the Computer Aided Drafting software to draw: • Ellipse and parabola • Epicycloid and Hypocycloid curves using pitch circle as directing circle of a cycloidal gear and an appropriate size smaller circle as generating circle • Involute of a circle	CO1
LSO 6.1. Use various Draw, Edit and Modify commands to create complex 2D entities.	6.	Use the Computer Aided Drafting software to draw four complex 2D entities assigned by the teacher using Draw, Edit and Modify commands	CO1
LSO 7.1. Use Computer aided Drafting software to create and modify 2D entities. *LSO 7.2.* Use computer aided drafting software to create and modify the given orthographic views.	7.	Use the Computer Aided Drafting software to draw Orthographic projections of following using first angle method: • A pentagonal pyramid is placed in first quadrant with its axis parallel to H.P. and V.P • A frustum of a hexagonal is placed in first quadrant with its axis perpendicular to H.P. and parallel to V.P • Different objects having cylindrical surfaces, ribs.	CO2
LSO 8.1. Use computer aided drafting software to create and modify the given orthographic views of mechanical components.	8.	Use the software to draw Orthographic projections of following using first angle method: • Front and side view of V-Groove Pulley • Front view of 2-Wheeler Piston • Front view of typical Open Ended Spanner • Front view of Connecting Rod (similar objects can be taken up)	CO2
LSO 9.1. Use dimensional and Geometric tolerance and text to the given 2D drawing.	9.	Apply geometrical tolerance, dimensional tolerance and text to the drawing drawn under Sr. No. 6 to 8.	CO1
LSO 10.1. Use of layer to handle complex 2D entities.	10.	Use the software to draw sectional view of piston of a two-wheeler. Main drawing of Piston in one layer, hatching in another layer and dimensioning and text in third layer	CO1
LSO 11.1. Use computer aided drafting software to create and modify the given isometric entities.	11.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO2
LSO 12.1. Visualize the 3D shape of the given object. *LSO 12.2.* Convert the given 2D figures/views into isometric views.	12.	Convert the orthographic views of an object to isometric view (Two problems)	CO2
LSO 13.1. Print drawing on A4 and A3 papers with dimensions and text.	13.	Print any three drawings from above list along with the template of institute prepared.	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 14.1. Use the given Computer Aided Design (CAD) Software *LSO 14.2.* Customize the given CAD Software *LSO 14.3.* Create simple 3D parts models using the given CAD Software	14.	• Customize main window and interface of the 3D modeling software using customization tool bar. • Create given simple part models using commands like Extrude, Revolve, Shell etc.;	CO3
LSO 15.1. Create Complex 3D parts models using the given CAD Software	15.	Create the given complex 3D part model(s) using advanced commands like Sweep, Variable Section Sweep, Blend, Draft, Mirror, Chamfer, Fillet, Rib, Pattern etc.	CO3
LSO 16.1. Create Simple mechanical 3D parts models using the given CAD Software	16.	Develop following mechanical components: • Stepped shaft • Muff coupling • Hexagonal nut • Hexagonal bolt • Cast Iron Pulley	CO3
LSO 17.1. Create mechanical 3D parts models and assemblies using the given CAD Software	17.	Develop following mechanical components and assemblies: • Cotter joint • Flange coupling • Screw jack • Tool Post • Bench vice • Plummer Block • Drill Jig • (OR any six similar components)	CO3
LSO 18.1. Print Production drawings related o mechanical components and assemblies using the given CAD software.	18.	• Print orthographic views (regular and sectioned) of the solid models developed under Sr. No. 16 • Print drawing of the solid models developed Sr. No. 16 • Print drawing of the assembly developed Sr. No. 17 with Bill of Materials.	CO4

L) Suggested Term Work and Self Learning: S2425305 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

1. Differentiate Parametric and Non parametric modeling approaches with example.
2. List sketch based commands available in any parametric CAD software.
3. List feature based commands available in any parametric CAD software.
4. Explain the procedure of creating and inserting 'Blocks' in AutoCAD software.
5. Explain the procedure of modeling a Ball bearing and Helical Gear using any parametric CAD software.
6. Explain the procedure of modeling open coil helical spring using any parametric CAD software.
7. Draw Front and Top views of Hexagonal bolt in AutoCAD and convert it into blocks. Insert copies of these blocks in other AutoCAD files.
8. Each student should explain at least one problem for construction and method of drawing/modeling in computer to all batch colleagues. Teacher will assign the problem to be explained to each student batch.
9. Each student will assess at least one 2D digital drawing/part model of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

b. Micro Projects:

1. Prepare an A4 digital drawing template of your institute with title block and institute logo.
2. Download 5 videos on shortcuts used in AutoCAD, watch them and write a report to detail out the steps involved, Commands used.
3. Each student will identify a small assembly from the institute workshop/laboratory (e.g. Bench vice, Machine vice, Tool post, Couplings, Joints, Ball/Roller Bearings, Gears, Mouse, Motor casing etc.) Or any items like White Board Marker pen, TV Remote, 3 pin electrical Top of charger, Tooth Brush etc. Specify the material and try to find out mass of the complete assembly/object.
4. Develop 3D model and complete assembly of 'computer mouse' you are using, specify the material and try to find out mass of the complete assembly.
5. Down load already prepared solid models and modify them.

c. Other Activities:

1. Seminar Topics:
   - Commercially available other Computer Aided Drafting Software
   - Compatibility of AutoCAD drawings compared to Conventional Drawing
   - Commercially available other Computer Aided Design Software
   - Effective use of Layers in AutoCAD
   - Surface Modelling
   - Parametric Modelling

2. Visits: Collect production/construction/circuit drawings from nearby industries/shop/builders and develop 2D digital drawing and 3D model of any of the component.

3. Self-Learning Topics:
   - Arrays in AutoCAD
   - Blocks in AutoCAD
   - Modelling of threaded components
   - Modelling of Spur Gear
   - Modelling of Ball Bearing.

L) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

M)

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Term Work Assessment (TWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Term Work& Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1	**-**	**-**	05%	25%	25%	30%	25%
CO-2	-	-	05%	25%	25%	20%	25%
CO-3	-	-	20%	25%	25%	40%	25%
CO-4	-	-	20%	25%	25%	10%	25%
Total Marks	**-**	**-**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Use the Computer Aided Drafting software to draw following simple 2-D entities using Draw commands • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1	30	60	10
2.	• Use customization tool bar of CADr software to customize main window and to do interfacing. • Use existing standard 2D drawing templates.	CO1	30	60	10
3.	Prepare a template for your institute of A-4 size with title block and institute logo using the Computer Aided Drafting software.	CO1	30	60	10
4.	Use the Computer Aided Drafting software to estimate Area, Perimeter, and Centroid for the given 2D entities like Circle, Pentagon, Trapezium, hexagon and 2D entity with arcs and spline curves using 'Enquiry' and 'List' commands.	CO1	30	60	10
5.	Use the Computer Aided Drafting software to draw: • Ellipse and parabola • Epicycloid and Hypocycloid curves using pitch circle as directing circle of a cycloidal gear and an appropriate size smaller circle as generating circle • Involute of a circle	CO1	30	60	10
6.	Use the Computer Aided Drafting software to draw four complex 2D entities assigned by the teacher using Draw, Edit and Modify commands	CO1	30	60	10
7.	Use the Computer Aided Drafting software to draw Orthographic projections of following using first angle method: • A pentagonal pyramid is placed in first quadrant with its axis parallel to H.P. and V.P • A frustum of a hexagonal is placed in first quadrant with its axis perpendicular to H.P. and parallel to V.P • Different objects having cylindrical surfaces, ribs.	CO2	30	60	10
8.	Use the software to draw Orthographic projections of following using first angle method: • Front and side view of V-Groove Pulley • Front view of 2-Wheeler Piston • Front view of typical Open Ended Spanner • Front view of Connecting Rod (similar objects can be taken up)	CO2	30	60	10
9.	Apply geometrical tolerance, dimensional tolerance and text to the drawing drawn under Sr. No. 6 to 8.	CO1	40	50	10
10.	Use the software to draw sectional view of piston of a two-wheeler. Main drawing of Piston in one layer, hatching in another layer and dimensioning and text in third layer	CO1	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
11.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO2	40	50	10
12.	Convert the orthographic views of an object to isometric view (Two problems)	CO2	40	50	10
13.	Print any three drawings from above list along with the template of institute prepared.	CO1	40	50	10
14.	• Customize main window and interface of the 3D modeling software using customization tool bar. • Create given simple part models using commands like Extrude, Revolve, Shell etc.;	CO3	40	50	10
15.	Create the given complex 3D part model(s) using advanced commands like Sweep, Variable Section Sweep, Blend, Draft, Mirror, Chamfer, Fillet, Rib, Pattern etc.	CO3	40	50	10
16.	Develop following mechanical components: • Stepped shaft • Muff coupling • Hexagonal nut • Hexagonal bolt • Cast Iron Pulley	CO3	40	50	10
17.	Develop following mechanical components and assemblies: • Cotter joint • Flange coupling • Screw jack • Tool Post • Bench vice • Plummer Block • Drill Jig • (OR any six similar components)	CO3	40	50	10
18.	• Print orthographic views (regular and sectioned) of the solid models developed under Sr. No. 16 • Print production drawing of the solid models developed Sr. No. 16 Print production drawing of the assembly developed Sr. No. 17 with Bill of Materials.	CO4	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Computer aided drafting software like AutoCAD	Latest educational licensed network version	1 to 13
2.	Computer Aided Design Software like CATIA, CREO, NX, Solid works etc.	Latest educational licensed network version	14 to 18
3.	CAD workstations	latest configuration Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
4.	Interactive board (165 x 130 cm)	Supports dual touch, dual write and intuitive gestures, such as toss, rotate and zoom, available with multitouch operating systems, such as Windows®	All
5.	Sample production/construction drawings	From nearby industries, construction companies and developed by senior teachers of the state	All
6.	Printer/plotter	A4/A3 size	13, 18
7.	Models for projection and demonstration	Wooden models	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Graphics with AutoCAD	A.K. Sarkar, A.P. Rastogi, D.M. Kulkarni	PHI Learning Private Limited-New Delhi (2010); ISBN: 978-8120337831.
2.	Computer Aided Drafting & Modelling Lab	K. Venugopal	Scitech Publications (India) Pvt Ltd, ISBN-10 : 8183714366
3.	Engineering Graphics	S. K. Pradhan K.K. Jain	Khanna Book Publishing Company Pvt. Ltd., New Delhi ASIN : B0BM5BMMXT ISBN-10 : 9355381891 ISBN-13 : 978-9355381897
4.	Catia V5r16 for Designers	Sham Tickoo	CADCIM Technologies, USA (2006) ISBN-10 : 1932709185 ISBN-13 : 978-1932709186
5.	Creo Parametric 9.0 for Designers	Sham Tickoo	CADCIM Technologies, USA 9th ed, 978-1-64057-163-1
8.	NX 9.0 for Designers	Sham Tickoo	BPB Publications, (2017) ISBN-10 : 9386551225 ISBN-13 : 978-9386551221

(b) Online Educational Resources:

1. Scales: https://youtu.be/YSEZu3Ch26k
2. Dimensioning: https://youtu.be/_OSY04TnlEM
3. Simple Orthographic Projections: https://youtu.be/DW7dpKdxVrA
4. Orthographic Projections of objects with slant and curved surfaces: https://youtu.be/dCWjBvZBpjM
5. Illustrative Example: https://youtu.be/MR5de9EC940
6. Illustrative Example: https://youtu.be/mahh-WONNHA
7. Isometric Projection of 3D objects: https://youtu.be/0K-5URiyi50
8. Isometric Projection-Object with slant surfaces: https://youtu.be/qSPJOiXKv98
9. Isometric Projection-Object with curved surfaces: https://youtu.be/qSPJOiXKv98
10. Missing lines and missing views: https://nptel.ac.in/courses/105/104/105104148/
11. Launching AutoCAD and Opening drawing: https://youtu.be/aoo-t0-gEfw
12. AutoCAD Main Screen: https://youtu.be/D0YyEiCjwpk
13. Draw and Modify Toolbars: https://youtu.be/T_RN_RBFk7o
14. Illustrative Example-1: https://youtu.be/_Bheo9MzeVk
15. Block creation: https://youtu.be/ZguZZVjxaek
16. Rectangular and Polar array : https://youtu.be/YgYZgbrUJ_M
17. Illustrative Example-2: Array: https://youtu.be/yJf_IsWX4gM
18. Dimensioning: https://youtu.be/sEiRsi14u0U
19. Use of layers: https://youtu.be/fdQqNdDtOI8
20. Illustrative Example 3: Flywheel: https://youtu.be/AU-Vsd2T0DA
21. https://www.inc.com/encyclopedia/computer-aided-design-cad-and-computer-aided-cam.html
22. https://all3dp.com/2/surface-modeling-cad-simply-explained/
23. http://www.dm.unibo.it/~casciola/html/research_ssm.html
24. https://www.youtube.com/watch?v=WY0YuCkJWdw
25. https://www.youtube.com/watch?v=OIYrkF_FId8
26. https://www.youtube.com/watch?v=zoMW_usjaJo
27. https://www.youtube.com/watch?v=fx6kt9djIpc
28. https://www.youtube.com/watcAh?v=8wdOIHxICxw
29. https://www.youtube.com/watch?v=srnm--IKtl4
30. https://www.youtube.com/watch?v=rtjDfZXscrI

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Bureau of Indian Standards, Engineering Drawing Practice for Schools and Colleges IS: SP-46, BIS, Government of India, Third Reprint, October 1998; ISBN: 81-7061-091-2.
2. AutoCAD e manual
3. Already prepared Production Drawings

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A) Course Code **:2433306(P2433306/S2433306)**

B) Course Title **:** Summer Internship -I (Common For all Programmes)

C) Pre- requisite Course(s) **:**

D) Rationale **:**

Diploma students are required to give exposure of their own diploma programme related industrial hardware, software and practices, just after completing one semester, so that they can correlate this industrial exposure with the concept being taught in the branch specific specialized engineering courses in forthcoming semesters. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the 'Whole to Part' approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the diploma programme – and then teaching the related concepts ('Part') of the same in subsequent semesters. In this way before actually being exposed to academic input specific to diploma programmes, the students need to be sent to the nearby/local industries and also may be advised to explore information related to their programme of study using different sources related to potential employment opportunities of both wage and self-employment, job function, job position, nearby relevant industries and so on.

The summer internship will provide the direction to the students and also help in mind mapping to plan their futuristic course of action, after passing the diploma. This would also bridge the gap between their virtual imagination about the outcome of the programme and real happenings related to the diploma programme.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Comprehend the practices of identified industry or world of work related to diploma engineering programme of study.
- **CO-2** Map real equipment, processes, product, management, operations etc. to the course of study through various glimpses of input, process and output in different type of industries.
- **CO-3** Identify the probable enterprises /startups for futuristic planning and self-growth.
- **CO-4** Identify the probable job function and job position in their relevant programme of study.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	-	1	-	-	1		
CO-2	3	-	-	1	-	-	1		
CO-3	3	-	-	-	1	-	2		
CO-4	3	-	-	-	1	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2433306	Summer Internship -I	-	-	02	02	04	02

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2433306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Suggested Instructional/Implementation Strategies: Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the whole to part approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

- Industrial Layout
- Organizational Structure
- Corporate Communications
- Strategic, Rolling and Developmental plans
- Maintenance Procedures
- Inventory Control and Management System
- Purchase and Store Procedures
- Major Machinery, Tools, Equipment, Devices, Software, Control System etc.
- Product Development, Manufacturing, Packaging and Delivery
- Project Management
- Operation and Maintenance
- Warehouse Management
- Assembly Line
- Quality Assurance and Testing Cell
- Process/ Software Development/ Fabrication/ Construction Work Management
- Testing and Quality Assurance Practices
- Total quality management
- Calliberation and Certification practices
- Safety Practices
- Industrial Acts
- Industrial Grievances
- Behavioural Aspects
- Conduction of Meetings and Discussions
- Sales and Marketing Strategies
- Forecasting and Target Setting
- Production Planning and Control
- Storage Retrieved and Material handling Practices
- Automation and Control Facilities
- Enterprise Resource Planning (ERP)
- Supply Chain
- Customer Satisfaction Strategies
- Finance and Accounts
- Research and Development
- Promotion and Capacity Building Schemes
- Reduce, Reuse and Recycling Efforts and Policies
- Recognitions and Rewards
- After Sale Services
- Promotional Avenues
- Social Corporate responsibilities

J) Assessment of Summer Internship -I

S. No.	Criteria of Assessment	% of Weightage
1.	Maintaining the log book after having exposure to different types of industry/ world of work	15
2.	Preparing the list of job functions and job positions of relevant programme	20
3.	Identify the probable enterprise/ startup for futuristic planning	15
4.	Report writing of summer internship as per the prescribed format	30
5.	Presentation of Report	20
Total		**100**

Note: S. no. 1 to 3 shall be considered for progressive assessment. While S. No. 4 & 5 shall be considered for end term assessment

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A) Course Code :2400207(T2400207)

B) Course Title : Indian Constitution (Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course out comes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Enumerate salient features and characteristics of the constitution of India.

CO-2 Follow fundamental rights and duties as responsible citizen and engineer of the country.

CO-3 Analyze major constitutional amendments in the constitution.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	1	-	-	-	2	-	-		
CO-2	1	-	-	-	2	-	-		
CO-3	1	2	-	-	2	-	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400307	Indian Constitution	01	-	-	-	01	01

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture(L), Tutorial(T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits= (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400307	Indian Constitution	25	-	25	-	-	-	50

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400207

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the meaning of preamble of the constitution. TSO 1b. List the salient features of constitution. TSO 1c. List the characteristics of constitution.	**Unit-1.0 Constitution and Preamble** 1.1 Meaning of the constitution of India. 1.2 Historical perspective of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble to the Constitution of India.	**CO1**
TSO 2a. Enlist the fundamental rights. *TSO 2b.* Identify fundamental duties in general and in particular with engineering field. *TSO 2c.* identify situations where directive principles prevail over fundamental rights.	**Unit-2.0 Fundamental Rights and Directive Principles** 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance. 2.3 Relevance of Directive Principles of State Policy under part-IV.	**CO2**
TSO 3a. Enlist the constitutional amendments. *TSO 3b.* Analyze the purposes of various amendments.	**Unit-3.0 Governance and Amendments** 3.1 Amendment of the Constitutional Powers and Procedure 3.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st	**CO3**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Role of Media in Spreading Awareness regarding Fundamental Rights
2. Analysis of Situations where directive principle of State policy has prevailed over Fundamental rights
3. Analyze 42nd and 97th Amendment of Indian Constitution

c. Other Activities:

1. Seminar Topics:
- Democracy and Political Participation in India
- Situations where directive principles prevail over fundamental rights.

2. Visits:
    - Arrange Mock Parliament.
3. Design games and simulation on emergencies declared in last thirty years.

4. Group discussions on current print articles.
    - Adoption of Article 365 in India.
    - Need of amendments in the constitution.

5. Prepare collage/posters on current constitutional issues.
   - Emergencies declared in India
   - Seven fundamental rights

6. Cases: Suggestive cases for usage in teaching:

Case	Relevance
A.K. Gopalan Case (1950)	SC contented that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21.
Shankari Prasad Case (1951)	This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution.
Minerva Mills case (1980)	This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme.
Maneka Gandhi case (1978)	A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable."

7. Self-Learning Topics:

- Parts of the constitution and a brief discussion of each part.
- Right to education.
- Right to equality.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	30%	-	30%	-	-	-	-
CO-2	40%	-	40%	50%	50%	-	-
CO-3	30%		30%	50%	50%		
Total Marks	**25**	**-**	**5**	**10**	**10**	**-**	**-**
			25				

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)

O) Suggested AssessmentTable for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The Constitution of India	P.M. Bakshi	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105
2.	Introduction to Indian Constitution	D.D. Basu	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3.	Introduction to Constitution of India	B. K. Sharma	PHI, New Delhi, 6thedition, 2011, ISBN:8120344197
4.	The Constitution of India	B.L. Fadia	Sahitya Bhawan, Agra, 2017, ISBN:8193413768
5.	The Constitutional Law of India	Durga Das Basu	LexisNexis Butterworths Wadhwa, Nagpur 978-81-8038-426-4

(b) Online Educational Resources:

1. https://www.coursera.org/learn/principles-of-management
2. http://www.legislative.gov.in/constitution-of-india
3. https://en.wikipedia.org/wiki/Constitution_of_India
4. https://www.india.gov.in/my-government/constitution-india
5. https://eci.gov.in/about/about-eci/the-setup-r1/
6. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/
7. https://main.sci.gov.in/constitution
8. https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf
9. https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf
10. https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm
11. https://constitutionnet.org/vl/item/basic-structure-indian-constitution

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others: -

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