Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Production Engineering**		
Programme Code	**: PG**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 16 WEEKS**
Semester	**: Third** **NCrF Entry Level : 3.5**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																							
1	STRENGTH OF MATERIALS	SOM	DSC	313308	1	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125
2	PRODUCTION DRAWING	PDR	SEC	313311	-	2	-	4	2	8	4	4	30	70	100	40	25	10	25@	10	25	10	175
3	INDUSTRIAL FLUID POWER	IFP	DSC	313315	-	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125
4	METROLOGY AND MEASUREMENT	MAM	DSC	313316	1	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
5	MECHANICAL ENGINEERING MATERIALS	MEM	DSC	313317	4	3	-	2	1	6	3	1.5	30	70*#	100	40	25	10	-	-	25	10	150
6	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	313002	-	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50
7	COMPUTER AIDED DRAFTING	CAD	SEC	313006	-	-	-	4	-	4	2	-	-	-	-	-	25	10	25#	10	-	-	50
Total					**6**	**18**	**0**	**16**	**6**		**20**		**150**	**350**	**500**		**150**		**75**		**125**		**850**

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

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

Note :

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

Course Category : Discipline Specific Course Core (DSC) : 4, Discipline Specific Elective (DSE) : 0, Value Education Course (VEC) : 1, Intern./Apprenti./Project./Community (INP) : 0, AbilityEnhancement Course (AEC) : 0, Skill Enhancement Course (SEC) : 2, GenericElective (GE) : 0

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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

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

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

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

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different components of UTM .	1	*Conduct sample compressive and tensile tests on metal using Universal Testing Machine along with introduction to machine & other tests to be conducted on UTM.	2	CO2
LLO 2.1 Perform Tension test on mild steel as per IS:432(1) .	2	*Tension test on mild steel as per IS:432(1) .	2	CO2
LLO 3.1 Perform tension test on Tor steel as per IS:1608, IS:1139 .	3	Tension test on Tor steel as per IS:1608, IS:1139 .	2	CO2
LLO 4.1 Conduct compression test on sample test piece using Compression Testing Machine .	4	*Compression test on any two metals like Mild Steel, Brass, Al etc. using Compression Testing Machine .	2	CO2
LLO 5.1 Conduct Izod Impact test on given metals as per IS:1598 .	5	*Izod Impact test on any two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1598 .	2	CO2
LLO 6.1 Conduct Charpy Impact test on given metals as per IS:1598 .	6	Charpy Impact test on two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1757 .	2	CO2
LLO 7.1 Determine Compressive strength of dry and wet bricks .	7	Compressive strength of dry and wet bricks as per IS:3495 (part I), IS:1077 .	2	CO2
LLO 8.1 Perform Single Shear and double shear test on given metals as per IS:5242 .	8	*Single Shear and double shear test on any two metals like Mild steel/ brass/ Al / copper / cast iron etc. as per IS:5242 .	2	CO2 CO4
LLO 9.1 Conduct Compression test on timber section along the grain and across the grain .	9	Compression test on timber section along the grain and across the grain as per IS:2408 .	2	CO1 CO2
LLO 10.1 Plot Shear force and Bending Moment diagrams of beams subjected to different types of loads.	10	*Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loading . (02 problems on each type of beam) .	4	CO3
LLO 11.1 Conduct Flexural test on timber beam on rectangular section.	11	*Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408 .	2	CO1 CO4
LLO 12.1 Prepare PPT on Strain Energy. LLO 12.2 Prepare PPT on Thermal Stresses & Thermal Strains.	12	a) Prepare PPT of minimum 05 slides on the concept of Strain Energy & instantaneous stress induced in a material due to gradual, Sudden & impact load. b) Prepare PPT of minimum 04 slides on Thermal Stresses & Thermal Strains.	2	CO2
LLO 13.1 Conduct Flexure test on floor tiles/roofing tiles.	13	Flexure test on floor tiles IS:1237, IS:13630 or roofing tiles as per IS:654, IS:2690 .	2	CO4
LLO 14.1 Determine hardness no. for given metal using Rockwell Hardness Tester.	14	Rockwell Hardness Test on any two Metals like Mild Steel, Brass Copper, Aluminum etc.	2	CO2
LLO 15.1 Determine hardness no for given metals using Brinell Hardness Tester.	15	Brinell hardens test on any two metals like Mild Steel, Brass Copper, Aluminum etc.	2	CO2

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

Note : Out of above suggestive LLOs -

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

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

Micro project

- Collect the information of Indian Knowledge System (IKS) given in different units.
- Prepare charts of maximum bending moment and shear force values in standard beams.
- Two Numericals on Chimneys (of rectangular and circular cross section) subjected to wind pressure & also draw stress distribution diagram at base of it.
- Draw & identify difference between Bending stress distribution & Shear stress distribution diagrams for square, rectangular, circle, hollow square, rectangular, circle, T- section, & symmetrical I- section.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

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

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

- Pen and Paper Test (Written Test)

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

Note :

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

Programme Name/s : **Mechanical Engineering/ Mechatronics/ Production Engineering**
Programme Code : **ME/ MK/ PG**
Semester : **Third**
Course Title : **PRODUCTION DRAWING**
Course Code : **313311**

I. RATIONALE

Production drawing is essential for communicating ideas in manufacturing industry as well as other engineering applications. Production drawings illustrate set of instructions to manufacture a product, providing information about dimensions, materials, finishes, tools required, methods of assembly and so on. Therefore, this course has been developed for interpretation and preparation of the production drawing.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare Production drawing of a given part / component as per requirement.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Construct an auxiliary view of given object.
- CO2 - Use convention for representation of material and mechanical components.
- CO3 - Interpret and draw production drawing.
- CO4 - Prepare assembly drawing using given details.
- CO5 - Prepare detail drawing based on the given assembly drawing/data.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313311	PRODUCTION DRAWING	PDR	SEC	2	-	4	2	8	4	4	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : Hrs

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

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

Note :

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3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
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V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Construct an auxiliary view of a given object. TLO 1.2 Construct an incomplete principal view from the given auxiliary view.	**Unit - I Auxiliary View** 1.1 Auxiliary planes and views. 1.2 Draw Auxiliary view from the given orthographic views. 1.3 Complete the partial view from the given auxiliary and other principal view.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
2	TLO 2.1 Use IS SP-46 codes for preparing production drawing. TLO 2.2 Prepare production drawing using standard conventions.	**Unit - II Conventional representation** 2.1 Engineering Material Conventions 2.2 Conventional breaks in pipes, rod and shaft 2.3 Conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shaft, holes on circular pitch, internal and external threads 2.4 Conventional representation of standard parts like ball and roller bearing, gears, springs 2.5 Pipe joints and valves 2.6 Counter sunk and counter bored holes 2.7 Tapers	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Calculate tolerances on the given machine components. TLO 3.2 Identify type of fit between mating parts of machine components based on given tolerance values. TLO 3.3 Prepare production drawing using suitable convention and codes.	**Unit - III Production Drawing** 3.1 Limits, Fits and Tolerances: Definitions, introductions to ISO system of Tolerance. Dimensional tolerances: Terminology, selection and representation of dimensional tolerance- number and grade method. Definitions concerning Tolerancing and Limits system, unilateral and bilateral tolerance, Hole and shaft basis systems, Types of fits- Clearance, transition and Interference, Selection of fit for engineering applications. Calculation of limit sizes and identification of type of fit from the given sizes like 50 H7/s6, 30 H7/d9 etc. 3.2 Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, representation of geometrical tolerance on drawing. 3.3 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation. 3.4 Machining symbol and surface texture: Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
4	TLO 4.1 Identify various components in given detail drawings. TLO 4.2 Identify sequence of assembling it. TLO 4.3 Prepare assembly drawing from given detailed drawing. TLO 4.4 Prepare bill of material.	**Unit - IV Details to assembly** 4.1 Introduction to assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing, Bill of Material (BOM). 4.2 Couplings: Oldham & Universal couplings. 4.3 Bearing: Foot Step & Pedestal Bearing. 4.4 Lathe: Single (pillar type) and square tool Post. 4.5 Bench vice & Pipe Vice. 4.6 Screw-jack 4.7 Drill Jig	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
5	TLO 5.1 Interpret various components in given assembly drawings. TLO 5.2 Identify sequence of dismantling in given assembly drawing. TLO 5.3 Prepare the detailed drawing from given assembly drawing.	**Unit - V Assembly to Details** 5.1 Basic principles of process of dismantling the assembly into components. 5.2 Couplings: Oldham & Universal couplings. 5.3 Bearing: Foot Step & Pedestal Bearing. 5.4 Lathe: Single (pillar type) and square tool Post. 5.5 Bench vice & Pipe Vice. 5.6 Screw-jack 5.7 Drill Jig	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw an auxiliary view from given drawing.	1	*Draw an auxiliary view or complete given partial drawing. (any two)	4	CO1
LLO 2.1 Draw an auxiliary view from given drawing.	2	*Draw an auxiliary view or complete given partial drawing. (Continue Sr No 1)	4	CO1
LLO 3.1 Prepare drawing using convention and code as per IS-SP46.	3	*Draw various conventional representations as per IS SP-46	4	CO2
LLO 4.1 Use various tolerances and symbols in drawing.	4	*Draw Dimensional and Geometrical Tolerances, Welding Symbols, Surface Roughness and Machining Symbols on the given figures.	4	CO2 CO3
LLO 5.1 Use various tolerances and symbols in production drawing.	5	Develop Production drawing of machine components showing dimensional and geometrical Tolerance, surface finish etc. (any two)	4	CO2 CO3
LLO 6.1 Draw assembly drawing using standard procedure for assembly of components.	6	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions (Any one)	4	CO2 CO3 CO4 CO5
LLO 7.1 Draw assembly drawing using standard procedure for assembly of components.	7	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 6 continue)	4	CO2 CO3 CO4 CO5
LLO 8.1 Draw assembly drawing using standard procedure for assembly of components.	8	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 6 continue)	4	CO2 CO3 CO4 CO5
LLO 9.1 Draw assembly drawing using standard procedure for assembly of components.	9	*Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (any one)	4	CO2 CO3 CO4 CO5
LLO 10.1 Draw assembly drawing using standard procedure for assembly of components.	10	*Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 9 continue)	4	CO2 CO3 CO4 CO5
LLO 11.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	11	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (any one)	4	CO2 CO3 CO4 CO5
LLO 12.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	12	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 11 continue)	4	CO2 CO3 CO4 CO5
LLO 13.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	13	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 11 continue)	4	CO2 CO3 CO4 CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	14	*Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (any one)	4	CO2 CO3 CO4 CO5
LLO 15.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	15	*Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 14 continue)	4	CO2 CO3 CO4 CO5

Note : Out of above suggestive LLOs -

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

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

Micro project

- Prepare assembly drawing/detailed drawing of machine vice/ lathe tailstock/ tool post etc. by visiting Institute's workshop.
- Prepare report on various types of welding symbols used for fabrication work by Visiting nearby fabrication workshop.
- Any other micro-projects suggested by subject faculty on similar line.
- Prepare detailed drawings of Various IC Engine components using proper measuring instruments by visiting Institute's Power engineering Lab or any other.
- Students should collect Production drawings from nearby workshops/industries and establish item reference numbers on that drawing for convention or tolerance value. Prepare report showing item reference numbers and their meaning.
- Prepare report representing conventional representation of various piping joints by visiting nearby process industries like sugar factory, chemical industries, water treatment plant, etc.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Models, charts of objects for Auxiliary view.	1

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Models/ Charts of Conventional representation and Production drawing.	3,4,5
3	Models, charts of assembly and details drawings.	6,7,8,9,10,11,12,13,14,15
4	Drawing equipment and instruments for classroom teaching-large size: a. T-square or drafter (Drafting Machine). b. Set square (45-45-90 and 30-60-90) c. Protector. d. Drawing instrument box (containing set of compasses and dividers). Drawing sheets, drawing pencils H,2H, Eraser, Drawing pins / clips	All
5	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
6	Set of various industrial drawings being used by industries.	All

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Auxiliary View	CO1	4	0	0	8	8
2	II	Conventional representation	CO2	4	6	8	0	14
3	III	Production Drawing	CO3	6	4	8	4	16
4	IV	Details to assembly	CO4	8	0	0	16	16
5	V	Assembly to Details	CO5	8	0	0	16	16
Grand Total				**30**	**10**	**16**	**44**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- continuous assessment based on laboratory performance.

Summative Assessment (Assessment of Learning)

- End term exam- Theory
- End term exam- Practical (Lab performance)

XI. SUGGESTED COS - POS MATRIX FORM

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

CO5	3	2	1	-	-	-	-			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bureau of Indian Standards.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	October 2003, ISBN: 81-7061-091-2
2	Bhatt, N.D.	Engineering Drawing	Charotar Publishing House, 2011, ISBN: 978-93-80358-17-8
3	Bhatt, N.D.; Panchal, V. M	Machine Drawing	Charotar Publishing House, 2011, ISBN: 978-93-80358-11-6
4	Narayan, K. L. Kannaiah, P. Venkata Reddy, K.	Production Drawing	New Age International Publications, 2011, ISBN: 978-81-224-2288-7
5	Sidheswar, N. Kannaiah, P. Sastry, V.V.S.	Machine Drawing	Tata McGraw Hill Education Private Ltd, New Delhi, 2011, ISBN-13: 978-0-07-460337-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/599ThWCvMVA	Auxiliary View
2	https://youtu.be/k7-POcJfjAU	Auxiliary View
3	https://youtu.be/5Pj7vkcolXk	Introduction to working drawing.
4	https://youtu.be/VRi2LMm6jHU	Assembly
5	https://youtu.be/FqzplEaE4Z0	Details to Assembly

Note :

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

Programme Name/s : **Production Engineering**
Programme Code : **PG**
Semester : **Third**
Course Title : **INDUSTRIAL FLUID POWER**
Course Code : **313315**

I. RATIONALE

Diploma engineering holder is required to operate and use fluid operated devices for various engineering applications. This course will give the basic knowledge and skills to select and use different types of fluid powered equipment for various industrial applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Construct fluid power circuits for simple industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Measure properties of fluid using appropriate measuring devices.
- CO2 - Calculate friction losses in flow through pipes.
- CO3 - Select relevant components for hydraulic and pneumatic systems.
- CO4 - Select relevant control valves and actuators for hydraulic and pneumatic systems in given situation.
- CO5 - Develop different hydraulic and pneumatic circuits for given simple applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313315	INDUSTRIAL FLUID POWER	IFP	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify fluids TLO 1.2 State properties of fluid. TLO 1.3 Describe pressure measurement devices. TLO 1.4 Calculate centre of pressure and total pressure of an immersed surface.	**Unit - I Basics of fluid power** 1.1 Classification of fluids, properties of fluids: Viscosity, Specific gravity, Specific weight, Demulsibilty, Neuralization number, Lubricity, Low foam tendency, Heat dissipation and ISO grades of oil. 1.2 Concept of Atmospheric, Gauge and Vacuum pressure. 1.3 Pressure measurement devices : U tube manometer (No numericals), Bourdon tube pressure gauge, construction and working. 1.4 Concept of Static pressure, Pressure head, Center of pressure and Total pressure (Simple Numerical).	Fluid samples for Demonstration of properties of fluids. Models /Charts of pressure measurement devices .

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 State types of fluid flow. TLO 2.2 Apply Pascal's law, Continuity equation, Bernoulli's Theorem. TLO 2.3 Calculate frictional coefficient using Darcy's equation. TLO 2.4 Determine minor losses for fittings and valves.	**Unit - II Fluid Flow and flow through pipes** 2.1 Types of fluid flow: Steady, Unsteady, Laminar, Turbulent, One, Two and Three dimensional flow, Uniform and Non uniform flow. 2.2 Pascal's law, Continuity equation, Bernoulli's Theorem. 2.3 Flow through pipes: Laws of fluid friction for Laminar and Turbulent flow. 2.4 Darcy's and Chezy's equation for frictional losses , Minor losses in fittings and Valves (Simple Numericals on sudden enlargement and contraction).	Display chart for types of fluid flow. Models/Setup of friction through pipes. Display chart for minor losses.
3	TLO 3.1 Draw layout of fluid power system. TLO 3.2 Describe construction and working of pump/compressor. TLO 3.3 Select pump/compressor for given application. TLO 3.4 Select various accessories required in the given hydraulic/pneumatics. TLO 3.5 Use of ISO symbols for fluid power system.	**Unit - III Components of Industrial Fluid power system** 3.1 General layout of oil Hydraulic and Pneumatic system and its comparison. 3.2 Pumps for oil hydraulic system : Gear pump, Vane pump and Piston pump. 3.3 Compressor for pneumatic system :Construction and working of reciprocating , screw, vane and centrifugal compressor. 3.4 Accessories for Hydraulic and Pneumatic system : Oil reservoir, Pipes, Hoses, fittings, Oil filters, Air filters, FRL unit, Seals and Gaskets, Intensifiers, Accumulators, Heat exchanger and muffler. 3.5 ISO symbols of components of fluid power system.	Display chart for Layout of fluid power system. Demonstration set up of fluid power system Models/charts of pumps, compressor and accessories. Display chart for ISO symbols.
4	TLO 4.1 Classify control valves. TLO 4.2 Describe construction and working of control valves. TLO 4.3 Select appropriate control valves for given application. TLO 4.4 Compare control valves based on function and construction.	**Unit - IV Control valves and Actuators** 4.1 Classification of Control valves: As per type of control valve element and parameter under control. 4.2 Pressure control valves: Construction and working of Pressure relief valve, Pressure reducing valve, Sequence valve and Counter balance valve. 4.3 Direction control valve : Construction and working of 2/2 , 3/2, 4/2, 4/3 DC valves. 4.4 Flow control valve : Pressure compensated and non-compensated. 4.5 Special valves in pneumatics: Dual (twin) Pressure valve, Shuttle valve, Quick exhaust valve, Time delay valve.	Models/charts of Control valves: pressure control valve, direction control valve , flow control valve and special valves of fluid power systems. Models/charts of Actuators used in fluid power system.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Draw basic fluid circuits for given actuators. TLO 5.2 Select components for speed control circuit for given application. TLO 5.3 Construct sequencing hydraulic circuit for given application. TLO 5.4 Draw Pilot control Hydraulic circuits for given applications. TLO 5.5 Identify common faults in oil hydraulic system.	**Unit - V Oil Hydraulic and Pneumatic circuit** 5.1 Basic circuits to actuate Single Acting Cylinder, Double Acting Cylinder, motors. 5.2 Speed control circuits: Meter in, Meter out and their application (Shaper machine tool movement, Table movement of milling or Grinding machine). 5.3 Sequencing circuit for Simple applications. 5.4 Pilot control/impulse control circuit. 5.5 Maintenance of Oil hydraulic system-common faults,causes and remedies.	Charts of fluid power circuits. Animation of fluid power circuits. Charts for faults and remedies.

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure pressure of water, oil and compressed air. LLO 1.2 Calculate pressure of water, oil and compressed air.	1	*Measurement of pressure of given fluid using suitable instrument.	2	CO1
LLO 2.1 Measure parameters of Total energy. LLO 2.2 Calculate parameters of Total energy.	2	Verification of Bernoulli's theorem.	2	CO2
LLO 3.1 Measure parameters of water required to calculate friction factor. LLO 3.2 Calculate Darcy's friction factor.	3	Determination of Darcy's friction factor.	2	CO2
LLO 4.1 Measure parameters required to calculate minor frictional losses. LLO 4.2 Calculate minor frictional losses.	4	*Determination of minor frictional losses in pipes.	2	CO2
LLO 5.1 Identify components of hydraulic and pneumatic system. LLO 5.2 Draw ISO symbols of hydraulic and pneumatic components.	5	*Identification of hydraulic and pneumatic system components.	2	CO3
LLO 6.1 Actuate Pump and compressor. LLO 6.2 Measure pressure and flow rate.	6	Measure parameters of oil hydraulic pump and compressor.	2	CO3
LLO 7.1 Identify components of control valves. LLO 7.2 Set/Operate Control valves.	7	*Demonstration of Pressure relief valve, direction control valve and flow control valve.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Identify components of actuators. LLO 8.2 Operate actuators.	8	* Demonstration of SA , DA cylinders and motors in fluid power system.	2	CO4
LLO 9.1 Identify components of FRL unit, Shuttle valve, Twin pressure valve. LLO 9.2 Set/Operate FRL unit, Shuttle valve, Twin pressure valve.	9	Demonstration of FRL unit, Shuttle valve, Twin pressure valve used in pneumatic system.	2	CO4
LLO 10.1 Select components for given circuit. LLO 10.2 Construct hydraulic circuit. LLO 10.3 Actuate given actuators.	10	Hydraulic circuit for SAC and DAC, Hydromotor.	2	CO4 CO5
LLO 11.1 Select components for given circuit. LLO 11.2 Construct pneumatic circuit. LLO 11.3 Operate given actuators.	11	Pneumatic circuits for SAC and DAC, Air motor.	2	CO4 CO5
LLO 12.1 Select components for given speed control circuit. LLO 12.2 Construct and actuate hydraulic speed control circuit.	12	* Speed control circuits: Meter-in and Meter out hydraulic circuit.	2	CO4 CO5
LLO 13.1 Select components for given speed control circuit. LLO 13.2 Construct and actuate pneumatic speed control circuit.	13	Speed control circuits for pneumatic system.	2	CO4 CO5
LLO 14.1 Select components for given sequencing hydraulic circuit. LLO 14.2 Construct and actuate given sequencing hydraulic circuit.	14	Sequencing hydraulic circuit.	2	CO4 CO5
LLO 15.1 Select components for given sequencing pneumatic circuit. LLO 15.2 Construct given sequencing pneumatic circuit. LLO 15.3 Actuate the sequencing circuit.	15	*Sequencing pneumatic circuit.	2	CO4 CO5
LLO 16.1 Operate given fluid power system. LLO 16.2 Trouble shoot the occurred faults. LLO 16.3 Solve the identified faults.	16	*Maintenance of Hydraulic and Pneumatic System.	2	CO4 CO5

Note : Out of above suggestive LLOs -

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

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

Not Applicable

- Not Applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	U tube differential manometer (Mercury/water), Bourdon tube pressure gauge Manometer 0--300cm Liquid : Mercury or water, Bourdon Gauge 0-20 Kg/cm2, Dial Size : 1.5 inch, 2.5 Inch, 4 Inch	1
2	Maintenance tool kit with spanner set (4-5 to 30-32), Allen keys set (0 - 6 mm)	16
3	Bernoulli's theorem apparatus With Pipe of Varying cross sectional area, Pump of Max Head 21 Meter, Water flow 1.35 Lit/Sec, Motor rating -O.37KW, Sump Tank Capacity:250 Liiter	2
4	Test rig of frictional losses (Darcy's friction factor) Pump: Maximum Head 21 m, Water Flow :1.35 Lit/sec Maximum, Motor rating: 0.37 KW, Sump Capacity : 250 Liter	3
5	Test rig of minor frictional losses in pipes, The set up with sudden enlargement and contraction , pipe fittings, Pump: Maximum Head 21 m, Water Flow :1.35 Lit/sec Maximum, Motor rating: 0.37 KW, Sump Capacity : 250 Liter	4
6	Hydraulic Trainer kit with various components like Hydraulic power pack, Set of Pressure relief, Pressure reducing and Sequence valve , 3/2 , 4/2,4/3 DCV, Flow control valve with built in check valve, pipes and hoses, SA Cylinder, DA Cylinder	5,6,7,8,10,12,14,16
7	Pneumatic trainer kit with portable compressor Pressure up to 12 Bar, FRL Unit, 3/2 , 5/2,5/3 DCV, Flow control valve with check valve, Twin pressure valve, Shuttle valve, pipes and low pressure hoses, SA Cylinder, DA Cylinder	5,6,7,8,9,11,13,15,16
8	Charts, cut section models, actual samples of different components of fluid power system	7,8,9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of fluid power	CO1	8	2	4	4	10
2	II	Fluid Flow and flow through pipes	CO2	12	4	4	4	12
3	III	Components of Industrial Fluid power system	CO3	14	2	8	6	16

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
4	IV	Control valves and Actuators	CO4	14	4	6	6	16
5	V	Oil Hydraulic and Pneumatic circuit	CO5	12	0	4	12	16
Grand Total				**60**	**12**	**26**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Class Test, Term work

Summative Assessment (Assessment of Learning)

- Theory

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. P. N. Modi, Dr. S. M. Seth	Hydraulics and Fluid mechanics including hydraulics machines	Standard Book House, Rajsons Publication Pvt. Ltd., New Delhi, ISBN 978-81-89401-26-9, Year: 2017
2	C. P. Kothandaraman, R. Rudramoorthy	Fluid Mechanics and Machinery	New Age International (P) Limited, New Delhi, ISBN : 978-81-224-3398-2, Year : 2012
3	Majumdar S.R.	Oil Hydraulic system-Principles and maintenance	Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013
4	Majumdar S.R.	Pneumatics Systems Principles and Maintenance	Tata McGraw Hill, ISBN-978-0-07-460231-7, Year: 2015

Sr.No	Author	Title	Publisher with ISBN Number
5	Shanmuga Sundaram	Hydraulic and Pneumatic Controls	S. Chand Publishing, New Delhi, ISBN: 978-8-12-192635-5, Year:2013
6	Andrew Parr	Hydraulics & Pneumatics A Technicians & Engineers Guide	Butterworth-Heinemann Publisher, New Delhi ISBN: 978-0-08-096675-5, Year: 2006

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://en.wikipedia.org/wiki/Hydraulic_pump	Hydraulic Pumps (all types)
2	https://www.youtube.com/watch?v=Qy1iV6EzNHg	Animation of Hydraulic pumps (all types)
3	https://www.youtube.com/watch?v=pWuxYnqYDnk	Animation of Hydraulic pumps
4	https://www.youtube.com/watch?v=sEVTIRYHoGg	Eaton Pump assembly
5	https://www.youtube.com/watch?v=XAItnsUcES0	Pneumatic control valves animation
6	https://www.youtube.com/watch?v=yIot4shcOkE	Control valve symbol generation
7	https://www.youtube.com/watch?v=jsMJbJQkGTs	Animation of D.C.Valve
8	https://www.youtube.com/watch?v=CQPwvWXbV3w	Animation of 4/2,4/3 D.C Valves
9	https://www.youtube.com/watch?v=bovfDsAYSbc	Animation of Hydraulic cylinder
10	https://www.youtube.com/watch?v=icaqvfAtccY	Telescopic cylinder animation
11	https://www.youtube.com/watch?v=MmYpzgh6Gok	Pneumatic cylinder
12	https://www.youtube.com/watch?v=4eCuPVxezzY	Speed control hydraulic circuit

Note :

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

Programme Name/s : **Mechanical Engineering/ Production Engineering**

Programme Code : **ME/ PG**

Semester : **Third / Fourth**

Course Title : **METROLOGY AND MEASUREMENT**

Course Code : **313316**

I. RATIONALE

The Diploma Mechanical Engineer should understand, use and select various measuring instruments as they often come across measuring different parameters of machined components and the appropriate fitment of interchangeable components in the assemblies. Students should also be familiar with the principles of instrumentation, transducers and measurement of non-electrical parameters like, force and sound.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The diploma technician will be able to Use relevant measuring instruments for various conditions of measurement efficiently.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select relevant linear measuring instrument for measurement.
- CO2 - Select different gauges and comparators for measurement of given components.
- CO3 - Use relevant instrument for measurement of different parameters of engineering components.
- CO4 - Select relevant instrument for measuring the physical parameters of given system.
- CO5 - Use relevant instrument for measurement of operating parameters of system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313316	METROLOGY AND MEASUREMENT	MAM	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define various parameters of Metrology and Measurement. TLO 1.2 Explain characteristics of measuring instruments. TLO 1.3 Explain different types of standards. TLO 1.4 Describe working principle of Linear measuring instruments. TLO 1.5 Identify errors in given instrument. TLO 1.6 Select relevant measuring instrument for the given job with justification.	**Unit - I Overview of Metrology and Linear Measurement** 1.1 Definition of Metrology, objective and types of Metrology, Need of inspection, Methods of measurements. 1.2 Characteristics of instruments – Static characteristics: Least count (resolution), Range and Span, Accuracy and Precision, Reliability, Calibration, Hysteresis, Dead Zone, Drift, Sensitivity, Threshold, Repeatability, Reproducibility, Linearity, Amplification, Magnification. Dynamic characteristics: Speed of response, Fidelity, Overshoot. 1.3 Standards: Definition and characteristics of Line standard, End standard and Wavelength standard. 1.4 Linear measuring Instruments: Working principle of Vernier caliper, micrometer, height gauge and depth gauge. 1.5 Types of Errors and its sources in Measurements, Factors affecting on accuracy. 1.6 Selection of instrument, Precautions while using an instrument for getting higher precision and accuracy.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain construction and working of given comparators. TLO 2.2 Use gauges for given job with justification. TLO 2.3 Select slip gauges for building specific dimensions.	**Unit - II Gauges and Comparators** 2.1 Comparators: Definition, Requirement of a good comparator, Classification, Use of comparators, Working principle (Merits and Demerits) of Dial indicator and Pneumatic Comparator (Air Gauge), Selective Assembly, Interchangeability. 2.2 Gauges: Limit gauges. Taylor's principle of Gauge design, Plug, Ring Gauges, Snap gauges. 2.3 Slip gauges: Wringing of Slip Gauges (Numerical). Precautions	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration
3	TLO 3.1 Select Angular measuring instrument for given component and calculate unknown angle. TLO 3.2 Calculate screw thread parameters using given method. TLO 3.3 Explain procedure of measuring the given parameters of gear. TLO 3.4 Describe procedure for examining surface finish of the given component. TLO 3.5 Explain procedure for Measurement by CMM.	**Unit - III Angular, Screw Thread, Gear and Surface Finish Measurements** 3.1 Angle measurement: Instruments used in Angular Measurements: Angle Gauges (No Numerical), Bevel Protractor, sine bar. Principle of Working of Angle Dekkor. 3.2 Screw thread Measurements: Screw thread terminology, measurement of different elements such as major diameter, minor diameter, effective diameter, pitch, thread angle. Best wire size, Two wire method, Working principle of floating carriage micrometer. 3.3 Gear Measurement: Parkinson Gear tester, Gear tooth Vernier, Profile projector. 3.4 Surface Roughness Measurement: Meanings of surface texture and definitions, methods of surface measurement - Ra, Rz and RMS values (No Numerical), Principle of Interferometry, Taylors Hobsons Talysurf. 3.5 CMM: Introduction to Coordinate Measurement Machine (CMM) and its merits.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration
4	TLO 4.1 Classify transducers for the given application. TLO 4.2 Identify the given transducer with justification. TLO 4.3 Explain displacement measuring instrument. TLO 4.4 Explain temperature measuring instruments. TLO 4.5 Interpret principles of flow measuring instruments for given system.	**Unit - IV Displacement, Temperature and Flow Measurement** 4.1 Generalized measuring system and its components. 4.2 Transducers: Classification of transducers- active and passive, contact, non-contact, Mechanical, Electrical, analog, digital. Applications of transducers. 4.3 Displacement Measurement: Specification, selection and application of displacement transducer, LVDT, RVDT, Potentiometer. 4.4 Temperature Measurement: Non-electrical methods- Bimetal and Liquid in glass thermometer. Electrical methods- RTD, Thermistor, Thermocouple. 4.5 Flow measurement: Types of flow meters. Selection criteria for flow meters. Variable area meter- Rota meter. Vane type Anemometer.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain principles and constructional features of sound measuring device. TLO 5.2 Explain principles and constructional features of force measuring device. TLO 5.3 Choose speed measuring instrument for a given system with justification.	**Unit - V Miscellaneous Measurements** 5.1 Acoustics Measurement: Sound characteristics - intensity, frequency, pressure, power, sound level meter. 5.2 Force Measurement: Load cell- Hydraulic, Pneumatic and Strain Gauge 5.3 Speed Measurement: Tachometers: Eddy current Drag Cup Tachometer, Contact less Electrical tachometer - Inductive Pick Up, Capacitive Pick Up and Stroboscope.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use ancient measurement system for measurement of length and weight.	1	*Measurement of Length and weight by using ancient measurement system (IKS)	2	CO1 CO5
LLO 2.1 Measure dimensional parameters by using linear measuring instruments. LLO 2.2 Operate different linear measuring instruments.	2	*Measurement of dimensions of component using vernier caliper, vernier height gauge, vernier depth gauge, micrometer and inside micrometer.	2	CO1
LLO 3.1 Check the geometrical parameters of a component with the help of mechanical comparators. LLO 3.2 Operate dial gauge for different applications.	3	Roundness checking of the given component using dial indicator / dial gauge.	2	CO2
LLO 4.1 Use Bevel Protractor and Sine bar for measurement of unknown angle. LLO 4.2 Operate Bevel Protractor and Sine bar for angle measurement.	4	*Measurement of unknown angle of a component using Bevel Protractor and verification by Sine bar.	2	CO3
LLO 5.1 Use floating carriage micrometer for measurement of major, minor and effective diameter of screw threads. LLO 5.2 Operate optical profile projector for checking thread profile.	5	*Measurement of the screw thread elements by using floating carriage micrometer and verification by optical profile projector	2	CO3
LLO 6.1 Measure face width and tooth thickness of a gear by using gear tooth vernier caliper. LLO 6.2 Operate optical profile projector for measuring gear profile.	6	*Measurement of the gear tooth elements using gear tooth vernier caliper and verification by optical profile projector.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Examine the machined surface using surface roughness tester.	7	*Measurement of the surface roughness of machined surface by using surface roughness tester.	2	CO3
LLO 8.1 Use different optical flats for measurement of surface flatness. LLO 8.2 Identify the types of observed fringe patterns of optical flats.	8	Measurement of flatness of given component by using optical flats.	2	CO3
LLO 9.1 Use Autocollimator / Angle Dekkor for measurement of angle or taper of given component.	9	Measurement of the unknown angle of a given component by Autocollimator / Angle Dekkor.	2	CO3
LLO 10.1 Measure displacement of micrometer by using LVDT. LLO 10.2 Use LVDT for measurement of linear displacement.	10	*Measurement of displacement by using Linear Variable Displacement Transducer (LVDT).	2	CO4
LLO 11.1 Measure temperature of a system by using thermometer. LLO 11.2 Use Thermocouple for measurement of temperature of given system.	11	Measurement of temperature by thermocouple and Verification by thermometer.	2	CO4
LLO 12.1 Measure the flow rate of liquid by rotameter.	12	Measurement of flow rate of liquid by rotameter.	2	CO4
LLO 13.1 Measure given weights by using Load Cell.	13	*Measurement of weight by using a load cell.	2	CO5
LLO 14.1 Measure sound level using sound meter	14	Sound intensity measurement using sound meter	2	CO5
LLO 15.1 Measure the speed of rotating shaft by stroboscope or inductive pick up. LLO 15.2 Use stroboscope or inductive pick up for measurement of speed of rotating shaft.	15	Measurement of speed of rotating shaft by stroboscope or inductive pick up.	2	CO5

Note : Out of above suggestive LLOs -

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

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

Micro project

- 1)Comparative study of various linear measuring instruments like steel rule, Inside-outside micrometer, Vernier caliper and Digital caliper with proper justification.

2)Comparative study of surface finish of various samples machined by various machining / finishing processes using surface roughness tester.
3)Prepare a report on calibration procedure of Vernier Caliper and Micrometer followed by NABL Lab.
4)Prepare a visit report on measurement systems used in near by industries / SME / Workshops / Fabrication shops.

5)Perform comparative study of different contact and non contact type transducers / sensors.
6)Visit to Automobile service station, observe the different sensors used in cars and prepare a report of the same. (Name, Use, Location, Working, Applications)

Assignment

- 1)Prepare a report to interpret effect of errors on the accuracy of instrument and measurement.

2)Visit to any nearby shop or industry and list out different gauges used for inspection along with its purpose.
3)Prepare a comparative study of different screw threads measuring instruments on the basis of their least count, accuracy, cost, ease of operation
4)Prepare a short report on different types of Rotameter.
5)Prepare a set of procedure for sound measurement with suitable instrument.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Inductive transducer – measurement range 0 to 100mm – sensor – inducive (nonlinear) solenoid type onboard with micrometer, micrometer screw gauge assembly for displacement, bridge balance type circuit Display 3.5-digit display	10
2	Sensor – type K (Cr-AI) thermocouple, sensor assembly and water bath with heating arrangement Display 3.5-digit display.	11
3	Rotameter -Trainer -sensor – standard glass rotameter, process tank with motor pump display – flat position on graduated scale.	12
4	Load cell – Force measurement range 5-50N – sensor 4 arm bridge with strain gauge capacity – 2Kg 3.5-digit display	13
5	Sound level meter: Measuring range 30-130 dB, portable and easy to use	14
6	Multi digital Stroboscope cum Tachometer for speed measurement – up to 5000 rpm.	15
7	Vernier Calipers (0-200 mm)	2
8	Vernier Height Gauge and Depth Gauge. (0-300 mm)	2
9	Outside Micrometer (0-25mm, 25-50mm)	2
10	Inside Micrometer 0-25mm	2
11	Surface Plate-Granite (24 x 36 inch)	2,4,7
12	Dial indicator (0-25mm) with magnetic stand.	3,4
13	Universal bevel protractor Graduation: 5 min (0 deg-90 deg -0 deg)	4
14	Sine bar, Sine Center (0-200mm)	4

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
15	Floating Carriage Micrometer: Least Count 0.001mm; Standard micrometer or electronic type; Non rotary 8mm micrometer spindle; Indicator with 0.001 standard dial; admit between center 200mm; Max diameter capacity 100mm; Standard accuracy ± 0.005mm.	5
16	Profile projector with gear profile / Thread profile templates. Opaque fine grained ground glass screen with 90o, 60o, 30o cross line Location; fitted with graduated ring (0 to 360 o) L.C. 1 min; Optics Std 10X, 20X, Measuring Range Std 100mm X 100mm; opt X axis up to 400mm, Y axis up to 200mm; Focusing Travel 100mm; Magnification Accuracy Contour ± 0.05% Surface ± 0.05%; Illumination Countor 24V / 150W halogen lamp with illumination control; Resolution 0.005/0.001/0.0005 mm.	5,6
17	Surface roughness Tester (Max Sampling length 0.8 mm) having profile printing facility.	7
18	Optical flats set range (0.2 μm) Diameter / Thickness 45/12mm and 60/15mm.	8
19	Angle Dekkor and Autocollimator (0 to 30')	9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Metrology and Linear Measurement	CO1	12	4	4	6	14
2	II	Gauges and Comparators	CO2	10	2	6	4	12
3	III	Angular, Screw Thread, Gear and Surface Finish Measurements	CO3	18	4	6	10	20
4	IV	Displacement, Temperature and Flow Measurement	CO4	12	2	4	8	14
5	V	Miscellaneous Measurements	CO5	8	2	4	4	10
Grand Total				**60**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work (Lab Manual), Self-Learning (Assignment) Question and Answers in class room, quiz and group discussion. Note: Each practical will be assessed considering-60% weightage to process related and 40 % weightage to product related.

Summative Assessment (Assessment of Learning)

- Practical Examination, Pen and Paper Test

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	N.V. RAGHAVENDRA and L. KRISHNAMURTHY	ENGINEERING METROLOGY AND MEASUREMENTS	Oxford University Press, New Delhi, India ISBN-13: 978-0-19-808549-2. (2013)
2	Anand K Bewoor and Vinay A Kulkarni	METROLOGY AND MEASUREMENTS	Tata McGraw-Hill Education Private Limited, New Delhi , India ISBN (13): 978-0-07-014000-4 (2017)
3	R K Jain	Engineering Metrology	Khanna Publication, New Delhi, ISBN-10:817409153X (2022)
4	R. K. Rajput	Engineering Metrology & Instrumentation	S.K. Kataria and Sons ISBN:9788185749822 (2009)
5	R K Jain	Mechanical and Industrial Measurements	Khanna Publication, New Delhi ISBN: 8174091912 (1995)
6	Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard ·	Mechanical Measurements	Pearson Prentice Hall ISBN:9780136093763 (2013)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc20_me94/preview	NPTEL MOOCS course on Engineering Metrology
2	https://onlinecourses.nptel.ac.in/noc23_me09/preview	NPTEL MOOCS course on Mechanical measurement systems.

Sr.No	Link / Portal	Description
3	https://www.youtube.com/watch?v=Hi7NUJdznc0	Video Lecture on Engineering Metrology by IIT Madras.
4	http://www.digimat.in/nptel/courses/video/112106179/L33.html	Video Lecture on Electrical and electronic comparators, Optical comparators NPTEL Video Course : Metrology
5	https://www.bing.com/videos/riverview/relatedvideo?&q=videos+on+CMM+measurement+IIT&&mid=6C0843737C0E8F2019006C0843737C0E8F201900&&FORM=VRDGAR	Video on Part inspection by using CMM
6	https://www.bing.com/videos/riverview/relatedvideo?q=videos+on+screw+thread+measurement+IIT&&view=riverview&mmscn=mtsc&mid=9850B2C61C0872810AC19850B2C61C0872810AC1&&aps=196&FORM=VMSOVR	Measurement of screw thread elements.
7	https://www.bing.com/videos/riverview/relatedvideo?&q=videos+on+displacement+measurement&&mid=53BAFCB5E8DA5553247253BAFCB5E8DA55532472&&FORM=VRDGAR	Potentiometer Working Principle
8	https://www.bing.com/videos/riverview/relatedvideo?&q=bimetallic+temperature+measurement+devices&&mid=3ADB81DF5F95342EE5B53ADB81DF5F95342EE5B5&&FORM=VRDGAR	How Bimetallic Temperature Gauges Works
9	https://www.bing.com/videos/riverview/relatedvideo?&q=flow+measurement+devices+rotameter&&mid=145B5C41696FC6AFF30B145B5C41696FC6AFF30B&&FORM=VRDGAR	Flow Measurement Devices
10	https://www.bing.com/videos/riverview/relatedvideo?&q=carbon+microphone&&mid=B08AB66B421E46892B46B08AB66B421E46892B46&&FORM=VRDGAR	Build a carbon microphone with a soda can and a paper clip
11	https://www.bing.com/videos/riverview/relatedvideo?&q=hair+hygrometer+working+principle&&mid=20C836F03B5418F173D620C836F03B5418F173D6&&FORM=VRDGAR	Actual working of Hair Hygrometer

Note :

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

Programme Name/s : **Mechanical Engineering/ Mechatronics/ Production Engineering**
Programme Code : **ME/ MK/ PG**
Semester : **Third / Fourth**
Course Title : **MECHANICAL ENGINEERING MATERIALS**
Course Code : **313317**

I. RATIONALE

Mechanical diploma technician works in the metal working industry. To meet current and future metal demands it is essential to get material knowledge. Materials like ferrous and non-ferrous metals, polymer, ceramics and composites are widely used in a variety of engineering applications. This course deals with these materials along with advanced materials, their metallurgical considerations, heat treatment processes, structure property relationship and applications. This course will enable diploma engineering students to identify a variety of material and their selection for various applications which is used in connection with smelting, welding, machining, bending, extruding, tapping, soldering, casting, pumping, structural work, crushing, and other industrial processes.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use relevant mechanical engineering materials & processes based on different applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select suitable material(s) based on desired properties according to application.
- CO2 - Choose relevant alloy steel & Cast iron for mechanical components.
- CO3 - Select relevant non ferrous & powder material components for the engineering application.
- CO4 - Select relevant non metallic & Advanced material for the engineering application.
- CO5 - Use relevant heat treatment processes in given situations.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313317	MECHANICAL ENGINEERING MATERIALS	MEM	DSC	3	-	2	1	6	3	1.5	30	70*#	100	40	25	10	-	-	25	10	150

Total IKS Hrs for Sem. : 4 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Interpret the crystal structure of specified materials TLO 1.2 Identify microstructure of the given material with justification. TLO 1.3 Explain with sketches the procedure to prepare a given sample. TLO 1.4 Identify & Interpret the given equilibrium diagram & reactions with justification. TLO 1.5 Identify the given fields of steels on Iron carbon diagrams with justification. TLO 1.6 Choose a relevant hardness tester based on the given situation with justification.	**Unit - I Basics of Engineering Materials** 1.1 Classification of engineering materials 1.2 Crystal structure, Unit cell and space lattice 1.3 Microstructure, types of microscopes 1.4 Sample preparation, etching process, types of etchants. 1.5 Properties of metals Physical Properties, Mechanical Properties. 1.6 Concept of phase, pure metal, alloy and solid solutions. 1.7 Iron Carbon Equilibrium diagram various phases. Critical temperatures and significance. Reactions on Iron carbon equilibrium diagram 1.8 Hardness testing procedure on Brinell and Rockwell tester.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Select relevant steel for the given application with justification. TLO 2.2 Select the relevant cast irons as white, gray cast iron for the given job with justification. TLO 2.3 Interpret the given material designations. TLO 2.4 Identify the properties of the given composition of cast iron with justification.	**Unit - II Steel & Cast Iron** 2.1 Broad Classification of steels. i. Plain carbon steels: Definition, Types and Properties, Compositions and applications of low, medium and high carbon steels. ii. Alloy Steels: Definition and Effects of alloying elements on properties of alloy steels. iii. . Tool steels: Cold work tool steels. Hot work tool steels, High speed steels (HSS) iv. Stainless Steels: Types and Applications v. Spring Steels: Composition and Applications. vi. Specifications of steels and their equivalents. 2.2 Steels for following components: Shafts, axles, Nuts, bolts, Levers, crank shafts, camshafts, Shear blades, agricultural equipment, household utensils, machine tool beds, car bodies, Antifriction bearings and Gears. 2.3 Types of cast irons as white. Gray, nodular, malleable 2.4 Specifications of cast iron. 2.5 Selection of appropriate cast iron for engineering applications. 2.6 Designation and coding (as per BIS, ASME, EN, DIN, TIS) of cast iron, plain and alloy steel. 2.7 Use of iron and steel in ancient India; Munda, Tikshna and Kanta types of iron and steels (IKS)	Lecture Using Chalk-Board Model Demonstration Presentations
3	TLO 3.1 Describe the properties and applications of the given copper alloy & aluminium alloy. TLO 3.2 Describe the properties and applications of the given bearing material TLO 3.3 Select relevant non-ferrous material for the specified application with justification. TLO 3.4 Explain various powder manufacturing processes.	**Unit - III Non Ferrous Materials & Powder Metallurgy** 3.1 Copper and its alloys - brasses, bronzes Chemical compositions, properties and Applications. 3.2 Use of copper in ancient India and its mention in Rigveda (IKS) 3.3 Aluminum alloys -Y-alloy, Hindalium, duralium with their composition and Applications. 3.4 Bearing materials like white metals (Sn based), aluminum, bronzes. Porous, Self -lubricating bearings. 3.5 Powder Metallurgy: Introduction, Advantages, limitations and applications. Preparation of Metal Powders, Basic Steps for Powder Metallurgy.	Model Demonstration Lecture Using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Distinguish between metallic and non-metallic materials on the basis of given composition, properties and applications. TLO 4.2 Choose relevant non-metallic material for the given job with justification. TLO 4.3 Select relevant composite material for the given job with justification. TLO 4.4 Suggest relevant alternative materials for the given job with justification.	**Unit - IV Non Metallic Materials & Advanced Materials** 4.1 Polymeric Materials i. Polymers:- types, characteristics, ii. Properties and uses of Thermoplastics, Thermosetting Plastics and Rubbers. iii.Thermoplastic and Thermosetting Plastic materials 4.2 Characteristics and uses of ABS, Acrylics. Nylons and Vinyls, Epoxides, Melamines and Bakelites 4.3 Rubbers: Neoprene, Butadiene, Buna and Silicons - Properties and applications. 4.4 Ceramics -types of ceramics, properties and applications of glasses and refractories 4.5 Composite Materials - properties and applications of Laminated and Fiber reinforced materials 4.6 Advanced Engineering Materials: Properties and applications of Nanomaterials and smart materials & Biomedical materials.	Lecture Using Chalk-Board Presentations Demonstration
5	TLO 5.1 Describe with sketches the specified heat treatment processes. TLO 5.2 Select the relevant heat treatment processes for given material with justification. TLO 5.3 Explain with sketches the working principle of the given heat treatment furnace. TLO 5.4 Suggest the relevant heat treatment process for the given situation with justification.	**Unit - V Heat Treatment processes** 5.1 Overview of heat treatment. 5.2 Annealing: Purposes of annealing, Annealing temperature range, Types and applications. 5.3 Normalizing: Purposes of Normalizing, temperature range. Broad applications of Normalizing. 5.4 Hardening: Purposes of hardening, Hardening temperature range, applications 5.5 Tempering: Purpose of tempering Types of tempering and its applications 5.6 Case hardening methods like Carburizing, Nitriding, and Cyaniding. 5.7 Heat treatment Furnaces - Muffle, Box type.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Presentations

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use slitting machine to prepare sample of given dimension. LLO 1.2 Use grinding machine & polishing papers to prepare surface of given sample.	1	*Specimen preparation of a given material for microscopic examination.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Use suitable etchant for microscopic examination of given sample. LLO 2.2 Use a metallurgical microscope to observe micro structure of given specimen. LLO 2.3 Interpret the micro structure of given specimen.	2	*Interpretation of microstructure of steels and alloy steels using metallurgical microscope on standard specimens.	2	CO1
LLO 3.1 Use Brinell Hardness tester LLO 3.2 Determine hardness of given sample.	3	*Hardness testing on Brinell Hardness tester of given sample material.	2	CO1
LLO 4.1 Use a Rockwell Hardness tester. LLO 4.2 Determine hardness of given sample.	4	Hardness testing on Rockwell Hardness tester of given sample material.	2	CO1
LLO 5.1 Choose appropriate hardness tester for mild steel. LLO 5.2 Use an appropriate hardness tester for mild steel.	5	Hardness testing on relevant hardness testers of given untreated and heat treated Mild Steels.	2	CO1
LLO 6.1 Choose appropriate hardness tester for alloy steel. LLO 6.2 Use an appropriate hardness tester for alloy steel.	6	Hardness testing on relevant hardness testers of given untreated and heat treated Alloy Steels.	2	CO1
LLO 7.1 Use a metallurgical microscope LLO 7.2 Interpret the microstructure of Cast Iron.	7	*Microstructure of cast iron using metallurgical microscope on standard specimens.	2	CO1 CO2
LLO 8.1 Choose appropriate hardness testers for copper & Brass. LLO 8.2 Use appropriate hardness testers for copper & Brass.	8	Hardness testing on relevant hardness testers of given Copper and Brass specimens.	2	CO1 CO3
LLO 9.1 Choose the appropriate hardness tester for Aluminium. LLO 9.2 Use an appropriate hardness tester for aluminum.	9	Hardness testing on relevant hardness testers of given Aluminuim specimens.	2	CO1 CO3
LLO 10.1 Use an appropriate peel tester LLO 10.2 Determine the adhesive strength of cellophane tape and duct tape.	10	*Adhesive strength determination of cellophane tape and duct tape using a relevant peel tester.	2	CO3
LLO 11.1 Use an appropriate peel tester LLO 11.2 Determine the adhesive strength of scotch tape, electrical tape.	11	Adhesive strength determination of scotch tape, electrical tape and masking tape using relevant peel testers.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Perform flame tests. LLO 12.2 Identify different types of plastics. Identification of different types of plastics using flame tests.	12	*Identification of different types of plastics using flame tests.	2	CO3
LLO 13.1 Use a High-temperature oven or electrical current LLO 13.2 Identify behavior of the shape-memory alloy .	13	*Identification of behavior of the shape-memory alloy as a function with regards to temperature using High-temperature oven or electrical current.	2	CO4
LLO 14.1 Use a muffle /box type furnace LLO 14.2 Use various quenching mediums for mild steel. LLO 14.3 Compare the hardness of mild steel.	14	*Comparison of hardness of mild steel using quenching mediums like oil ,water & brine in a muffle /box type furnace .	2	CO1 CO5
LLO 15.1 Use a muffle /box type furnace LLO 15.2 Use various quenching mediums for alloy steel. LLO 15.3 Compare the hardness of alloy steel.	15	Comparison of hardness of alloy steel using quenching mediums like oil ,water & brine in a muffle /box type furnace .	2	CO1 CO5
LLO 16.1 List various ancient Indian material development processes. LLO 16.2 Compare Ancient Indian material development processes with recent processes.	16	Comparison of Ancient Indian material development processes with recent processes.	2	CO1 CO2 CO3 CO4 CO5

Note : Out of above suggestive LLOs -

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

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

Micro project

- Collect information related to Types, Properties and applications of smart materials from websites. Present the information in the form of a Chart.
- Collect samples of various types of plastics, ceramics, composites used in day-to-day applications and prepare charts containing properties, applications of the samples.
- Comparative study of various materials used in previous and current generation components of mechanical engineering equipment like IC Engine, Compressor, turbine, pumps, refrigerator, water cooler, Lathe Machine, Milling Machine, Drilling Machine grinding machine (any one) with proper justifications.
- Preparation of a chart of comparison of hardness of various materials.
- Prepare models showing various crystal structures.
- Prepare a puzzle game on Iron-carbon Equilibrium diagram.
- Determine the microstructure of different metallic components (minimum 5) using metallurgical Microscope and compare their microstructure in the given group.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Slitting machine Specifications: • Capacity: 18 gauge / 1.2mm • Throat Depth: 24 inch (600mm) • Motor: 1 Hp, 230V, 50 Hz. • Minimum Slitting Width: 1 inch (25.4mm)	1
2	Double Disk polishing machine. Two independent polishing units mounted on a common MS frame, Disc dia 200mm, made of Aluminum. Speed continuously variable upto 950 RPM. Rating - 0.25 HP single phase 220 Volt A.C. provided with sink and swing type laboratory water tap. Waterproof Formica table top.	1
3	Digital Brinell hardness Tester 1) Test loads - 500 to 3000 Kgf. in steps of 250 Kg. 2) Magnification of objective - 14 X 3) Maximum test height - 380 mm. 4) Least count - 0.001 mm. 5) Throat depth - 200 mm.	1,3,5,6,8,9,14,15
4	Digital Rockwell hardness Tester 1) Test loads - 60, 100 & 150 kgf 2) Minor load - 10 kg 3) Max test height - 230 mm 4) Throat depth - 133 mm along with essential accessories.	1,4,5,6,8,9,14,15
5	Digital Peel Strength Tester: Make: XEEPL • Load capacity: 0 - 5 kg; Resolution: 1 gram. • Load Indicator: Microprocessor based digital load indicator with memory facility of peak load. • Clear Distance between two plates: Maximum up to 250 mm. • Speed of testing: 300 mm/minute. • Motor: Synchronous Motor. • Grips: A pair of hard chrome plated grips for thin poly film samples would be supplied. • Paint: Powder coated. • Power requirement: Single phase 230 Volts, 50Hz.	10,11
6	Spring coil of Shape memory sample (NiTi alloy) Burner/ Lighter , Sample Holder	12,13
7	Laboratory box furnace Light weight with ceramic fiber wool insulation. Exterior made of G.I. sheets powder coated. Temperature Controlled by Microprocessor based Auto tune PID digital temperature controller with CR/AL Thermocouple. Temperature Range: 1100°C., Muffle Size (inside): Temperature Range: 1100°C., Muffle Size (inside): 6”x6”x12’’, Power: 3.5 KW	14,15
8	Standard Samples of Metallurgical Microstructure Plain carbon steels, alloy steels and cast iron (before and after heat treatment) : 03 Each • Aluminum, Copper and Brass/Bronze (before and after heat-treatment): 03 Each Total 36 Specimens	2
9	Trinocular Upright Metallurgical Microscope: Coaxial Body • Body: Trinocular Head inclined at 45-degrees. • Focusing: Both side co-axial focusing knobs. • Nosepiece: Quadruple revolving nosepiece with accurate centering & amp; positive click stops. Trinocular Inverted Metallurgical Microscope (Magnification 100X, 200X, 400X & 800X) Eyepieces - WF 10X, 20X (Paired) Objectives - M 5x, M 10x, M 20x and M 40x (SL) Stage - Built-in graduated mechanical stage of size 165mm.x180mm. is controlled by convenient low coaxial positioned knobs for easy and smooth scanning of specimen.	2,7

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Engineering Materials	CO1	10	4	4	6	14
2	II	Steel & Cast Iron	CO2	12	4	6	6	16
3	III	Non Ferrous Materials & Powder Metallurgy	CO3	10	4	4	6	14
4	IV	Non Metallic Materials & Advanced Materials	CO4	8	4	4	6	14
5	V	Heat Treatment processes	CO5	5	2	4	6	12
Grand Total				**45**	**18**	**22**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning term work -25 Marks
- For Self Learning 25 Marks
- Two-unit tests of 30 marks and average of two-unit tests.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dieter, G.D	Mechanical Metallurgy	McGraw Hill Edu. New Delhi, 2017, ISBN. 978-1259064791
2	Avner,S.H	Introduction to Physical Metallurgy	McGraw Hill Edu. New Delhi, 2017, ISBN. 978-0074630068
3	Rajput, R.K S.	Engineering Materials And Metallurgy	Chand and Company New Delhi,2006, ISBN 978-8121927093
4	Balasubramaniam R	Callister's Materials Science and Engineering	Wiley, New Delhi, 2014, ISBN 978-8131518052
5	Parashivamurthy,K. I.	Material Science and Metallurgy	Pearson Education India, 2012, ISBN. 978-8131761625
6	Fulay, P.P., Askeland D.R	Essentials of Materials Science and Engineering	Cengage India Private Limited, 2012 , ISBN 978-8131520703
7	Kodgire, V.D., Kodgire. S.V	Material Science and Metallurgy for Engineers	Everest Publishing House, 2017, ISBN. 978-8176314008

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=jn9cP6JJ7xA	Iron - Carbon diagram
2	https://www.youtube.com/watch?v=skQRLfU3plM	Heat Treatment Processes
3	https://www.youtube.com/watch?v=E6oCdckcwYQ&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ&index=3	Crystal structure
4	https://www.youtube.com/watch?v=c1ZbiBIY6Sc&list=PLxQzQgOy_JvYd32Y6XOwFOnVc4_Dkv7v6&index=38	Ceramics
5	https://www.youtube.com/watch?v=04K0bLwCDdM	Composite materials
6	https://vedicheritage.gov.in/vedic-heritage-in-present-context/metallurgy/	IKS
7	https://www.youtube.com/watch?v=_eM49JlmFp0	Powder Metallurgy

Note :

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

Programme Name/s : **Mechanical Engineering/ Production Engineering**
Programme Code : **ME/ PG**
Semester : **Third**
Course Title : **COMPUTER AIDED DRAFTING**
Course Code : **313006**

I. RATIONALE

With the advent of technology, the process of drafting and design has transitioned from manual techniques to digital methods. The study of Computer Aided Drawing and Drafting (CADD) is representing the forefront of this evolution, providing designers with powerful tools to streamline the creation, modification, and visualization of technical drawings.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Create technical drawings using CADD software accurately and efficiently according to industry standards in multidisciplinary teams.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use basic commands in CADD software.
- CO2 - Draw complex 2D drawings in CADD software using draw and modify tools.
- CO3 - Draw isometric drawings using CADD software.
- CO4 - Use software to dimension and write text on 2D geometric entities.
- CO5 - Plot given 2D entities using proper plotting parameters in CADD.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313006	COMPUTER AIDED DRAFTING	CAD	SEC	-	-	4	-	4	2	-	-	-	-	-	25	10	25#	10	-	-	50

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the importance of computer in drafting and designing. TLO 1.2 Set the CADD workspace and interface. TLO 1.3 Prepare drawing using User Coordinate System (UCS) and World Coordinate System (WCS) TLO 1.4 Apply different object selection methods in a given situation. TLO 1.5 Use various commands in application menu bar.	**Unit - I Fundamentals of CAD Drawing** 1.1 Fundamentals of Computer Aided Drafting and its applications, Various Software for Computer Aided Drafting. 1.2 CADD Interface: Application Menu, Quick Access Toolbar, Ribbons, InfoCenter, Command Window, Graphical Area, Status Bar 1.3 CADD initial setting commands: Snap, grid, Ortho, Osnap, Dynamic input, Limits, Units, Ltscale, Object tracking. 1.4 Co-ordinate System- Cartesian and Polar, Absolute and Relative mode, Direct Distance Entry, UCS, WCS. 1.5 Object Selection methods- picking, window, crossing, fence, last and previous. 1.6 Opening, saving and closing a new and existing drawing.	Video Demonstrations Presentations Hands-on
2	TLO 2.1 Use viewing commands. TLO 2.2 Apply formatting commands. TLO 2.3 Draw simple 2D entities using given draw commands. TLO 2.4 Determine coordinates, distance, area, length, centroid of the given 2D entity.	**Unit - II Zoom, Draw, Formatting and Enquiry Commands** 2.1 Zoom Commands – all, previous, out, in, extent, Realtime, dynamic, window, pan. 2.2 Draw Command - Line, Polyline, arc, circle, rectangle, polygon, ellipse, spline, block, hatch. 2.3 Formatting commands - Layers, block, linetype, lineweight, color. 2.4 Enquiry commands – distance, area.	Video Demonstrations Presentations Hands-on

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Draw given complex 2D entities using modify commands. TLO 3.2 Use grip command to manipulate given 2D entity.	**Unit - III Modify and Edit Commands** 3.1 Modify Command - Erase, trim, extend, copy, move, mirror, offset, fillet, chamfer, array, rotate, scale, lengthen, stretch, measure, break, divide, explode, align. 3.2 Editing Objects by Using Grips - Moving, Rotating, Scaling, Mirroring and Stretching.	Video Demonstrations Presentations Hands-on
4	TLO 4.1 Draw isometric entities. TLO 4.2 Draw isometric object from given orthographic views. TLO 4.3 Use Layers for 2D drawings. TLO 4.4 Draw and modify blocks for given 2D entities. TLO 4.5 Use blocks in same and in another given file.	**Unit - IV Isometric Drawings, Layers, and Blocks** 4.1 Isometric drafting- Isometric grid & snap, Isometric axis & plane, Polyline, Isocircle. 4.2 Dimensioning Isometric drawings. 4.3 Text writing on Isometric drawing. 4.4 Layer, Layer properties and applications. 4.5 Blocks: create, modify and use in same file and in another file.	Video Demonstrations Presentations Hands-on
5	TLO 5.1 Use various dimensioning styles to drawn 2D entities. TLO 5.2 Apply Geometric and dimension tolerance symbols on the given entity. TLO 5.3 Write text on given 2D entity. TLO 5.4 Insert table in drawing. TLO 5.5 Prepare new template for drawing as per requirement. TLO 5.6 Plot given 2D entities using proper plotting parameters.	**Unit - V Dimensioning, Text and Plot Commands** 5.1 Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, Modify dimension style. 5.2 Text commands - dtext, mtext command. 5.3 Insert table – table, tablestyle command. 5.4 Template Drawing- Standard template, loading template, create new template. 5.5 Plotting a drawing – adding plotter/printer, page setup, plot style commands.	Video Demonstrations Presentations Hands-on

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use basic commands in CADD software. LLO 1.2 Draw 2D entities in CADD software.	1	*Drawing 2-D entities like Line, Polyline, Circle, Rectangle, Polygon and Ellipse by using CADD software.	4	CO1 CO2
LLO 2.1 Use basic commands in CADD software. LLO 2.2 Draw 2D entities in CADD software using Draw commands individually.	2	Drawing simple 2-D objects using any combination of 2 or more commands, like polygon+circle, line+circle, etc.	4	CO1 CO2
LLO 3.1 Use basic commands in CADD software. LLO 3.2 Draw 2D entities in CADD software using Draw, Edit and Modify commands.	3	Drawing complex 2-D objects like pulley/ gear.	4	CO1 CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Use basic commands in CADD software. LLO 4.2 Draw 2D entities in CADD software using Draw, Edit and Modify commands. LLO 4.3 Apply dimension and write text on 2D geometric entities.	4	*Drawing complex 2-D object like coupling/joints.	4	CO1 CO2 CO4
LLO 5.1 Use basic commands in CADD software. LLO 5.2 Draw 2D entities in CADD software. LLO 5.3 Apply dimension and write text on 2D geometric entities.	5	* Drawing any two problems of orthographic projections using first angle method of projection.	4	CO1 CO2 CO4
LLO 6.1 Use basic commands in CADD software. LLO 6.2 Draw 2D entities in CADD software. LLO 6.3 Apply dimension and write text on 2D geometric entities.	6	Drawing any two problems of orthographic projections using third angle method of projection.	4	CO1 CO2 CO4
LLO 7.1 Use basic commands in CADD software. LLO 7.2 Draw 2D entities in CADD software. LLO 7.3 Apply dimension and write text on 2D geometric entities.	7	* Drawing any two problems of sectional orthographic projections using First angle method of projection.	4	CO1 CO2 CO4
LLO 8.1 Use basic commands in CADD software. LLO 8.2 Draw 2D entities in CADD software. LLO 8.3 Apply dimension and write text on 2D geometric entities.	8	Drawing any two problems of sectional orthographic projections using third angle method of projection.	4	CO1 CO2 CO4
LLO 9.1 Use basic commands in CADD software. LLO 9.2 Draw 2D entities in CADD software. LLO 9.3 Apply dimension and write text on 2D geometric entities.	9	Drawing any two problems of development of solids.	4	CO1 CO2 CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Use basic commands in CADD software. LLO 10.2 Draw 2D entities in CADD software. LLO 10.3 Apply dimension and write text on 2D geometric entities.	10	Drawing any two problems on Auxiliary views.	4	CO1 CO2 CO4
LLO 11.1 Use basic commands in CADD software. LLO 11.2 Draw 2D entities in CADD software. LLO 11.3 Apply dimension and write text on 2D geometric entities.	11	*Drawing an assembly drawing from the given detailed drawing showing assembly dimensions, part number and bill of Material.	8	CO1 CO2 CO4
LLO 12.1 Use basic commands in CADD software. LLO 12.2 Draw 2D entities in CADD software. LLO 12.3 Apply dimension and write text on 2D geometric entities.	12	Drawing working drawings from given assembly drawing showing conventional representation, dimensions, geometrical tolerances and machining symbols.	8	CO1 CO2 CO4
LLO 13.1 Use basic commands in CADD software. LLO 13.2 Draw isometric drawings using CADD software.	13	Drawing isometric views of given two objects containing lines, arcs, circles, holes, ribs and slots.	8	CO1 CO3
LLO 14.1 Use basic commands in CADD software. LLO 14.2 Draw isometric drawings using CADD software	14	*Drawing Isometric drawings from given Isometric views and dimension it.	8	CO1 CO3 CO4
LLO 15.1 Use basic commands in CADD software. LLO 15.2 Write text in title block.	15	*Prepare a template for your institute of predefined paper size with title block and institute logo.	4	CO1 CO4
LLO 16.1 Use basic commands in CADD software. LLO 16.2 Take printout by using plot option	16	*Plot the drawings from Sr. 3 to 13 on Paper with title block and institute logo	4	CO1 CO5

Note : Out of above suggestive LLOs -

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

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

Not Applicable

- Not Applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Networked Licensed latest version of Computer Aided Drafting software.	All
2	CAD workstation with latest configurations for each student.	All
3	Plotter/Printer with latest versions.	All
4	LCD projector and Screen/ Interactive board.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Termwork Each practical will be assessed considering - - 60% weightage to process and - 40% weightage to product Continuous assessment based on process and product related performance indicators, laboratory experience.

Summative Assessment (Assessment of Learning)

- Practical Exam of 25 marks

XI. SUGGESTED COS - POS MATRIX FORM

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

CO1	2	-	-	1	-	-	1			
CO2	2	1	1	-	-	-	1			
CO3	2	1	1	-	-	-	1			
CO4	2	-	-	-	-	-	1			
CO5	1	-	-	1	1	1	1			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Prof. Sham Tickoo	AutoCAD 2021 for Engineers & Designers, Basic & Intermediate	Publisher: BPB Publications, 21 February 2021, ISBN-10: 9389898986, ISBN-13: 978-9389898989
2	Sankar Prasad Dey	Autocad 2014 for Engineers Volume 1	Publisher: Vikas, 21 December 2021, ISBN-13: 978-9325983373
3	Prof. Sham Tickoo	AutoCAD 2024: A Problem-Solving Approach, Basic and Intermediate	Dreamtech Press publication, August 20, 2023, ISBN-10 1640571779, ISBN-13 978-1640571778
4	Kulkarni D.M	Engineering Graphics with AutoCAD	Publisher: Prentice Hall India Learning Private Limited, 1 January 2010, ISBN-10: 8120337832, ISBN-13: 978-8120337831
5	Cadfolks	AutoCAD 2021 For Beginners	Publication: Kishore, 5 May 2020, ISBN-10 819419539X ISBN-13: 978-8194195399
6	Luke Jumper, Randy H. Shih	AutoCAD 2024 Tutorial First Level 2D Fundamentals	SDC Publication, June 27, 2023, ISBN-10 1630575852, ISBN: 978-1-63057-585-4
7	Sharad K. Pradhan, K K Jain	Engineering Graphics , AICTE Prescribed Textbook	Khanna Book Publishing; First Edition, 1 January 2023, ISBN-10 9391505503, ISBN-13 978-9391505509

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.autodesk.com/education/online-learning	Tutorials, courses, and resources for AutoCAD
2	https://www.cadtutor.net/	Tutorials, articles, forums and downloadable resources covering various CAD software applications.
3	https://www.cadin360.com/	Video tutorials, articles, and downloadable resources to enhance CAD skills.
4	https://ocw.mit.edu/courses/mechanical-engineering/	Lectures, assignments and projects covering topics such as engineering design, CAD/CAM, and product development.
5	https://www.engineering.com/LearningCenter/CAD.aspx	Tutorials, articles, and videos covering CAD software, simulation tools, and engineering design concepts.
6	https://www.youtube.com/watch?v=cmR9cfWJRUU	Introductory tutorial for beginners to AutoCAD, covering topics such as interface navigation, basic drawing commands and setting up units and layers.

Sr.No	Link / Portal	Description
7	https://www.youtube.com/watch?v=QuR-VKis3jU	2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions, annotations and creating detailed technical drawings.
8	https://www.youtube.com/watch?v=IWYKfzx-M1E	2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions and annotations, and creating detailed technical drawings.
9	https://www.youtube.com/watch?v=RA0O6AZewTc	Isometric drawings in AutoCAD
10	https://www.youtube.com/playlist?list=PLYEkKxSL5Gt1hR6Jg0ZiQSlc7vn-HTd7h	Isometric drawings in AutoCAD
11	https://www.youtube.com/watch?v=PHSmwXQriIc	Isometric drawings in AutoCAD

Note :

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

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ TC/ TE/ TR/ TX**
Semester	**: Third**
Course Title	**: ESSENCE OF INDIAN CONSTITUTION**
Course Code	**: 313002**

I. 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.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry /employer expected outcome – Abide by the Constitution in their personal and professional life.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - List salient features and characteristics of the constitution of India.
- CO2 - Follow fundamental rights and duties as responsible citizen of the country.
- CO3 - Analyze major constitutional amendments in the constitution.
- CO4 - Follow procedure to cast vote using voter-id.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313002	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50

Total IKS Hrs for Sem. : 0 Hrs

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

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

Note :

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the meaning of preamble of the constitution. TLO 1.2 Explain the doctrine of basic structure of the constitution. TLO 1.3 List the salient features of constitution. TLO 1.4 List the characteristics of constitution.	**Unit - I Constitution and Preamble** 1.1 Meaning of the constitution of India. 1.2 Historical perspectives of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble of the Constitution of India.	Presentations Blogs Hand-outs Modules Flipped classrooms Case studies

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Enlist the fundamental rights. TLO 2.2 . Identify fundamental duties in general and in particular with engineering field. TLO 2.3 Identify situations where directive principles prevail over fundamental rights.	**Unit - II Fundamental Rights and Directive Principles** 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance under part-IV-A. 2.3 Relevance of Directive Principles of State Policy under part-IV A.	Presentations Blogs Hand-outs Modules Case Study Flipped Classroom
3	TLO 3.1 Enlist the constitutional amendments. TLO 3.2 Elaborate the elements of Centre-State Relationship TLO 3.3 Analyze the purposes of various amendments.	**Unit - III Governance and Amendments** 3.1 3.1 Amendment procedure of the Constitution and their types - simple and special procedures. 3.2 The Principle of Federalism and its contemporary significance along with special committees that were setup. 3.3 Major Constitutional Amendment procedure - 1st, 7th, 42nd, 44th, 73rd & 74th, 76th, 86th, 52nd & 91st, 102nd	Cases of Federal disputes with relevant Supreme court powers and Judgements Presentations Blogs Hand-outs Problem based learning
4	TLO 4.1 Explain the importance of electoral rights. TLO 4.2 Write the step by step procedure for process of registration TLO 4.3 Explain the significance of Ethical electoral participation TLO 4.4 Explain the steps to motivation and facilitation for electoral participation TLO 4.5 Enlist the features of the voter's guide TLO 4.6 Explain the role of empowered voter TLO 4.7 Write the steps of voting procedure TLO 4.8 Write steps to create voter awareness TLO 4.9 Fill the online voter registration form TLO TLO 4.10 Follow procedure to cast vote using voter-id.	**Unit - IV Electoral Literacy and Voter's Education** 4.1 Electoral rights , Electoral process of registration 4.2 Ethical electoral participation 4.3 Motivation and facilitation for electoral participation 4.4 Voter's guide 4.5 Prospective empowered voter 4.6 Voting procedure 4.7 Voter awareness 4.8 Voter online registration https:/ /www.ceodelhi.gov.in/ELCdetails.aspx	Presentations Hand-outs Modules Blogs Problem based Learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

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

Assignment

- Outline the procedure to submit application for Voter-id
- Assignments are to be provided by the course teacher in line with the targeted COs.

A1. Prepare an essay on Constitution of India .
A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA

- Assignments are to be provided by the course teacher in line with the targeted COs. A1. Prepare an essay on Constitution of India . A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA A3. Self-learning topics: Parts of the constitution and a brief discussion of each part Right to education and girl enrollment in schools. GER of Girls and Boys. Right to equality. Social Democracy. Women Representation in Parliament and State Assemblies. LGBTQIA+

Micro project

- 1. Organize a workshop-cum discussions for spreading awareness regarding Fundamental Rights of the citizen of the country

2. Prepare elaborations where directive principle of State policy has prevailed over Fundamental rights with relevant Supreme Court Judgements.
3. Organize a debate on 42nd, 97th and 103rd Constitutional Amendment Acts of Constitution of India.

Seminar

- 1 Differences in the ideals of Social democracy and Political democracy.

2 Democracy and Women's Political Participation in India.
3 Khap Panchayat - an unconstitutional institution infringing upon Constitutional ethos.
4 Situations where directive principles prevail over fundamental rights.

Group discussions on current print articles.

-

- Art 356 and its working in Post-Independent India.
- Women's Resrvation in Panchayat leading to Pati Panchayats - Problems and Solutions.
- Adoption of Article 365 in India.
- Need of Amendments in the constitution.
- Is India moving towards a Unitary State Model ?

Activity

- Arrange Mock Parliament debates.

Prepare collage/posters on current constitutional issues.
i. National (Art 352) & State Emergencies (Art 356) declared in India.
ii. Seven fundamental rights.
iii. Land Reforms and its effectiveness - Case study of West-Bengal and Kerala.

Cases: Suggestive cases for usage in teaching:

- 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."
Other cases:
1. Kesavananda Bharati Case (1973) : In this case the Hon. SC laid down a new doctrine of the 'basic structure' (or 'basic features') of the Constitution. It ruled that the constituent power of Parliament under Article 368 does not enable it to alter the 'basic structure' of the Constitution. This means that the Parliament cannot abridge or take away a Fundamental Right that forms a part of the 'basic structure' of the Constitution.
2. Mathura Rape Case(1979) : A tribal woman Mathura (aged 14 to 16 years) was raped in Police Custody. The case raised the questions on the idea of 'Modesty of Woman' and here it was was a tribal woman who succumbs to multiple pattiarchies. Custodial rape was made an offence and was culpable with the detainment of 7 years or more under Section 376 of Indian Penal Code. The weight of proofing the allegations moved from the victim to the offender, once sexual intercourse is established. The publication of the victim's identity was banned and it was also held that rape trials should be conducted under the cameras.
3. Puttswamy vs Union of India (2017) : In this landmark case which was finally pronounced by a 9-judge bench of the Supreme Court on 24th August 2017, upholding the fundamental right to privacy emanating from Article 21. The court stated that Right to Privacy is an inherent and integral part of Part III of the Constitution that guarantees fundamental rights. The conflict in this area mainly arises between an individual's right to privacy and the legitimate aim of the government to implement its policies and a balance needs to be maintained while doing the same.
4. Navtej Singh Johar & Ors. v. Union of India (2018) : Hon. SC Decriminalised all consensual sex among adults, including homosexual sex by scrapping down section 377 of the Indian penal code (IPC). The court ruled that LGBTQ community are equal citizens and underlined that there cannot be discrimination in law based on sexual orientation and gender.
5. Anuradha Bhasin Judgement (2020) : The Supreme Court of India ruled that an indefinite suspension of internet services would be illegal under Indian law and that orders for internet shutdown must satisfy the tests of necessity and proportionality. The Court reiterated that freedom of expression online enjoyed Constitutional protection, but could be restricted in the name of national security. The Court held that though the Government was empowered to impose a complete internet shutdown, any order(s) imposing such restrictions had to be made public and was subject to judicial review.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Constitution and Preamble	CO1	4	0	0	0	0
2	II	Fundamental Rights and Directive Principles	CO2	4	0	0	0	0
3	III	Governance and Amendments	CO3	4	0	0	0	0
4	IV	Electoral Literacy and Voter's Education	CO4	3	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assignment, Self-learning and Terms work Seminar/Presentation

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	P.M.Bakshi	The Constitution of India	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105 (Check the new edition)
2	D.D.Basu	Introduction to Indian Constitution	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X

Sr.No	Author	Title	Publisher with ISBN Number
3	B. K. Sharma	Introduction to Constitution of India	PHI, New Delhi, 6thedition, 2011, ISBN:8120344197
4	MORE READS :	Oxford Short Introductions - The Indian Constitution by Madhav Khosla. The Indian Constitution: Cornerstone of a Nation by Granville Austin. Working a Democratic Constitution: A History by Garnville Austin Founding Mothers of the Indian Republic: Gender Politics of the Framing of the Constitution by Achyut Chetan. Our Parliament by Subhash C. Kashyap. Our Political System by Subhash C. Kashyap. Our Constitution by Subhash C. Kashyap. Indian Constitutional Law by Rumi Pal.	Extra Read
5	B.L. Fadia	The Constitution of India	Sahitya Bhawan,Agra, 2017, ISBN:8193413768

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.legislative.gov.in/constitution-of-india	Constitution overview
2	https://en.wikipedia.org/wiki/Constitution_of_India	Parts of constitution
3	https://www.india.gov.in/my-government/constitution-india	Constitution overview
4	https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/	Fundamental rights and duties
5	https://main.sci.gov.in/constitution	Directive principles
6	https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf	Parts of constitution
7	https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm	Parts of constitution
8	https://constitutionnet.org/vl/item/basic-structure-indian-constitution	Parts of constitution

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