GANPAT UNIVERSITY

FACULTY OF DIPLOMA ENGINEERING

Programme	Mechatronics Engineering				
Semester	II		Version	1.0.0.0	
Effective from Academic Year	2025-26		Effective for the batch Admitted in		JULY 2025
Course code	1MC2102	Course Name	Mechanics of Solid		

I.TEACHING-LEARNING AND ASSESSMENT SCHEME

Course Type	Course Code	Learning Scheme						Assessment Scheme											
		Actual Contact Hrs./Week			SLH	NLH	Credits	Theory				Practical				Based on SL		Total Marks
		CL	TL	LL				FA-TH	SA-TH	TOTAL		FA-PR	SA-PR	TOTAL		SLA		
								MAX	MAX	MAX	MIN	MAX	MAX	MAX	MIN	MAX	MIN	
DSC	1MC2102	3	-	2	1	6	3	40	60	100	40	30	20	50	20	20	8	170

Abbreviation:	**CL-** Classroom Learning	**TL -** Tutorial Learning	**LL -** Laboratory Learning
	SLH - Self Learning Hours	**NLH -** Notional Learning Hours	**SLA -** Self Learning Assessment
	FA - Formative Assessment (Term work +Mid Sem Exam +Attendance)		**SA -** Summative Assessment

II. PRE-REQUISITES

Zeal to learn.

III. INDUSTRY / EMPLOYER EXPECTED OUTCOMES

Apply basic mechanics principles to analyse and solve engineering problems in manufacturing, construction, automotive, and maintenance sectors. Interpret and use engineering drawings, force diagrams, and free-body diagrams for practical applications. Perform accurate measurements and calculations related to force, stress, strain, torque, moment of inertia, and power transmission. Select and justify suitable materials, machine components, and lifting devices based on mechanical analysis and safety considerations. Work effectively in multidisciplinary teams to address practical engineering challenges using applied mechanics concepts.

IV. COURSE LEARNING OUTCOMES

At the end of the course, students will be able to achieve the following course learning outcomes:

CO1: Understand fundamental concepts of mechanics, applied mechanics, statics, dynamics, force systems, and their practical significance.

CO2: Resolve forces, determine resultants, and analyse conditions of equilibrium for different force systems.

CO3: Determine centroid and centre of gravity of simple and composite geometrical figures and solids.

CO4: Analyse simple stresses, strains, and related elastic properties under various loading conditions.

CO5: Calculate moment of inertia for standard and composite sections using applicable theorems.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:

Name of Unit	Theory Learning outcomes (TLO's) aligned to CO's	Learning Content mapped with Theory Learning outcomes (TLO's) & CO's	Marks	Hours
Unit-1: Basics of Mechanics	**TLO 1.1** Explain significance of mechanics, applied mechanics, statics, and dynamics. **TLO 1.2** Define space, time, mass, particle, flexible body, and rigid body. **TLO 1.3** Differentiate scalar and vector quantities; state SI fundamental and derived units.	**1.1** Significance and relevance of Mechanics, Applied mechanics, Statics, Dynamics. Space, time, mass, particle, flexible body and rigid body. **1.2** Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units.	5	3

	TLO 1.4 Define force, its units, characteristics, and effects; represent force using vector and Bow's notation. **TLO 1.5** State and apply principles of transmissibility and superposition of forces. **TLO 1.6** Classify force systems with suitable examples.	**1.3** Force – unit, representation as a vector and by Bow's notation, characteristics and effects of a Force. **1.4** Principle of transmissibility of force, Principle of Superposition **1.5** Force system and its classification.		
Unit-2: Coplanar Concurrent Forces	**TLO 2.1** Resolve a given force into orthogonal components. **TLO 2.2** Explain equilibrium, equilibrant, free body, and draw free body diagrams; state conditions of equilibrium. **TLO 2.3** Determine the resultant of concurrent forces using analytical and graphical methods (Parallelogram, Triangle, and Polygon laws). **TLO 2.4** State and apply Lami's theorem to solve simple engineering problems.	**2.1** Resolution of a force - Orthogonal components of a force **2.2** Equilibrium and Equilibrant, Free body and Free body diagram, conditions of equilibrium, **2.3** Resultant of forces using analytical and graphical methods for the forces acting at a point: 1. Law of Parallelogram 2. Law of triangle 3. Law of Polygon **2.4** Lami's Theorem – statement and explanation, Application for various engineering problems.	12	8
Unit-3: Centroid & Centre of Gravity	**TLO 3.1** Explain the concept of centroid and centre of gravity. **TLO 3.2** Define axis of reference and axis of symmetry**.** **TLO 3.3** Determine centroid of one-dimensional figures using the principle of moments. **TLO 3.4** Calculate centroid of two-dimensional plane figures and simple composite figures using the first moment of area. **TLO 3.5** Calculate centre of gravity of simple solids and composite solids using the first moment of mass.	**3.1** Concept of Centroid, Centre of Gravity. **3.2** Axis of reference and Axis of Symmetry. **3.3** Centroid of One-Dimensional geometrical figures using principle of moment. **3.4** Centroid of Two-Dimensional geometrical Plane figures (Square, Rectangle, Triangle, Circle, Semi-circle, Quarter-circle) & Composite figures (not more than three figures) using first moment of area. **3.5** Centre of Gravity of Simple solids (Cube, Cuboid, Cone, Cylinder, Sphere, Hemisphere) & Composite solids (not more than two solids) using first moment of mass.	10	7
Unit-4: Direct Stress and Strain	**TLO 4.1** Define direct stress, linear strain, elasticity, elastic limit, Hooke's law, Young's modulus; interpret stress–strain curve for mild steel. **TLO 4.2** Explain lateral stress, lateral strain, Poisson's ratio, volumetric strain, bulk modulus,	**4.1** Direct stress, Linear strain, Elasticity, Elastic limit, Hook's law, Modulus of Elasticity or Young's modulus, Stress Strain curve for mild steel bar under tension with numerical problems.	10	7

	relation between elastic moduli; define shear stress, shear strain, and modulus of rigidity. **TLO 4.3** Explain composite and compound sections, define modular ratio, and solve related problems. **TLO 4.4** Explain thermal stress and strain, and calculate thermal stresses for yielding and non-yielding conditions. **TLO 4.5 Explain** stresses due to gradual, sudden, and impact loads; define strain energy, resilience, proof resilience, and modulus of resilience, with numerical applications.	**4.2** Lateral stress and strain, Poisson's ratio, Volumetric strain, Bulk modulus, relation between three moduli and numerical. Basics Concepts of Shear Stress, Shear Strain & Modulus of rigidity. **4.3** Concept of composite and compound section, modular ratio and numerical. **4.4** Concept of Thermal stress and strain, Thermal stresses for non-yielding and yielding condition with numerical. **4.5** Stresses due to gradual, sudden and impact load, corresponding deformation, Strain energy, Resilience, Proof resilience and Modulus of resilience with numerical.		
Unit-5: Moment of Inertia	**TLO 5.1** Explain the concept and importance of moment of inertia in engineering applications. **TLO 5.2** Define section modulus, radius of gyration, and polar moment of inertia. **TLO 5.3** State and apply the parallel axis theorem and perpendicular axis theorem. **TLO 5.4** Recall formulas for moment of inertia of basic geometrical shapes (solid and hollow rectangle, square, circle, triangle). **TLO 5.5** Calculate moment of inertia of symmetrical and asymmetrical sections (I, channel, T, angle, hollow, built-up) about centroidal and other reference axes using the parallel axis theorem.	**5.1** Concept and Importance of Moment of Inertia. **5.2** Concept of Section modulus, Radius of gyration, Polar moment of Inertia. **5.3** Parallel Axis Theorem & Perpendicular Axis Theorem **5.4** Formulas to calculate Moment of Inertia of solid and hollow rectangle, square, circle, triangle shapes (without derivations). **5.5** Moment of Inertia of symmetrical and asymmetrical I-section, Channel section, T-section, Angle section, Hollow sections and Built-up sections about Centroidal axis and any other reference axis using Parallel axis theorem.	8	6
Unit-6: Torsion	**TLO 6.1** Define torque (turning/twisting moment), angle of twist, shear stress in shafts, strength of shafts, polar moment of inertia, torsional rigidity, and state assumptions in torsion theory. **TLO 6.2** State the torsion equation (without derivation) and solve related numerical problems.	**6.1** Torque or turning moment or twisting moment, Angle of twist, Shear stress in shaft, strength of shafts, Polar moment of inertia, Torsional rigidity, assumptions in the theory of torsion. **6.2** Equation of Torsion (without derivation) and related numerical.	7	5

	TLO 6.3 Explain and apply the relationship between horsepower (H.P.), torque, and RPM with numerical applications.	**6.3** Relationship of H.P., Torsion and RPM and related numerical		
Unit-7: Simple Lifting Machine:	**TLO 7.1** Describe the components of a given lifting machine. **TLO 7.2** Calculate mechanical advantage, velocity ratio, efficiency, and law of simple lifting machines. **TLO 7.3** Differentiate between reversible and irreversible machines. **TLO 7.4** Select an eco-friendly lifting machine for a given purpose with proper justification.	**7.1** Describe the components of the given lifting machine. **7.2** Determine mechanical advantage, velocity ratio, efficiency and law of the given simple lifting machines. **7.3** Compare reversible & irreversible machines. **7.4** Select the relevant eco-friendly lifting machine required for the given purpose with justification.	4	5
Unit-8: Mechanical Properties and Tests on Metals:	**TLO 8.1** Classify engineering materials into metals, non-metals, polymers, ceramics, and composites. **TLO 8.2** Define and explain physical properties of materials such as elasticity, plasticity, ductility, brittleness, malleability, fatigue, creep, toughness, and hardness. **TLO 8.3** Describe and perform standard tests for impact value (Izod and Charpy) and hardness (Brinell and Rockwell). **TLO 8.4** Identify factors affecting selection of materials for different engineering applications.	**8.1** Classification of engineering materials. **8.2** Physical properties of material: Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness etc. **8.3** Testing of materials for impact value (Izod impact and Charpy impact test) and hardness (Brinell and Rockwell hardness test). **8.4** Factors affecting selection of materials.	4	4

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL

Sr. No.	Practical/Laboratory Learning Outcome (LLO)	Practical Titles	Relevant COs
1	**LLO 2.3** Law of Parallelogram (Analytical & Graphical)	Verify and calculate resultant force through Law of Parallelogram using analytical and graphical methods.	CO2
2	**LLO 2.3** Law of Triangle (Analytical & Graphical)	Verify Law of Triangle using analytical and graphical methods.	CO2
3	**LLO 2.3** Polygon Law of Forces (Analytical & Graphical)	Verify and calculate resultant force through Polygon Law of Forces using analytical and graphical methods.	CO2
4	**LLO 2.4** Lami's Theorem	Verify and calculate the value of unknown force through Lami's Theorem.	CO2
5	**LLO 3.3** Centroid of Lamina (Regular	Calculate Centroid of a lamina having regular and irregular shapes.	CO3

	& Irregular)		
6	**LLO 4.1** Tension Test & Stress–Strain Curve	Conduct tension test on a given sample of mild steel and draw stress strain curve.	CO3
7	**LLO 7.2** Velocity Ratio of Simple Lifting Machines	Verify and calculate theoretical and practical velocity ratios of any four simple lifting machines. (Simple wheel and axle, Differential axle and wheel, simple screw jack, worm and worm wheel. Single purchase crab, Double purchase crab)	CO4
8	**LLO 8.3** Compressive Strength Test — Cast Iron, Mild Steel, Wooden Specimens (parallel & perpendicular to grain)	Find out Compressive Strength of Cast Iron, Mild Steel, Wooden specimen with parallel & perpendicular to grains.	CO4
9	**LLO 8.3** Hardness Test — Brinell and Rockwell	Determine Brinell and Rockwell hardness of given materials.	CO5
10	**LLO 8.3** Izod Impact Test	Determine Izod impact value of given materials.	CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENTS / ACTIVITIES FOR SELF LEARNING / SKILL DEVELOPMENT (SELF LEARNING)

- Measure force using a spring balance and represent it with arrows.
- Draw free body diagrams of objects suspended by ropes and resolve forces into components.
- Find the centroid of cardboard shapes by balancing them on a knife edge.
- Stretch rubber bands with weights to observe elasticity and plot force vs. extension.
- Swing a ruler as a pendulum with added masses to understand moment of inertia.
- Build a simple pulley system to calculate mechanical advantage and efficiency.

VIII. LIST OF INSTRUMENTS / EQUIPMENT / TRAINER BOARD

1.	Apparatus for Law of Parallelogram.
2.	Universal Force table with all accessories
3.	Centre of Gravity apparatus, Gravimeter
4.	Universal Testing Machine (UTM)
5.	Simple wheel and axle, Differential axle and wheel Single and double purchase crab, simple screw jack, worm and worm wheel
6.	Izod Impact test Apparatus
7.	Charpy Impact test Apparatus
8.	Brinnel Hardness test Apparatus
9.	Measuring Tape / Steel Scale.
10.	Vernier Caliper / Micrometer.

IX. LIST OF REFERENCE BOOKS

Sr.No.	Title	Author	Publication
1.	Engineering Mechanics.	R. S. Khurmi S. Chand, New Delhi. (2019)	S. Chand, New Delhi. (2019) ISBN: 978-93-5283-396-2
2.	Engineering Mechanics	D.S. Kumar	S. K. Kataria & Sons, New Delhi (2021 reprint) ISBN: 978-93-5014-311-7
3.	EngineeringMechanic s7thedition	Bear & Johnston	New media-McGraw Hill (India), Noida (1999) ISBN: 978-00-7239-513-6

4.	Applied Mechanics	Dr. H. J. Shah& S. B. Junnarkar	CHAROTAR Publication, Anand(2013) ISBN:978-93-803-5861-1
5.	Engineering Mechanics	D. S. Bedi	Khanna Publications, New Delhi(2019) ISBN:978-93-861-7326-3
6.	Applied Mechanics	R. S. Khurmi N. Khurmi	S. Chand & Co. Ltd, New Delhi (2018) ISBN: 978-8121916431
7.	Strength of Material (Part-I & II)	Stephen Timoshenko	CBS Publishers & Distributors Pvt. Ltd., New Delhi (3rd Edition) ISBN: 978-0898746211
8.	Strength of Materials	Dr. B. C. Punmia Er. Ashok Kr. Jain Dr. Arun Kumar Jain	Laxmi Publications, New Delhi (2019) ISBN: 978- 8131809259

X. LINK OF LEARNING WEB RESOURCE	
1.	https://nptel.ac.in/
2.	https://swayam.gov.in/
3.	https://www.asme.org/
4.	https://www.astm.org/
5.	https://www.ansi.org/
6.	https://www.edx.org/
7.	https://www.howstuffworks.com/
8.	https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
9.	http://icrank.com/cgi-bin/pageman/pageout.cgi?path=%2Findex_html.html
10.	https://www.matweb.com/
11.	https://www.engineeringtoolbox.com/
12.	https://www.coursera.org/learn/engineering-mechanics-statics

XI. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	Basics of Mechanics	CO1	3	2	1	2	5
2	Coplanar Concurrent Forces	CO2	8	2	4	6	12
3	Centroid & Centre of Gravity	CO3	7	2	3	5	10
4	Direct Stress and Strain	CO4	7	2	3	5	10
5	Moment of Inertia	CO5	6	2	3	3	8
6	Torsion	CO4	5	2	2	3	7
7	Simple Lifting Machines	CO5	5	1	2	1	4
8	Mechanical Properties & Tests on Metals	CO5	4	2	1	1	4
		Grand Total	**45**	**15**	**19**	**26**	**60**

XII. COs AND POs AND PSOs MAPPING

Course outcome (Cos)	**Programme Outcomes (POs)**							**Programme Specific Outcomes (PSOs)**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	2	2	3	2	2
CO2	3	3	2	3	1	2	2	3	3	2
CO3	3	3	3	3	1	2	2	3	3	2
CO4	3	3	3	3	1	3	2	3	3	3
CO5	3	2	2	3	2	3	3	3	3	3

Legends: - *3- High 2-Moderate/Medium 1-Slight/Low 0-None*