GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Mechanical Engineering / Mechanical Engineering (CAD/CAM) / Mechatronics Engineering

Course/Subject Code: DI03000201

Course/Subject Name: Basics of Applied Mechanics

w.e.f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	ESC

Prerequisite:	Basic knowledge of Laws and Principles of Mathematics and Physics.
Rationale:	The primary purpose of the study of Basics of Applied Mechanics is to develop the capacity to predict the effects of force while carrying out the creative design functions of engineering. This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. The course addresses the modelling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving. It bridges the gap between physical theory and its application to technology. This course also deals with the behavior of solid materials by studying the distribution of internal forces, the stability and deformation of the materials under the applied loads or forces. To choose proper material by keeping its strength and suitability in mind is very important stage in production and design level in the field of Mechanical Engineering. Hence the course is prerequisite for understanding principles of machine design at various levels.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Identify the force systems for given conditions by applying the basics of mechanics and study coplanar concurrent and non-concurrent forces.
02	Find the Centroid and Centre of gravity of various components in engineering Systems.
03	Analyze structural behaviour of various materials under axial loading and study stress and strain under various types of loadings.
04	Determine Moment of inertia of a symmetrical and asymmetrical section about a given axis.
05	Determine stresses in the shaft and apply the basics for relevant simple machines for given purposes

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial/ Practical		
L	T	PR	C	ESE (E)	PA(M)	PA (I)	ESE (V)	
2	0	2	3	70	30	20	30	150

Legends: ***L****-Lecture;* ***T*** *- Tutorial/Teacher Guided Theory Practice;* ***P****- Practical;* ***C*** *- Credit,* ***CA*** *- Continuous Assessment;* ***PA*** *-Progressive Assessment,* ***ESE*** *-End Semester Examination.*

Course Content:

Unit No.	Content	No. of Hours	%of Weightage
1.	**Basics of Mechanics:** 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. 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.	02	06
2.	**Coplanar Concurrent Forces:** 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.	06	19
3.	**Centroid & Centre of Gravity:**	04	13

	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.		
4.	**Direct Stress and Strain:** 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. 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.	06	19
5.	**Moment of Inertia:** 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.	04	13
6.	**Torsion:** 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.	04	11

	6.2 Equation of Torsion (without derivation) and related numericals. 6.3 Relationship of H.P., Torsion and RPM and related numericals		
7.	**Simple Lifting Machine:** 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.	04	11
8.	**Mechanical Properties and Tests on Metals:** 7.1. Classification of engineering materials. 7.2. Physical properties of material: Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness etc. 7.3. Testing of materials for impact value (Izod impact and Charpy impact test) and hardness (Brinell and Rockwell hardness test). 7.4. Factors affecting selection of materials.	**To be Covered in Laboratory**	08
	Total	30	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	30	50	--	--	--

WhereR:Remember;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asper Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Mechanics	R. S. Khurmi	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 s7th edition	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	Applied Mechanics	S. B. Junnarkar, Dr. H. J. Shah	Charotar *Publishing* House Pvt. Ltd., Anand (2015) ISBN: 978-9385039065
8	Strength of Material (Part-I & II)	Stephen Timoshenko	CBS Publishers & Distributors Pvt. Ltd., New Delhi (3rd Edition) ISBN: 978-0898746211
9	Strength of Materials	Dr. B. C. Punmia Er. Ashok Kr. Jain Dr. Arun Kumar Jain	Laxmi Publications, New Delhi (2019) ISBN: 978- 8131809259
10	Strength of Materials (Mechanics of Solids)	R. S. Khurmi N. Khurmi	S. Chand Publishing (2019) ISBN:97-893-528-339-79
11	Strength of Materials	Dr . R. K. Bansal	Laxmi Publications (P) Ltd. NewDelhi(2005) ISBN:97-881-700-814-70
12	Strength of Materials	S. Ramamrutham& R. Narayanan	Dhanpat Rai Publishing Company(2011) ISBN:97-881-874-335-45
13	Strength of Materials (Mechanics of Materials)	R. S. Laheri A. S. Laheri	S.K. Karatia & Sons, Delhi. (2010) ISBN: 97-881-857-494-40

Open source software and website:

1. https://swayam.gov.in/
2. https://nptel.ac.in/
3. https://www.asme.org/
4. https://www.astm.org/
5. https://www.iso.org/home.html
6. https://www.ansi.org/
7. https://www.aws.org/home
8. https://www.edx.org/
9. http://www.efunda.com/home.cfm
10. https://www.howstuffworks.com/
11. https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
12. http://icrank.com/cgi-bin/pageman/pageout.cgi?path=%2Findex_html.html
13. https://www.matweb.com/
14. https://www.engineeringtoolbox.com/
15. https://www.coursera.org/learn/engineering-mechanics-statics

Suggested Course Practical List :If any

Sr. No.	Name of Practical	Unit No.	Approx. Hrs. required
1	Verify and calculate resultant force through Law of Parallelogram using analytical and graphical methods.	2	4
2	Verify Law of Triangle using analytical and graphical methods.	2	2
3	Verify and calculate resultant force through Polygon Law of Forces using analytical and graphical methods.	2	4
4	Verify and calculate the value of unknown force through Lami's Theorem.	2	2

5	Calculate Centroid of a lamina having regular and irregular shapes.	3	2
6	Conduct tension test on a given sample of mild steel and draw stress-strain curve.	4	4
7	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)	7	2
8	Find out Compressive Strength of Cast Iron, Mild Steel, Wooden specimen with parallel & perpendicular to grains.	8	4
9	Determine Izod impact value of given materials.	8	2
10	Determine Charpy impact value of given materials.	8	2
11	Determine Brinell and Rockwell hardness of given materials.	8	2
	Total Hrs.		**30**

List of Laboratory / Learning Resources Required:

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	Practical No.
1	Apparatus for Law of Parallelogram.	1, 2, 4
2	Universal Force table with all accessories.	3
3	Center of Gravity apparatus, Gravimeter etc.	5
4	Universal Testing Machine (UTM)	6, 8
5	Simple wheel and axle, Differential axle and wheel Single and double purchase crab, simple screw jack, worm and worm wheel.	7
6	Izod Impact test Apparatus	10
7	Charpy Impact test Apparatus	11
8	Brinnel Hardness test Apparatus	11

Suggested Project List:

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, in the fifth and sixth semesters, the number of students in the group should not exceed three. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about 14- 16 (fourteen to sixteen) student engagement hours during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare spreadsheet or computer program to calculate the resultant force by the law of parallelogram and the law of polygon.

b) Using Drafting software calculate graphically the resultant force by the law of parallelogram and the law of polygon for at least five different conditions.

c) Prepare a spreadsheet or computer program to find out reactions for at least five different loading conditions on a simply supported beam.

d) Prepare spreadsheet or computer program to calculate centroid and centre of gravity for different geometrical sections.

e) Compare coefficient of sliding Friction for different surfaces (Wood , Glass, Steel, plastic, wrought iron etc.) with & without lubricant

f) Compare a suitable simple lifting machine used in your daily life in your branch.

Suggested Activities for Students : If any

Other than the classroom and laboratory learning, following are the suggested studentrelated co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group andprepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect five different situations with photographs indicating concurrent, parallel, general force system in equilibrium.

b) Collect five different situations with photographs where law of moment plays an important role.

c) Prepare models in the form of geometrical figures and solids and locate centroid and centre of gravity of

them.
d) Prepare a chart for friction examples which you are facing in day to day life and also interpret whether it is useful and harmful.
e) Prepare a list with photographs of simple lifting machines used in your daily life in your branch.

Any Other (Suggested Special Instructional Strategies):

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course: a) Massive open online courses (MOOCs) may be used to teach various topics/sub topics. b) Guide student(s) in undertaking micro-projects. c) 'L' in section No. 4means different types of teaching methods that are to be employed by teachers to develop the outcomes. d) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature is to be given to the students for self-learning, but to be assessed using different assessment methods. e) With respect to section No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities. f) Guide students on how to address issues on environment and sustainability. g) Guide students for using data manuals.

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