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ENGINEERING MECHANICS **Course Code : 312312**

Programme Name/s	**: Automobile Engineering./ Agricultural Engineering/ Civil Engineering/ Chemical Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/**
Programme Code	**: AE/ AL/ CE/ CH/ CR/ CS/ LE/ ME/ MK/ MRT/ MY/ PG**
Semester	**: Second**
Course Title	**: ENGINEERING MECHANICS**
Course Code	**: 312312**

I. RATIONALE

The analysis of forces acting on various structural and machine components using principles of mechanics enable to fetch the relevant data for detailing with design of structure/machine. The analysis of forces helps to prevent the defects, errors and subsequent failures arising in such elements under the action of forces. This course is designed for diploma aspirants to acquire and apply the basic discipline knowledge to solve the practical problems related with the design and detailing of components related to civil, mechanical, agricultural engineering etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply the principles of engineering mechanics to solve the given engineering problem(s)

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select the suitable machine under given loading condition.
- CO2 - Analyze the given force system to calculate resultant force.
- CO3 - Determine unknown force(s) of given load combinations in the given situation.
- CO4 - Apply the laws of friction in the given situation.
- CO5 - Determine the centroid/centre of gravity of the given lamina.

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	
312312	ENGINEERING MECHANICS	EGM	DSC	3	1	2	2	8	4	3	30	70	100	40	25	10	-	-	25	10	150

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Total IKS Hrs for Sem. : 2 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 Identify the type of machine based on efficiency of machine. TLO 1.2 Calculate effort required and load lifted by the given simple lifting machine. TLO 1.3 Verify law of machine for the given loading condition. TLO 1.4 Determine effort required along with efficiency for given machine with varying velocity ratio.	**Unit - I Simple Lifting Machine** 1.1 Concept of simple lifting machine, load, effort, mechanical advantage, velocity ratio, efficiency of machines, reversible and non-reversible/self locking machines. (IKS*: Hand axe as wedge, Lever in battle, Inclined Plane for loading, Pulleys to lift water in irrigation) 1.2 Concept of ideal machine and its conditions, machine friction, ideal effort, ideal load, effort lost in friction and load lost in friction, maximum mechanical advantage and maximum efficiency. 1.3 Nature of graphs: Load vs. effort, load vs. ideal effort, load vs. MA, load vs. efficiency, Law of machine and its uses. 1.4 Velocity ratios of inclined plane, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston’s differential pulley block, geared pulley block, two sheave pulley block, three sheave pulley block.	Chalk-Board Video Demonstrations Presentations Demonstration Hands-on Case Study

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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 Describe the characteristics of given type of force. TLO 2.2 Calculate the moment of forces in a given force system. TLO 2.3 Suggest the suitable law for the analysis of given force system. TLO 2.4 Determine the components of given force. TLO 2.5 Calculate analytically the resultant of given force system. TLO 2.6 Calculate graphically the resultant of given force system	**Unit - II Analysis of Forces** 2.1 Introduction of Mechanics: Engineering Mechanics, Statics, Dynamics, Kinetics, Kinematics, concept of rigid body, Force: definition, unit, graphical representation, Bow's notation, characteristics,Types of force system 2.2 Moment of force: Definition, unit, sign conventions, couple and its properties. 2.3 Law related to forces: Law of transmissibility of force, Law of polygon of forces, Varignon's theorem of moments, Law of moment, Law of parallelogram of forces. (IKS*:Weighing scale in Mohenjodaro, Harappa) 2.4 Resolution of coplanar forces: orthogonal and non orthogonal components of a force. 2.5 Composition of coplanar forces using analytical method. Resultant of collinear, concurrent and non-concurrent force system. 2.6 Composition of coplanar forces using graphical method. Resultant of concurrent force system and parallel force system consisting of maximum four forces only.	Chalk-Board Video Demonstrations Collaborative learning Presentations Hands-on Case Study
3	TLO 3.1 Draw the Free Body Diagram for given loading in given situation. TLO 3.2 Determine the equilibrant of the given concurrent force system. TLO 3.3 Use Lami's theorem to determine the unknown forces causing equilibrium for given practical situation. TLO 3.4 Identify the type of loading and beam in a given structure. TLO 3.5 Determine analytically the reactions in the given type of beam.	**Unit - III Equilibrium of Forces** 3.1 Equilibrium and its conditions. 3.2 Equilibrant and relation with resultant, Equilibrant of concurrent force system. 3.3 Lami's Theorem and its applications, Concept of Free body diagram, (Problems having not more than two unknown.) 3.4 Types of supports: fixed, simple, hinged and roller. Types of beams: cantilever, simply supported, overhanging, continuous and fixed. Types of loads: vertical and inclined point load, uniformly distributed load (UDL). 3.5 Determination of Beam reactions using analytical method for cantilever, simply supported and overhanging beam subjected to vertical load, inclined load and uniformly distributed load (combination of any two types of loading).	Chalk-Board Video Demonstrations Presentations Site/Industry Visit Hands-on Case Study

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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 Determine friction force along with coefficient of friction for the given condition. TLO 4.2 Describe the conditions for friction for the give situation. TLO 4.3 Draw FBD and analyze it for equilibrium of bodies on inclined plane in the given situation. TLO 4.4 Draw free body diagram for showing forces acting on a ladder under given condition.	**Unit - IV Friction** 4.1 Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, and their relationship. 4.2 Equilibrium of bodies on level surface subjected to force (Pull and Push) parallel to plane and inclined to plane. 4.3 Equilibrium of bodies on inclined plane subjected to force parallel to the plane only. 4.4 Forces acting on ladder (only free body diagram, no numerical).	Chalk-Board Video Demonstrations Presentations Demonstration Case Study Hands-on
5	TLO 5.1 Determine the centroid of given plane figure. TLO 5.2 Determine the centroid of given composite figure. TLO 5.3 Determine center of gravity of given solid. TLO 5.4 Determine Centre of gravity of the given composite solid.	**Unit - V Centroid and Centre of Gravity** 5.1 Centroid of geometrical plane figures: square, rectangle, triangle, circle, semi-circle, quarter circle (IKS*: Archery arrowheads in Ramayana, Arch in archeological structures such as Mahal, Gol Gumbaz). 5.2 Centroid of composite figures such as L, T, I, C, Z sections consisting of not more than three simple figures. 5.3 Centre of Gravity of simple solids: cube, cuboid, cylinder, cone, sphere and hemisphere (no hollow solids). 5.4 Centre of Gravity of composite solids composed of not more than two simple solids.	Chalk-Board Demonstration Video Demonstrations Model Demonstration Hands-on Case Study

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the relevant component of IKS from the given content.	1	Collect the photographic information of Indian knowledge system (IKS) given in various unit	2	CO1 CO2 CO5
LLO 2.1 Use the Differential Axle & Wheel to calculate relevant parameters under different loading condition.	2	*Determine mechanical advantage and velocity ratio of differential axle and wheel for different loading conditions.	2	CO1
LLO 3.1 Use the worm and worm wheel to calculate relevant parameters under different loading condition.	3	Determine mechanical advantage and velocity ratio of worm and worm wheel for different loading conditions.	2	CO1
LLO 4.1 Use the single or Double purchase crab winch to calculate relevant parameters under different loading condition.	4	Determine mechanical advantage and velocity ratio of single or Double purchase crab winch for different loading conditions.	2	CO1
LLO 5.1 Use the simple screw jack to calculate relevant parameters under different loading condition.	5	*Determine mechanical advantage and velocity ratio of simple screw jack for different loading conditions.	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Use the Weston's differential pulley block to calculate relevant parameters under different loading condition.	6	Determine mechanical advantage and velocity ratio of Weston's differential pulley block for different loading conditions.	2	CO1
LLO 7.1 Use the geared pulley block to calculate relevant parameters under different loading condition.	7	Determine mechanical advantage and velocity ratio of geared pulley block for different loading conditions.	2	CO1
LLO 8.1 Use the two or three sheave pulley block to calculate relevant parameters under different loading condition.	8	Determine mechanical advantage and velocity ratio of two or three sheave pulley block for different loading conditions.	2	CO1
LLO 9.1 Use the universal force table to verify the law of polygon.	9	*Verify law of polygon of forces using Universal force table for given forces.	2	CO2
LLO 10.1 Use moment apparatus to verify the law of moment.	10	*Verify law of moment of forces using law of moment apparatus for given forces.	2	CO2
LLO 11.1 Use universal force table to verify the Lami's theorem.	11	*Verify the Lami's theorem using Universal force table apparatus for given forces.	2	CO3
LLO 12.1 Use the beam reaction apparatus to determine support reactions of the given simply supported beam.	12	*Determine support reactions of simply supported beam using beam reaction apparatus for given vertical loading.	2	CO3
LLO 13.1 Use the horizontal plane friction apparatus for the given body to calculate coefficient of friction.	13	*Determine coefficient of friction using friction apparatus for given block on horizontal plane.	2	CO4
LLO 14.1 Use the inclined plane friction apparatus for the given body to calculate coefficient of friction.	14	Determine coefficient of friction using friction apparatus for given block on inclined plane.	2	CO4
LLO 15.1 Prepare a simple paper model of the given lamina to determine its centroid.	15	*Verify centroid of given plane lamina of by making simple paper model.	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

- Collect photographs of specific simple lifting machine and relate these machines with the machines being studied and prepare models of simple lifting machines using tools in "MECHANO" and "MECHANIX"
- Prepare chart of types of forces showing real-life examples.
- Prepare chart or flex of laws related to engineering mechanics like law of moment, law of machine, law of parallelogram of forces, Varignon's theorem of moments etc.
- Prepare chart showing all types of beams having types of support (roller, hinged, fixed) with sketches and corresponding photographs of real-life examples.
- Prepare models of types of beam subjected to all loads (Point load, UDL, UVL, moment, couple) with sketches and

corresponding photographs of real-life examples.
• Prepare photographic chart showing real life examples of uses of friction on horizontal (walking, writing, etc.) and inclined plane (slider in gardens, loading of heavy material in trucks etc.).
• Collect minimum Ten sample of materials having different coefficient of friction.
• Prepare a chart showing comparison of centroid and center of gravity for square-cube, rectangle-cylinder, triangle-cone, circle-sphere, semicircle-hemisphere.
• Prepare a models of solids like square, rectangle triangle, circle, semicircle, cube, cuboid, cylinder, cone, sphere, hemisphere.

Assignment

- Solve the examples on calculation of values of MA, VR, Pi, Pf, Wi, Wf, law of machine etc. for given type of machine.
• Solve the examples on calculation of orthogonal or non-orthogonal components of a force.
• Solve the examples on calculation of moments of a force from given problem statement or figure.
• Solve the examples on calculation of resultant for given force system from given problem statement or figure.
• Solve the examples on calculation of unknown forces using Lamis theorem from given problem statement or figure.
• Solve the examples on calculation of support reactions of given beam from given problem statement or figure.
• Solve the examples on calculation of coefficient of friction, normal reaction, force required to pull or push the block for given case of frictional bodies (horizontal or inclined plane).
• Solve the examples on calculation of centroid of simple/composite plane figures from given problem statement or figure.
• Solve the examples on calculation of center of gravity for simple/composite solid bodies from given problem statement or figure.

Note :

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

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Simple axle and wheel (wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter .	1
2	Law of moment’s apparatus consisting of a stainless steel graduated beam 12.5 mm square in section, 1m long, pivoted at centre.	10,11
3	Beam Reaction apparatus (The apparatus is with two circular dial type 10 kg.)	15
4	Friction apparatus for motion along horizontal and inclined plane (base to which a sector with graduated arc and vertical scale is provided. The plane may be clamped at any angle up to 45 degrees. pan. Two weight boxes (each of 5 gm,10 gm, 2-20 gm, 2-50 gm, 2-100 gm weight)	16,17

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Models of geometrical figures.	18
6	Differential axle and wheel (wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter .	2
7	Worm and worm wheel (wall mounted unit with threaded spindle, load drum, effort wheel; with necessary slotted weights, hanger and thread)	3
8	Single Purchase Crab winch (Table mounted heavy cast iron body. The effort wheel is of C.I. material of 25 cm diameter mounted on a shaft of about 40mm dia. On the same shaft a geared wheel of 15 cm dia.	4
9	Double Purchase Crab winch (Having assembly same as above but with double set of gearing arrangement.)	5
10	Simple screw Jack (Table mounted metallic body , screw with a pitch of 5 mm carrying a double flanged turn table of 20 cm diameter.	6
11	Weston's Differential pulley block (consisting of two pulleys; one bigger and other smaller.	7
12	Weston's Differential worm geared pulley block (Consists of a metallic (preferably steel) cogged wheel of about 20 cm along with a protruded load drum of 10 cm dia. to suspend the weights of 10 kg, 20 kg-2 weights and a 50 kg weights)	8
13	Universal Force Table (Consists of a circular 40 cm dia. Aluminum disc, graduated into 360 degrees.) with all accessories.	9,14

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	Simple Lifting Machine	CO1	9	2	8	4	14
2	II	Analysis of Forces	CO2	13	2	4	12	18
3	III	Equilibrium of Forces	CO3	9	2	8	4	14
4	IV	Friction	CO4	7	2	4	6	12
5	V	Centroid and Centre of Gravity	CO5	7	2	4	6	12
Grand Total				**45**	**10**	**28**	**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, Oral Examination, Pen and Paper Test.

XI. SUGGESTED COS - POS MATRIX FORM

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	2	1	-	1			
CO2	2	2	1	2	1	-	1			
CO3	2	2	1	2	1	-	1			
CO4	2	2	2	2	1	-	1			
CO5	2	2	1	2	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	S. Ramamrutham	Engineering Mechanics	Dhanpat Rai Publishing Co. 2016 ISBN-13: 978-9352164271
2	R. S. Khurmi, N.Khurmi	Engineering Mechanics	S.Chand & Co. New Delhi 2018 ISBN: 978-9352833962
3	S. S. Bhavikatti	Engineering Mechanics	New Age International Private Limited ISBN: 978-9388818698
4	Dr. R. K. Bansal	Engineering Mechanics	Laxmi Publications ISBN 13: 9788131804094
5	D. S. Bedi, M. P. Poonia	Engineering Mechanics	Khanna Publishing ISBN-13:978-9386173263

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.engineersrail.com/simple-lifting-machine/	Introduction of simple lifting machine
2	https://youtu.be/JnYVz1TSmBQ	Law of machine and types of machines useful in industry.
3	https://youtu.be/vWXIQYRXewc	Introduction to engineering mechanics
4	https://www.youtube.com/watch?v=6u_rjLjv-MY&list=PLOSWwFV98r fKXq2KBphJz95rao7q8PpwT&index=3	Introduction of force system with examples
5	https://www.youtube.com/watch?v=Fudcc0JoXdo&list=PLOSWwFV98r fKXq2KBphJz95rao7q8PpwT&index=4	Resolution and composition of forces
6	https://youtu.be/iy8l6vUm0iw	System of Forces
7	https://www.youtube.com/watch?v=tM5hsUiNpGA	Calculation of beam reactions for various types of beams

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Sr.No	Link / Portal	Description
8	https://www.youtube.com/watch?v=RGT1g_lu440	Calculation of coefficient of friction for horizontal and inclined plane
9	https://youtu.be/L_ABGYA8HFA	Friction
10	https://youtu.be/ET3ioTDFpfA	Moment of Force
11	https://econtent.msbte.edu.in/econtent/econtent_home.php	Engineering Mechanics

Note :

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

MSBTE Approval Dt. 01/10/2024 **Semester - 2, K Scheme**