

Techno India NJR Institute of Technology



Course File

Engineering Mechanics (3CE3-04)

Session 2022-23

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(Assistant Professor)

Department of civil engineering



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

II Year - III Semester: B.Tech. (Civil Engineering)

3CE3-04: ENGINEERING MECHANICS

Credit: 2
2L+0T+0P

Max. Marks: 100 (IA:20, ETE:80)
End Term Exam: 2 Hours

SN	CONTENT	Hrs.
1	Introduction: objective, scope and outcome of the course.	1
2	Statics of particles and rigid bodies: Fundamental laws of mechanics, Principle of transmissibility, System of forces (conservative and non-conservative), Resultant force, Resolution of force, Moment and Couples, Resolution of a force into a force and a couple, Free body diagram, Equilibrium, Conditions for equilibrium, Lami's theorem.	4
3	Plane trusses: Types of structures, Trusses, Support Conditions, Types of Loadings, Classification of trusses, Determinacy of trusses, Basic assumptions of truss analysis (zero force member, tension or compression member), Method of joints, Method of sections.	4
4	Centroid & Moment of inertia (M.I.): Location of centroid, Moment of inertia (mass and area), Parallel axis and perpendicular axis theorems, M.I of composite section, M.I. of solid bodies, Polar moment of inertia, principle axis and principle moment of inertia.	4
5	Virtual work: Principle of Virtual Work, Active forces and active force diagram, Stability of equilibrium. Work, Energy and Power: Work of a force, weight and couple, Power, Efficiency, Energy, Kinetic energy of rigid body, Principle of work and energy, Conservation of energy.	4
6	Friction: Types of Friction, Laws of friction, Angle of friction, Angle of repose, Ladder, Wedge, Belt Friction.	2
7	Springs: Stiffness of springs, springs in series and parallel, Introduction to laminated plate springs, leaf spring, close coiled helical springs, open coiled springs.	2
8	Simple Stresses and Strains: Concept of stress and strain in three dimensions and generalized Hooke's law; Young's modulus, Shear stress, Shear strain, Modulus of rigidity, Complementary shear stress; Poisson's ratio, Volumetric strain, Bulk modulus, relation between elastic constants, Stress and strain thin cylinder and spherical cell under internal pressure.	7
TOTAL		28

India NJR Institute of Technology
Office of Dean Academic Affairs
Rajasthan Technical University, Kota
Dr. Pankaj Kumar Purohit
(Principal)

Course Overview:

Engineering Mechanics is the practical application of mechanics concerned with the behavior of bodies subjected to external forces or displacement. The main objective of this course to help student's development a thorough understanding of the theories and principle and thereby acquire analytical capability required to solve real life problems.

- a) Relevance to Branch: The subject has the significance to understand & develop intuitive understanding of the subject to present world engineering examples to give students a feel of how engineering mechanics is useful in engineering practices.
- b) Relevance to Society: Providing adequate information about the mechanics which are beneficial to the society development and comfort to the occupant.
- c) Relevance to self-knowledge: Understand concept of mechanical behavior of materials and calculations of same using appropriate equations.

Course Outcomes:

3CE3-04	Cognitive Level	
3CE3-04.1	Understand	Describe free body diagrams and Solve the resultant of forces and/or Moments.
3CE3-04.2	Apply	Apply laws of mechanics to determine efficiency of simple machines with Consideration of friction.
3CE3-04.3	Apply	Execute solutions for planar frames and analyses the motion.
3CE3-04.4	Apply	Apply Newton's laws and conservation laws to elastic collisions and motion of rigid bodies.
3CE3-04.5	Apply	Solve the centroid and second moment of area of sections.

Prerequisites:

1. To demonstrate knowledge of mathematics and mechanics with logics in resolution and composition of force systems
2. To demonstrate the ability to relate kinematics with kinetic questions on linear is placement, velocity and acceleration
3. To develop the confidence for self learning in application of equilibrium conditions for co-planar and non co-planar force system...
4. Correlate power; work and energy to solve practical problems.
5. Solve practical examples related to curvi linear motion.

Course Outcome Mapping with Program Outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO233.1	2	2	2	2	0	1	1	0	0	0	0	1	1	1	0
CO233.2	2	2	2	2	1	1	0	0	0	1	0	0	1	1	0
CO233.3	2	2	2	1	2	2	2	2	1	1	2	1	1	1	0
CO233.4	2	2	2	1	2	2	2	2	1	1	2	1	1	1	0
CO233.5	2	2	2	2	1	1	0	0	0	1	0	0	1	1	0
CO233 (AVG)	2	2	2	1.6	1.2	1.4	1	0.8	0.4	0.8	0.8	0.6	1	1	0

Course Coverage Module Wise:

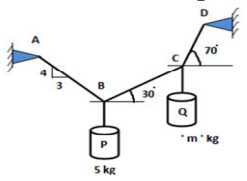
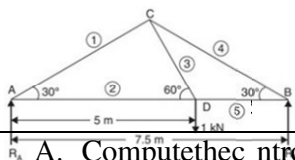
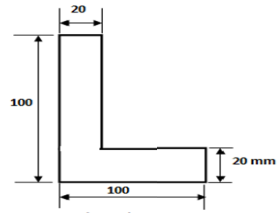
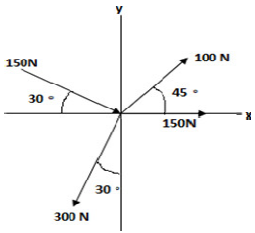
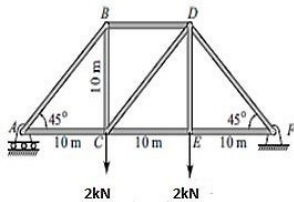
Lecture No.	Unit	Topic
1	1	INTRODUCTION: Objective, scope and outcome of the course.
2	2	Student should be able to understand Fundamental laws of mechanics, Principle of transmissibility
3	2	Student should be able to understand System of forces (conservative and non-conservative), Resultant force, Resolution of force
4	2	Student should be able to understand Moment and Couples, Resolution of a force in to a force and a couple
5	2	Student should be able to understand Free body diagram, Equilibrium, Conditions for equilibrium, Lami's theorem
6	3	Student should be able to understand Plane trusses: Types of structures, Trusses, support Conditions, Types of Loadings
7	3	Student should be able to understand Classification of trusses, Determinacy of trusses, Basic assumptions of truss analysis (zero force member, tension or compression member)

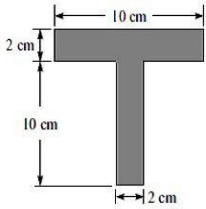
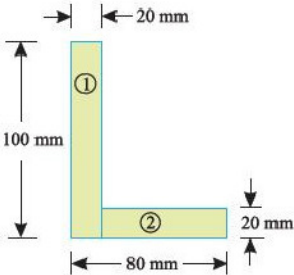
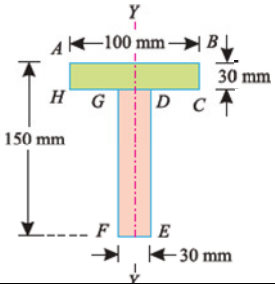
8	3	Student should be able to understand METHOD OF JOINTS
9	3	Student should be able to understand Method of sections
10	4	Student should be able to understand CENTROID & MOMENT OF INERTIA (M.I.): Location of centroid, Moment of inertia (mass and area)
11	4	Student should be able to understand Parallel axis and perpendicular axis theorems
12	4	Student should be able to understand M.I of composite section, M.I. of solid bodies
13	4	Student should be able to understand Polar moment of inertia, principle axis and principle moment of inertia.
14	5	Student should be able to understand Virtual work: Principle of Virtual Work, Active forces boundaries
15	5	Student should be able to understand Active force diagram, Stability of equilibrium
16	5	Student should be able to understand Work of a force, weight and couple, Power, Efficiency, Energy
17	5	Student should be able to understand Kinetic energy of rigid body, Principle of work and energy, Conservation of energy.
18	6	Student should be able to understand Types of Friction, Laws of friction, Angle of friction, Angle of repose
19	6	Student should be able to understand Ladder, Wedge, Belt Friction
20	7	Student should be able to understand Stiffness of springs, springs in series and parallel, Introduction to laminated plate springs.
21	7	Student should be able to understand Leaf spring, close coiled helical springs, open coiled springs.
22	8	Student should be able to understand Concept of stress and strain in three dimensions
23	8	Student should be able to understand generalized Hooke's law; Young's modulus
24	8	Student should be able to understand Shear Stress, Shear Strain
25	8	Student should be able to understand Modulus of rigidity, Complementary shear stress
26	8	Student should be able to understand Poisson's ratio, Volumetric strain, Bulk modulus
27	8	Student should be able to understand Relation between elastic constants
28	8	Student should be able to understand Stress and strain thin cylinder and spherical cell under internal pressure

TEXT/REFERENCE BOOKS

1. Vector Mechanics for Engineers, and Johnston, Tata McGraw-Hill.
2. Engineering Mechanics, Hibbeler, Pearson Education.
3. Engineering Mechanics, Meriam and Kraige, John Wiley & Sons.
4. Engineering Mechanics, Timoshenko and Young, Tata McGraw-Hill.
5. Engineering Mechanics, Shames, Pearson Education

Course Level Problems (Test Items):

CO.NO.	Problem description
1	<p>A. Explain various types of system of forces with suitable examples. B. In the figures shown below, masses P and Q are suspended with inelastic strings, and are in static equilibrium. Determine the mass of block Q.</p>  <p>C. Determine the support reactions and force in all members of the Truss shown below.</p> 
2	<p>A. Compute the centroid of the area shown in figure below and find moment of inertia of the area about horizontal axis passing through its centroid</p>  <p>B. State and prove law of parallelogram of forces C. Determine the magnitude and direction of the resultant of forces system shown in figure below.</p> 
3	<p>A. Determine the support reactions and forces in members AB, BD and CD, of the Truss shown below.</p>  <p>B. Compute the centroid of the area shown in figure below. Then find its</p>

	<p>moment of inertia about the horizontal centroidal axis. All dimensions in 'cm'.</p>  <p>C. Prove the parallel axis theorem for moment of inertia</p>
4	<p>A. Prove the perpendicular axis theorem for moment of inertia.</p> <p>A. Find the Centroid of following plane figures:-</p>  <p>B. Find the Centroid of following plane figures:-</p> 

Assessment Methodology:

1. Practical exam in lab where they have to analyze problem statement. (Once In a week)
2. Assignments one from each unit.
3. Midterm subjective paper based on topics as mentioned in the modules. (Twice during the semester)
4. Final paper attend of the semester subjective

Teaching and Learning resources unit-wise:

A. INTRODUCTION: Objective, scope and outcome of the course.

Video Tutorials:

https://youtu.be/Vb1aMHC1_BM

Theory concepts:

<https://pe.gatech.edu/courses/introduction-engineering-mechanics#:~:text=Engineers%20are%20the%20ultimate%20problem%20solvers.&text=It%20addresses%20the%20modeling%20and,and%20physics%20covering%20classical%20mechanics.>

Sample Quiz:

<https://jamdbokhtier.com/introduction-to-engineering-mechanics-quiz-answer/>

B. Plane Trusses and frame.

Video Tutorials:

<https://youtu.be/3-4wNORPjXY>

Theory concepts:

https://academic.csuohio.edu/duffy_s/511_07.pdf

Sample ppt:

<https://www.sanfoundry.com/engineering-mechanics-questions-answers-simple-trusses/>

C. Centroid and MOI.

Video Tutorials:

<https://youtu.be/TqOVBD4OrNo>

Theory concepts:

https://web.iit.edu/sites/web/files/departments/academic-affairs/academic-resource-center/pdfs/Moment_Inertia.pdf

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Centroid-Of-A-Body/8efd846d-d943-4906-8bcb-c9b6806a977b

D. Simple Stress and Strain

Video Tutorials:

https://youtu.be/KGCyT2oVa_A

Theory concepts:

<https://www.jntua.ac.in/gate-online-classes/registration/downloads/material/a158938439610.pdf>

Sample Quiz:

<https://testbook.com/objective-questions/mcq-on-simple-stress-and-strain--5eea6a0b39140f30f369de96>

E. Work energy and power

Video Tutorials:

<https://youtu.be/65Ytcr-KweQ>

Theory concepts:

<https://www.physicsclassroom.com/class/energy>

Sample Quiz:

<https://www.sparknotes.com/physics/workenergypower/review/quiz/>

F. Friction Video Tutorials:

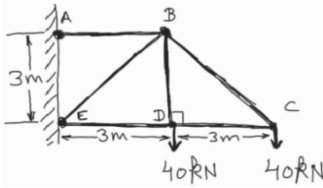
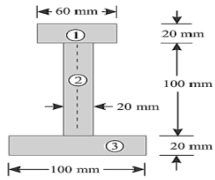
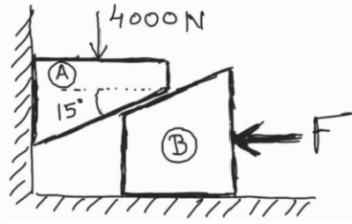
<https://youtu.be/4ygO9IonVKY>

Theory concepts:

<https://en.wikipedia.org/wiki/Friction>

SampleQuiz:https://www.ducksters.com/science/quiz/friction_questions.php

Important Question:

Q.No	Questions	CO
1.	<p>Find the forces in all members of the truss shown in figure below. Also state whether the forces are compressive or tensile in nature. Use method of joints.</p> 	
2.	<p>Find the moment of inertia of the sections shown in figure below, about the horizontal x-axis passing through its centroid. Given: considering the bottom edge of lamina as reference, the location of centroid is: $(\bar{y}) = 60.8 \text{ mm}$.</p> 	
3.	<p>A load of 4000 N is placed on wedge A (see figure given below). Find the force F (applied on wedge B) that is required to lift the loaded wedge A. Both the wedges have no weight of their own. The coefficient of friction on all surfaces is 0.2.</p> 	
4.	<p>The resultant of the two forces, when they act at an angle of 60° is 14 N. If the same forces are acting at right angles, their resultant is $\sqrt{136}$ N. Determine the magnitude of the two forces.</p>	

3E1213	Roll No. _____	Total No. of Pages : 2
3E1213		
B.Tech. III Sem. (Main) Examination, April/May - 2022		
Civil Engineering		
3CE3-04 Engineering Mechanics		

Time : 2 Hours

Maximum Marks : 70

Instructions to Candidates:

Attempt all ten questions from Part A. All five questions from Part B and three questions out of Five questions from Part C.

Schematic diagrams must be shown wherever necessary. Any data missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination.

(As Mentioned in form No. 205)

PART - A

(word limit 25)

(10×2=20)

1. Write down the expression of stiffness for spring.
2. Write the names of different types of friction.
3. State the Lami's theorem.
4. Write the conditions for equilibrium of a body.
5. What is the difference between close coiled helical springs and open coiled helical springs.
6. State the principle of virtual work.
7. What do you mean by complementary shear stress.
8. What is the value of poisson's ratio for mild steel.
9. What are the units of work done.
10. What are the various characteristics of a force?

PART - B

(word limit 100)

(5×4=20)

1. A load with as mass 5 kg was lifted up by a pulley to the height of 0.8 m for pile work. (Use, $g = 9.81 \text{ ms}^{-2}$). What is Potential Energy the load.
2. Explain Stress - Strain Curve of mild steel in tension showing its all principal points.

3E1213/2022

(1)

[Contd....

3. Two forces of 100 N and 150 N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45° ?
4. State and explain Newton's laws of mechanics.
5. Explain the method of sections and method of joints for plane truss.

PART - C

(Any three)

(3×10=30)

1. Four forces of magnitude P , $2P$, $3\sqrt{3}P$, and $4P$ are acting at a point O . The angles made by these forces with x - axis are 0° , 60° , 150° , and 300° respectively. Find the magnitude and direction of the resultant force.
2. Bring out the differences among perfect, deficient and redundant trusses.
3. Find the moment of inertia of a rectangular section 60 mm wide and 40 mm deep about its centre of gravity. <https://www.rtuonline.com>
4. A trolley of mass 200 kg moves on a level track for a distance of 500 metres. If the resistance of the track is 100 N, find the work done in moving the trolley.
5. A circular rod of diameter 16 mm and 500 mm long is subjected to a tensile force 40kN. The modulus of elasticity for steel is 200 kN/mm^2 . Find
 - i. Stresses.
 - ii. Strain.
 - iii. Elongation of the rod due to applied load.

