ENGINEERING MECHANICS

Subject Code : EE301ES

Regulations : R18 - JNTUH

Class : II Year B.Tech EEE I Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpatnam - 501 510, Hyderabad

ENGINEERING MECHANICS (EE301ES)

COURSE PLANNER

I. COURSE OVERVIEW:

Engineers are the ultimate problem solvers. This course introduces the principles required to solve engineering mechanics problems. It addresses the modeling and analysis of static equilibrium problems with an emphasis on real-world engineering applications and problem solving. To master this course, you should have a background in basic calculus and physics covering classical mechanics. Concepts will be applied in this course from previous courses you have taken in basic math and physics.

COURSE PURPOSE:

This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses you have taken in basic math and physics. The course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving.

II. PREREQUISITE(S): Nil

III. COURSE OBJECTIVES:

1. Explain the resolution of a system of forces, compute their resultant and solve problems using equations of equilibrium
2. Perform analysis of bodies lying on rough surfaces.
3. Locate the centroid of a body and compute the area moment of inertia and mass moment of inertia of standard and composite sections
4. Explain kinetics and kinematics of particles, projectiles, curvilinear motion, centroidal motion and plane motion of rigid bodies.
5. Explain the concepts of work-energy method and its applications to translation, rotation and plane motion and the concept of vibrations

IV. COURSE OUTCOME:

Sl. No.	Description	Bloom's Taxonomy level
CO1.	Determine resultant of forces acting on a body and analyze equilibrium of a body subjected to a system of forces.	**L4: Analyze**
CO2.	Solve problem of bodies subjected to friction.	**L4: Analyze**
CO3.	Find the location of centroid and calculate moment of inertia of a given section.	**L2: Understanding**
CO4.	Understand the kinetics and kinematics of a body undergoing rectilinear, curvilinear, rotatory motion and rigid body motion.	**L4: Analyze**
CO5.	Solve problems using work energy equations for translation, fixed axis rotation and plane motion and solve problems of vibration.	**L4: Analyze**

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignment / Exam
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	Assignment / Exam
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Assignment / Exam
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignment /Exams
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	Assignment /Exams
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	-
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	2	-
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	1	-
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Assignment /Exams
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Assignment /Exams
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	1	-
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Assignment /Exams

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Level	Proficiency assessed by
PSO1	The student will be able to apply the knowledge of Mathematics, Sciences and engineering fundamentals to formulate, analyze and provide solutions for the problems related to Mechanical engineering and communicate them effectively to the concerned.	3	Lectures, Assignments

PSO2	Design mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields by using various engineering/technological tools to meet the mercurial needs of the industry and society at large.	2	Lectures, Assignments
PSO3	The ability to grasp the latest development, methodologies of mechanical engineering and posses competent knowledge of design process, practical proficiencies, skills and knowledge of programme and developing ideas towards research.	1	Lectures, Assignments

VII. SYLLABUS (JNTUH)

UNIT - I

Introduction to Engineering Mechanics - Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

UNIT – II

Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Centroid and Centre of Gravity -Centroid of Lines, Areas and Volumes from first principle, Centroid of composite sections; Centre of Gravity and its implications. – Theorem of Pappus

UNIT – III

Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Product of Inertia, Parallel Axis Theorem, Perpendicular Axis Theorem Mass Moment of Inertia: Moment of Inertia of Masses - Transfer Formula for Mass Moments of Inertia – Mass moment of inertia of composite bodies.

UNIT – IV

Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).

UNIT – V

Kinetics of Rigid Bodies -Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work Energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

SUGGESTED BOOKS:

TEXT BOOK:

1. Shames and Rao (2006) , Engineering Mechanics, Pearson Education
2. Reddy Vijay Kumar K. and J. Suresh Kumar (2010), Singer's Engineering Mechanics – Statics & Dynamics

REFERENCES:

3. Timoshenko S.P and Young D.H., "Engineering Mechanics", McGraw Hill International Edition, 1983.

4. Andrew Pytel, Jaan Kiusalaas, "Engineering Mechanics", Cengage Learning, 2014.

5. Beer F.P & Johnston E.R Jr. Vector, "Mechanics for Engineers", TMH, 2004.

6. Hibbeler R.C & Ashok Gupta, “Engineering Mechanics”, Pearson Education, 2010.

7. Tayal A.K., “Engineering Mechanics – Statics & Dynamics”, Umesh Publications, 2011.

8. Basudeb Bhattacharyya, “Engineering Mechanics”, Oxford University Press, 2008.

9. Meriam. J. L., “Engineering Mechanics”, Volume-II Dynamics, John Wiley & Sons, 2008

GATE SYLLABUS:

Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

IES SYLLABUS:

Analysis of System of Forces, Friction, Centroid and Centre of Gravity, Dynamics; Stresses and Strains-Compound Stresses and Strains, Bending Moment and Shear Force Diagrams, Theory of Bending Stresses- Slope and deflection-Torsion, Thin and thick Cylinders, Spheres.

VIII. COURSE PLAN:

Lecture. No.	Topics to be covered	UNIT	Course Learning Outcomes	Teaching Methodology	REFERENCES
1	Introduction to Engineering Mechanics – Basic Concepts.	**1**	Define different types of force systems(L1)	Chalk and Talk	Text book 1,3
2	Resultants of Force System	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
3	Parallelogram law, Forces and components	**1**	Define Parallelogram law(L1)	Chalk and Talk	Text book 1,2
4	Resultant of coplanar Concurrent Forces	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
5	Components of forces in Space	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,3
6	Moment of Force - principle of moments – Coplanar Applications	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
7	Moment of Force - principle of moments – Coplanar Applications	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,3
8	Couples - Resultant of any Force System.	**1**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
9	Equilibrium of Force Systems	**1**	Explain about Equilibrium system (L1)	Chalk and Talk	Text book 1,3
10	Free Body Diagrams, Equations of	**1**	Understanding and applications(L2 and	Chalk and Talk	Text book 1

	Equilibrium		L3)		
11	Equilibrium of planar Systems - Equilibrium of Spatial Systems.	**1**	Understanding and applications(L2 and L3)	PPT	Text book 1
15	**FRICTION**: Introduction	**2**	Define Friction(L1)	Chalk and Talk	Text book 1,2
16	Theory of Friction	**2**	Explain about theory of friction (L1)	Chalk and Talk	Text book 1
17	Angle of friction - Laws of Friction	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
18	Static and Dynamic Frictions	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,2
19	Motion of Bodies: Wedge, Screw,	**2**	Explain about Wedge friction (L1)	Chalk and Talk	Text book 1
20	Screw-jack and Differential Screw-jack.	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
28	**CENTROIDS AND CENTERS OF GRAVITY**- Introduction	**2**	Define Centroids and Centre of gravity (L1)	Chalk and Talk	Text book 1,3
29	Centroids and Centre of gravity of simple figures	**2**	Understanding and applications(L2 and L3)	PPT	Text book 1
30	Centroids of Composite Figures -	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,2
31	Theorem of Pappus – Center of gravity of bodies and centroids of volumes.	**2**	Define Pappus theorem & application(L1 & L3)	Chalk and Talk	Text book 1
32	Moments of Inertia : Definition – Polar Moment of Inertia	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
33	Radius of gyration - Transfer formula for moment of inertia	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
34	Moments of Inertia for Composite areas - Products of Inertia	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,3
35	Transfer Formula for Product of Inertia. Mass Moment of Inertia : Moment of Inertia of Masses	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1

36	Transfer Formula for Mass Moments of Inertia	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
37	Mass moment of inertia of composite bodies.	**2**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
43	**Area moment of inertia**-Definition, Moment of inertia of plane sections from first principles	**3**	Define Area moment of inertia (L1)	Chalk and Talk	Text book 1,2
44	Theorems of moment of inertia	**3**	Explain about moment of inertia (L1)	PPT	Text book 1
45	Pappus Theorem and Problems	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
	Moment of Inertia-definition, parallel axis theorem	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,3
46	Perpendicular axis theorem.	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
47	Moment of inertia of basic fig -Triangle, Rectangle, Circular sec	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
	semicircular section and quarter circle	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1,3
48	Problems on Moment of inertia of composite sections	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
49	Moment of inertiaof Masses, transfer formula for mass moment of inertia	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
50	Mass Moment of inertia of composite bodies problems	**3**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1
56	**Review of particle dynamics**- Rectilinear motion	**4**	Define and Explain aboutRectilinear motion (L1)	Chalk and Talk	Text book 1, 7
57	Plane curvilinear motion (rectangular, path, and polar coordinates)	**4**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
58	3-D curvilinear motion	**4**	Explain about 3-D	PPT	Text book 1, 7

			curvilinear motion (L1)		
59	Relative and constrained motion	**4**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
60	Newton's 2nd law (rectangular, path, and polar coordinates).	**4**	Explain about Newton's 2nd law(L1)	Chalk and Talk	Text book 1, 7
61	Work-kinetic energy, power, potential energy	**4**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
62	Impulse-momentum - linear motion	**4**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
	Impulse-momentum - angular motion	**4**	Understanding and applications(L2 and L3)		Text book 1, 7
63	Impact (Direct and oblique)	**4**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
64	**Kinetics of Rigid Bodies -**Basic terms, general principles in dynamics	**5**	Define and Explain about Kinetics of Rigid Bodies (L1)	PPT	Text book 1, 7
65	Types of motion, Instantaneous centre of rotation in plane motion	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
66	simple problems on Instantaneous centre	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
67	D'Alembert's principle and its applications in plane motion and connected bodies	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
	Problems on D'Alembert's principle	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
68	Work Energy principle	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
69	Plane motion of connected bodies	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7
70	Kinetics of rigid body rotation	**5**	Understanding and applications(L2 and L3)	Chalk and Talk	Text book 1, 7

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	3	2	3	2	2	2	1	2	1
CO2	2	1	2	1	1	1	1	1	1	1	2	2	1	2	1
CO3	1	1	1	1	1	2	1	1	1	2	1	2	2	1	1
CO4	2	2	2	3	1	1	3	2	2	1	3	1	1	1	2
CO5	3	1	3	1	2	1	1	1	1	3	2	2	2	1	1

1: Slight (Low) **2: Moderate (Medium)** **3: Substantial (High)** **- : None**

X. QUESTION BANK: (JNTUH)

DESCRIPTIVE QUESTIONS:

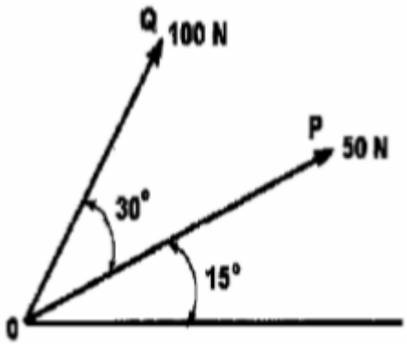
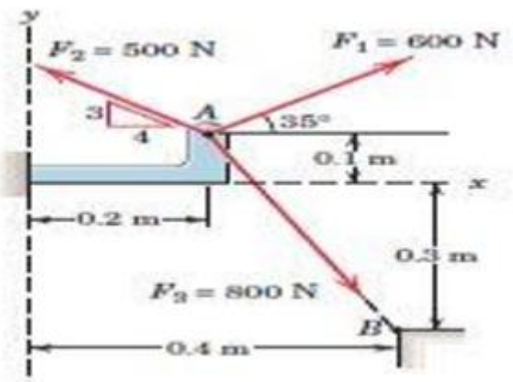
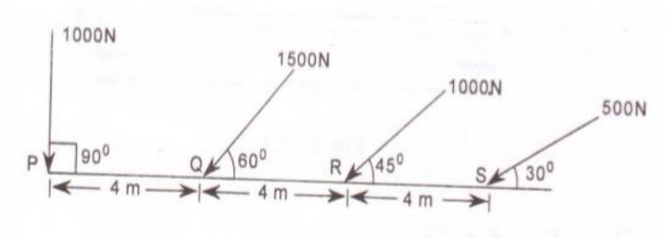
UNIT-I

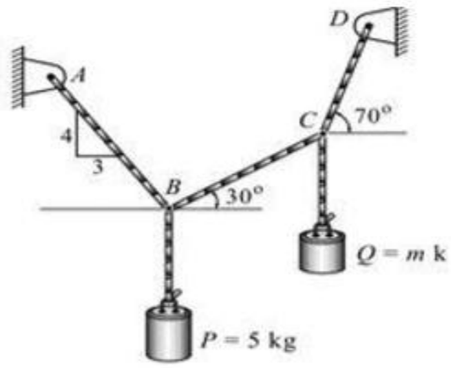
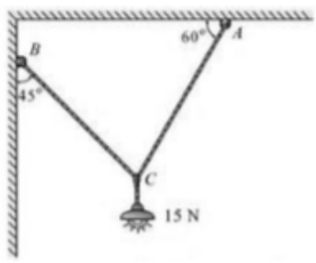
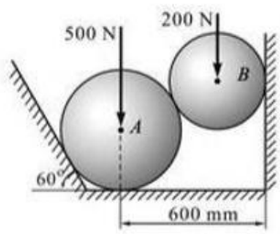
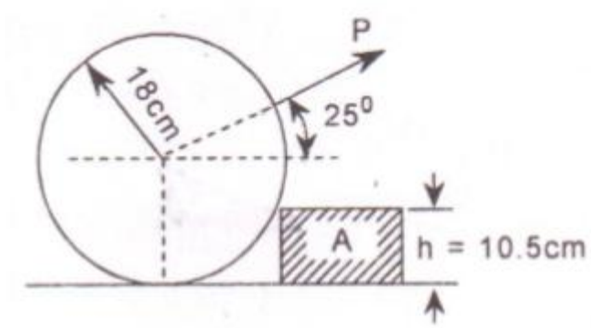
Short Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Define Engineering Mechanics.	L1	C01
2	Differentiate between kinetics and kinematics.	L1	C01
3	State the principle of Law of Transmissibility of forces.	L1	C01
4	Distinguish between coplanar forces and concurrent forces.	L2	C01
5	Write the conditions for equilibrium of a rigid body which is under coplanar non-concurrent system.	L1	C01

Long Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Two forces are acting at a point ‘O’ as shown in fig. below. Determine the magnitude and direction of resultant. And also find out the angle made by resultant with horizontal?	L1,L3	C01

			
2	Find the resultant of given system of forces as shown in figure below. 	**L1,L3**	**C01**
3	A horizontal rod of PQRS is 12 M long, where PQ = QR = RS = 4 m. Forces of 1000, 1500, 1000 and 500 N act at P, Q, R and S respectively and action of these forces make angles 900, 600, 450 and 300 respectively. Find out the magnitude, direction and position of the resultant of system. 	**L2**	**C01**
4	State and prove Lami's theorem?	**L2**	**C01**
5	a) State and prove parallel axis theorem? b) Four forces of magnitude 10kN, 15kN, 20kN and 40kN are acting at a point O as shown in figure 1. The angles made by 10kN, 15kN, 20kN and 40kN with x axis are 30', 45', 60' and 90' respectively. Find the magnitude and direction of resultant of force.	**L1,L3**	**C01**
6	The system show in fig is in equilibrium; find out the weight of block Q?	**L1,L3**	**C01**

			
7	An electric light 15 N hangs from a point 'C' by two strings AC and BC as shown in fig. Determine tensions developed in strings AC and BC? (TBC = 7.76 N, TAC = 10.98 N) 	**L1,L3**	**C01**
8	Find out reactions of system shown in fig. at each point of contact. Take radius of sphere A as 250 mm and B as 200 mm. 	**L1**	**C01**
9	The roller shown in fig weighs 340 N. What force P is necessary to start the roller over the block A. 	**L1,L3**	**C01**

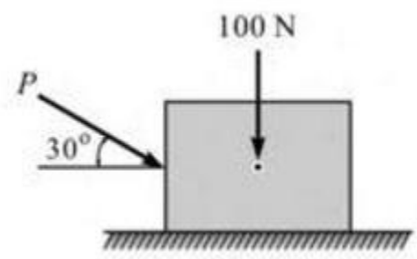
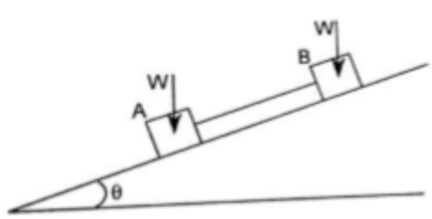
UNIT-2

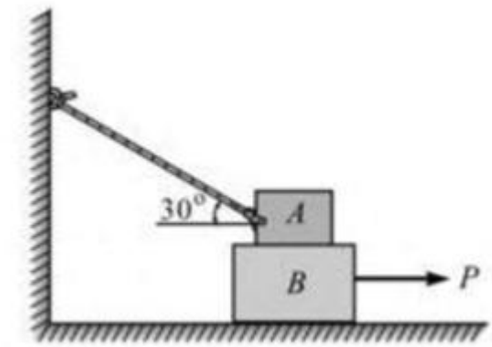
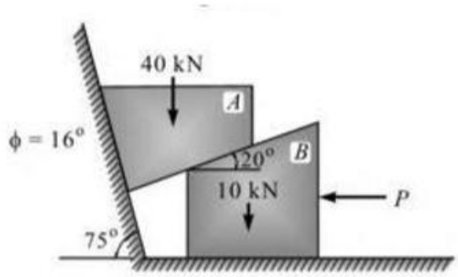
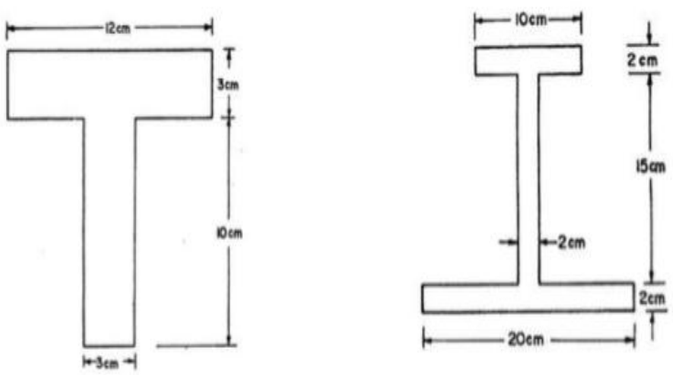
Short Answer Questions-

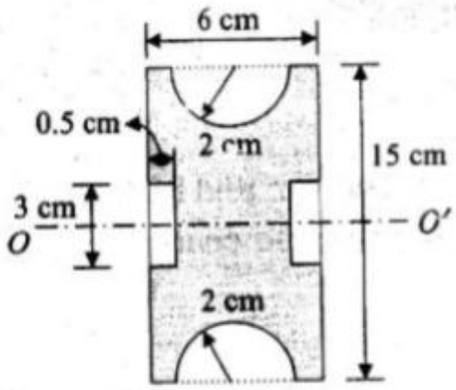
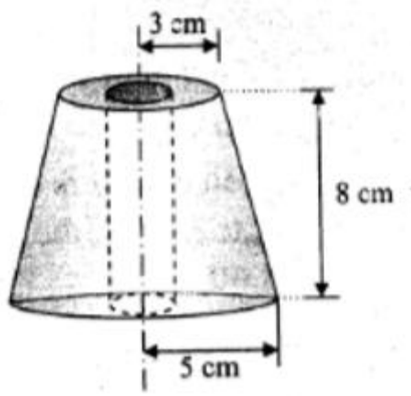
S.No	Question	Blooms	Course

			outcomes
1	Distinguish between coefficients of static friction and coefficient of dynamic friction.	**L2,L1**	**C03**
2	Define the term Friction.	**L2**	**C03**
3	Define the following terms: A) angle of friction B) angle of repose C) impending motion	**L1**	**C03**
4	Differentiate between centroid and centre of gravity	**L2**	**C03**
5	State the Pappus – Guildnus Theorems for finding surface area and volume.	**L1**	**C03**

Long Answer Questions-

S.No	Question	Blooms	Course outcomes
1	A) List out types of dynamic friction. B) Determine the frictional developed at the contact surface of system shown in fig. when i) P = 40 N ii) P = 80 N coefficient of static friction between block and floor is 0.3 and coefficient of kinetic friction between block and floor is 0.25. iii) Also find out P when the block is about to move. 	**L1,L3**	**C03**
2	An effort of 200 N is required just to move a certain body up in an inclined plane of angle 150, the force acting parallel to the plane. If the angle of inclination at the plane is made 200, the effort required again parallel to the plane, is found to be 230 N. Find the weight of the body and coefficient of friction. 	**L3**	**C03**
3	A ladder of 3 m length is placed against a vertical wall. The weight of the ladder is 18 N. the bottom of the ladder is making an angle 450 with the floor. Coefficient of friction between wall and ladder is 0.25 and that between ladder and floor is 0.35. In addition self weight, the ladder has to support a man of weight 90 N at its top end of ladder. Determine the minimum horizontal force (P) to be applied at the floor level, to prevent the ladder	**L3**	**C03**

	from slipping.		
4	Find force P required to just pull block B as shown in fig. coefficient of friction between block A & B is 0.3 and whereas between block B and floor is 0.25. Take m_A = 20 kg and m_B = 30 kg. (165.55 N) 	**L3**	**C03**
5	Find out force P applied on block B so as to just start the upward motion of A. 	**L1,L3**	**C03**
6	Locate the centroid of following composite sections. 	**L3**	**C03**
7	State and prove Pappus and Guldinus theorem for finding out surface area and volume.	**L1**	**C03**
8	Determine volume and surface area generated by revolving following composite line/ composite section about vertical axis as shown in fig.	**L3**	**C03**

			
9	Using the Pappus and Guldinus theorem, determine volume of frustum of cone with a vertical hole of 1 cm radius as shown in fig. 	**L1,L3**	**C03**

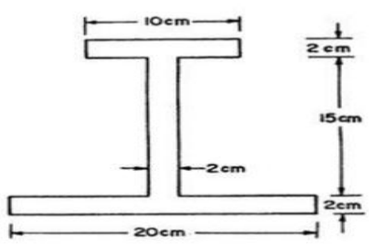
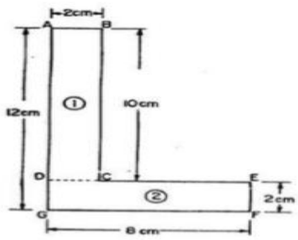
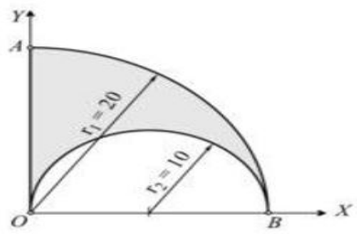
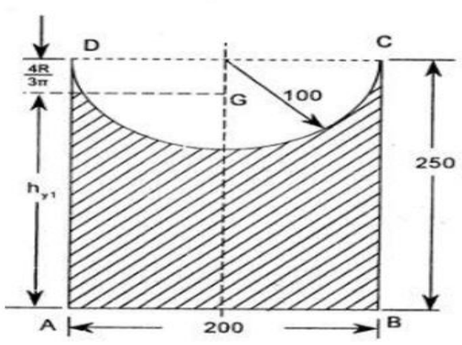
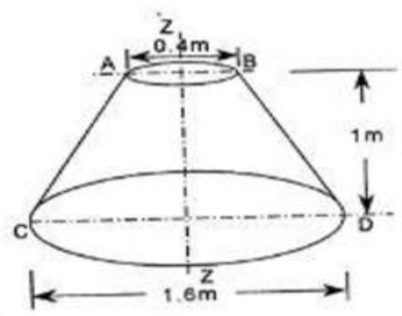
UNIT-3

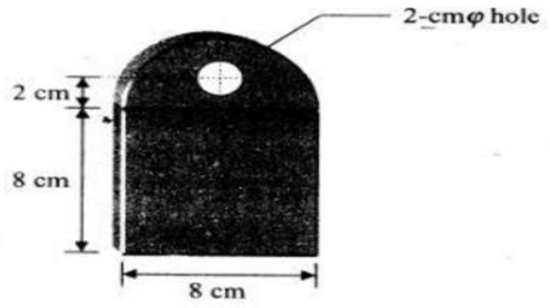
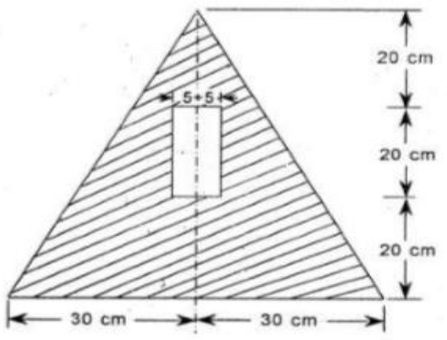
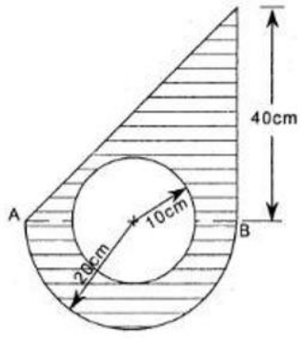
Short Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Define area moment of inertia.	**L1**	**C02**
2	Define radius of gyration of a lamina and radius of gyration of a body.	**L1**	**C02**
3	Differentiate between mass and area moment of inertia.	**L1, L2**	**C02**
4	Define mass moment of inertia and what is it application?	**L1**	**C02**
5	State and prove Parallel axis theorem.	**L1,L3**	**C02**

Long Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Find out area moment of inertia of composite areas about centroidal axes.	**L3**	**C02**

	 		
2	Find out area moment of inertia of shaded area about x and y axis as shown in fig. below. 	**L3**	**C02**
3	Find out area moment of inertia of shaded area about centroidal x and y axis as shown in fig. below 	**L3**	**C02**
4	Find out mass moment of inertia of frustum of a cone shown in fig about its geometrical axis. Take density of material as 2500 kg/m3. 	**L3**	**C02**
5	A vertical hollow cylinder made of steel has an outer diameter of 8 cm and inner diameter of 6 cm. Determine its mass moment of inertia about its geometrical axis. Take density of steel as 7850 kg/m^3	**L3**	**C02**
6	Find out mass moment of inertia of a thin aluminum plate of 3 mm thickness as shown in fig. about its base. Take density of aluminum as 2770 kg/m3.	**L3**	**C02**

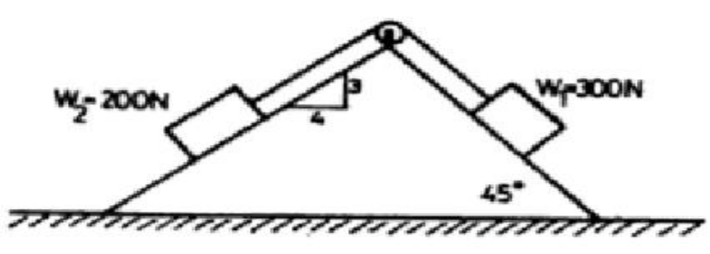
			
7	Find out area moment of inertia of shaded area about centroidal XX axis as shown in fig. 	**L3**	**C02**
8	A) State and prove Perpendicular axis theorem. B) Find out area moment of inertia of shaded area about centroidal x and y axis as shown in fig. below. 	**L3**	**C02**

UNIT-4

Short Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Differentiate between Dynamics and statics.	**L2**	**C05**
2	Define position, distance, displacement, velocity, speed and acceleration of a body.	**L1**	**C05**
3	What are the different types of rigid body motions?	**L2**	**C05**
4	State work energy principle.	**L1**	**C05**
5	State Impulse momentum principle.	**L2**	**C05**
6	Define velocity of projection, angle of projection, trajectory, horizontal range and time of flight.	**L1,L2**	**C05**

Long Answer Questions-

S.No	Question	Blooms	Course outcomes
1	A small steel ball is shot vertically upwards from the top of a building 25 m above the ground with an initial velocity of 18 m/sec. Determine I. In what time, it will reach the maximum height? II. How high above the building will the ball rise? III. The velocity with which it will strike the ground and the total time it is in motion.	L1, L3	C04
2	Two stations P and q are 5.2 km apart. An automobile starts from rest from the station P and accelerates uniformly to attain a speed of 48 kmph in 30 seconds. This speed is maintained until the brakes are applied. The automobile comes to rest at the station Q with a uniform retardation of 1 m/s2. Determine the total time required to cover the distance between these two stations.	L3	C04
3	The motion of a particle moving in a straight line is given by the expression $s = t^3 - 3t^2 + 2t + 5$ where, s is the displacement in meters and t is the time in seconds. Determine I. Velocity and acceleration after 4 seconds II. Maximum or minimum velocity and corresponding displacement III. Time at which velocity is zero.	L3	C04
4	A body moves along a straight line and its acceleration 'a' which varies with time is given by $a = 2 - 3t$. Five seconds after start of observations, the velocity is found to be 20 m/sec. Ten seconds after start of observation, the body is at 85 m from the origin. Determine I. Its acceleration, velocity and distance from the origin, and II. The time in which the velocity becomes zero and the corresponding distance from origin.	L2,L3	C04
5	A particle under a constant deceleration is moving in a straight line and covers 20 m in first two seconds and 40 m in the next 5 seconds. Calculate the distance it covers in the subsequent 3 seconds and the total distance covered, before it comes to rest.	L3	C04
6	A ball is dropped from the top of a tower 30 m high. At the same instant a second ball is thrown upward from the ground with an initial velocity of 15 m/sec. When and where do they cross and with what relative velocity?	L3	C04
7	Find the least initial velocity with which a projectile is to be projected so that it clears a wall of 4 m height located at 5 m and strikes the ground at a distance 4 m beyond the wall. The point of projection is at the same level as that of the wall.	L3	C04
8	In what distance will body 1 shown in fig. attain a velocity of a 3 m/sec starting from rest? Take coefficient of friction between the blocks and plane as 0.2. Assume pulley is smooth. What is the tension in the chord?  	L3	C04

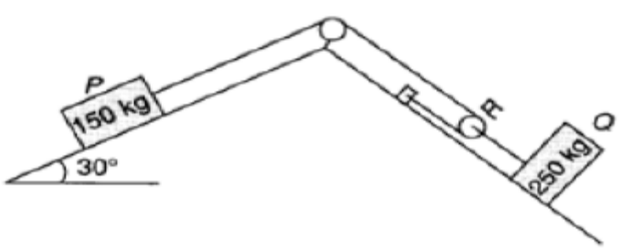
9	A body weighing 300 N is pushed up a 300 plane by a 400 N force acting parallel to the plane. If the initial velocity of the body is 1.5 m/s and coefficient of kinetic friction is 0.2, what velocity will the body have after moving 6 m?	**L3**	**C04**

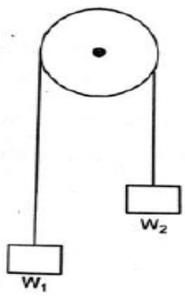
UNIT-5

Short Answer Questions-

S.No	Question	Blooms	Course outcomes
1	State the work-energy equation for translation.	**L1**	**C05**
2	State the assumptions made while studying projectile motion.	**L1**	**C05**
3	State the law of conservation of momentum.	**L1**	**C05**
4	The maximum range of a projectile is 2000 m. What should be the angle of elevation so as to obtain a range of 1400 m if the initial velocity remains unchanged?	**L3**	**C05**
5	The motion of a particle in rectilinear motion is defined by the relation $s = 2t^3 - 9t^2 + 12t - 10$ where s is expressed in meters and t in seconds. Find the acceleration of the particle when the velocity is zero.	**L3**	**C05**

Long Answer Questions-

S.No	Question	Blooms	Course outcomes
1	Derive work energy equation of translation.	**L1**	**C05**
2	A) Derive the impulse-Momentum equation of a body in motion. B) A bullet of 25 g mass is fired with a speed of 400 m/s. What is its kinetic energy?	**L1,L3**	**C05**
3	What are the parameters that define rectilinear motion? State the relationship between these parameters.	**L1**	**C04**
4	If the bullet can penetrate 20 cm in a block of wood, what is the average resistance of the wood? If the bullet were fired into a similar block of 10 cm thick wood, what would be the exit speed?	**L3**	**C04**
5	Find the tension in the string as shown in the figure below. 	**L2**	**C04**
6	Determine the work done by an electric motor in winding up a uniform cable which hangs from a hoisting drum if its free length is 20m and weighs 800N. The drum is rotated by the motor.	**L2**	**C05**
7	D A 20 kg block starting from rest slides up a 300 inclined plane under the action of a 175 N force directed along the inclined plane. The coefficient of kinetic friction between the block and the plane is 0.2. Determine the (i) speed of the block after it slides 4.5 m and (ii) the	**L3**	**C05**

	distance travelled by the block when its speed becomes 4.5 m/s.		
8	Define work energy principle. Also derive the equation for work energy.	**L1**	**C05**
9	A 320 kN gun fires a 6 kN shell horizontally with a velocity of 300m/s. What is the recoil velocity of the gun? The recoil is overcome by applying an average force of 500 kN. What is the distance travelled by the gun and the time taken?	**L3**	**C05**
10	Two blocks of weight W1 and W2 are connected by inextensible wire passing over a smooth pulley as in the figure. If W1 is greater than W2, find the tension in the string and the acceleration of the system. 	**L3**	**C05**

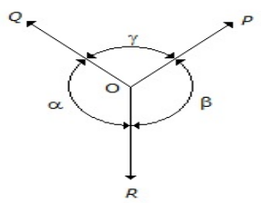
OBJECTIVE QUESTIONS:

JNTUH:

UNIT-1

FILL IN THE BLANKS:

1. Coefficient of friction depends upon_____.
2. The mechanical advantage of a lifting machine is the ratio of_____.
3. The bellow figure shows the three coplanar forces *P*, *Q* and *R* acting at a point *O*. If these forces are in equilibrium, then …….



4. Forces are called coplanar when all of them acting on body lie in_____.

MULTIPLE CHOICE QUESTIONS:

5. Forces are called concurrent when their lines of action meet in
   (a) one point
   (b) two points
   (c) plane
   (d) perpendicular planes
   (e) different planes.
   Ans: a
6. Effect of a force on a body depends upon
   (a) magnitude
   (b) direction
   (c) position or line of action
   (d) all of the above
   (e) none of the above.
   Ans: d
7. The algebraic sum of the resolved parts of a number of forces in a given direction is equal to the resolved part of their resultant in the same direction. This is as per the principle of
   (a) forces
   (b) independence of forces
   (c) dependence of forces

(d) balance of force
(e) resolution of forces.
Ans: e

8. According to principle of transmissibility of forces, the effect of a force upon a body is
(a) maximum when it acts at the center of gravity of a body
(b) different at different points in its line of action
(c) the same at every point in its line of action
(d) minimum when it acts at the C.G. of the body
(e) none of the above.
Ans: c

9. A number of forces acting at a point will be in equilibrium if
(a) their total sum is zero
(b) two resolved parts in two directions at right angles are equal
(c) sum of resolved parts in any two perpendicular directions are both zero
(d) all of them are inclined equally
(e) none of the above.
Ans: c

10. According to law of triangle of forces
(a) three forces acting at a point will be in equilibrium
(b) three forces acting at a point can be represented by a triangle, each side being proportional to force
(c) if three forces acting upon a particle are represented in magnitude and direction by the sides of a triangle, taken in order, they will be in equilibrium
(d) if three forces acting at a point are in equilibrium, each force is proportional to the sine of the angle between the other two
(e) none of the above.
Ans: c

UNIT-2

FILL IN THE BLANKS:

1. Frictional force encountered after commencement of motion is called _____.
2. The angle of inclination of the plane, at which the body begins to move down the plane, is called_____.
3. The C.G. of a plane lamina will not be at its geometrical centre in the case of _____.
4. The moment of inertia of a thin rod of mass '*m*' and length '*l*', about an axis through its centre of gravity and perpendicular to its length is _____.
5. A weight of 1000 N can be lifted by an effort of 80 N. If the velocity ratio is 20, the machine is_____.
6. Centre of gravity of a solid cone lies on the axis at the height_____.

MULTIPLE CHOICE QUESTIONS:

7. A heavy ladder resting on floor and against a vertical wall may not be in equilibrium, if
(a) the floor is smooth, the wall is rough
(b) the floor is rough, the wall is smooth
(c) the floor and wall both are smooth surfaces
(d) the floor and wall both are rough surfaces
(e) will be in equilibrium under all conditions.
Ans: c

8. The center of gravity of a uniform lamina lies at
(a) the center of heavy portion
(b) the bottom surface
(c) the midpoint of its axis
(d) all of the above
(e) none of the above.
Ans: c

9. Center of percussion is
(a) the point of C.G.
(b) the point of meta-centre
(c) the point of application of the resultant of all the forces tending to cause a body to rotate about a certain axis
(d) point of suspension
(e) the point in a body about which it can rotate horizontally and oscillate under the influence of

gravity.
Ans: c

10. The center of gravity of a triangle lies at the point of
(a) concurrence of the medians
(b) intersection of its altitudes
(c) intersection of bisector of angles
(d) intersection of diagonals
(e) all of the above.
Ans: a

UNIT-3

FILL IN THE BLANKS:

1. Whenever the distributed loading acts perpendicular to an area its intensity varies _____.
2. The calculation of the moment of the body due to the loadings involve a quantity called _____
3. The parallel axis theorem gives the moment of inertia _____ to the surface of considerance.
4. The measure of the body's resistance to angular acceleration is called _____
5. One of the use of the centre of mass or centroid is as in the mass moment of inertia is that the net force acts at the _____ of the loading body.
6. We use the distance of the axis and the particles, and in that we apply parallel axis theorem. The distance in the parallel axis theorem is multiplied by_____
7. What is the mass MOI of right circular cone of radius R and height H about its axis……..

MULTIPLE CHOICE QUESTIONS:

8. The body is sometimes acted by two or three force members and we need to find the mass moment of inertia for the same. The difference between the two and the three force members is:
a) The former is collinear and the latter is parallel
b) The former is parallel and the latter is perpendicular
c) The former is perpendicular and the latter is collinear
d) The former is acting on two points in the body while the latter is on three points
Answer: Option D
9. Two of the things of the composite materials are to be known so that their mass moment of inertia can be varied. Which of the following is one of them?
a) Weight of the centre of gravity
b) Weight of the body
c) Location of the centroid of gravity
d) Location of the centre of mass
Answer: Option B
10. What is parallel axis theorem and to whom it is applied?
a) Theorem used to add the two mutually perpendicular moment of inertias for areas
b) Theorem used to add the two mutually perpendicular moment of inertias for volumes
c) Theorem used to add the two mutually perpendicular moment of inertias for linear distances
d) Theorem used to add the two mutually perpendicular moment of inertias for vectorsIn railway axle boxes, the bearing used is:

Answer: Option C

11. If any external force also is applied on the distributed loading on which the mass moment of inertia is to be determined on the composite body then?
a) The net force will act at the centroid of the structure only
b) The net load will not be formed as all the forces will be cancelled
c) The net force will act on the base of the loading horizontally

d) The net force will not be considered, there would be a net force of the distribution, and rest will be the external forces

Answer: Option D

UNIT -4

FILL IN THE BLANKS:

1. The angular velocity (in rad/s) of a body rotating at N r.p.m. is _____.
2. _____ is the simplest type of motion and is along a straight line path.
3. Displacement of a body is a _____ quantity.
4. For a body moving in a circular path, the work done by the centripetal force is----------
5. A gardener pushes a lawn roller through a distance of 20m. If he applies a force of 20kg weight in a direction inclined at 60° to the ground, find the work done by him. ($g=9.8m/s^2$), answer ----------
6. A bullet fired from a gun can pierce a target due to its ----------
7. A person is holding a bucket by applying a force of 10N. He moves a horizontal distance of 5m and then climbs up a vertical distance of 10m. The total work done by him ---------

MULTIPLE CHOICE QUESTIONS:

8. A train covers 60 miles between 2 p.m. and 4 p.m. How fast was it going at 3 p.m.?
   a) 60 mph
   b) 30 mph
   c) 40 mph
   d) 50 mph

   Answer: Option B
9. When a particle moves along a straight path, then the particle has
   a) tangential acceleration only
   b) centripetal acceleration only
   c) both tangential and centripetal acceleration
   d) none of the mentioned

   Answer: Option A
10. When a body falls freely under gravity, then the work done by the gravity is
    a) Positive
    b) Negative
    c) Zero
    d) Infinity

    Answer: Option C

UNIT -5

FILL IN THE BLANKS:

1. Instantaneous center of rotation of a link in a four bar mechanism lies on ----------
2. According to the principle of conservation of energy, under the action of _____ force, the sum of P.E and K.E of a particle remains constant.
3. What is the shape of load-deformation curve for a linear elastic member_____
4. Conservation of energy will be applicable only when_____.
5. The force which acts along the radius of a circle and directed _____ the centre of the circle is known as centripetal force.

MULTIPLE CHOICE QUESTIONS:

6. The wheels of a moving car possess
   a) potential energy only
   b) kinetic energy of translation only
   c) kinetic energy of rotation only
   d) kinetic energy of translation and rotation both.

   Answer: Option D

7. Which of the following factors are related by work energy principle?
   A) Force, displacement and time
   B) force, velocity, time and mass
   C) force, velocity, displacement
   D) displacement, time and mass
   Answer: **Option** C

8. Two systems shall be dynamically equivalent when
   a) the mass of two are same
   b) CG of two coincides
   c) M.I. of two about an axis through CG is equal
   d) all of the mentioned
   Answer: Option D

9. According to D' Alembert's principle, the body is in equilibrium position if
   a. inertia force is applied in the direction opposite to the resultant force
   b. inertia force is applied in the same direction of the resultant force
   c. both a. and b.
   d. none of the above
   Answer: Option A

10. What is the relation between work done by external loads and work done by internal loads?
   a) They are unequal
   b) They are equal
   c) Can't say
   d) Depends upon load
   Answer: Option B

GATE:

1. The unit of force in S.I. units is
(a) kilogram
(b) newton
(c) watt
(d) dyne
(e) joule.
Ans: b

2. Forces are called coplanar when all of them acting on body lie in
(a) one point
(b) one plane
(c) different planes
(d) perpendicular planes
(e) different points.
Ans: b

3. A force acting on a body may
(a) introduce internal stresses
(b) balance the other forces acting on it
(c) retard its motion
(d) change its motion
(e) all of the above.
Ans: e

4. Which is the correct statement about law of polygon of forces?
(a) if any number of forces acting at a point can be represented by the sides of a polygon taken in order, then the forces are in equilibrium

(b) if any number of forces acting at a point can be represented in direction and magnitude by the sides of a polygon, then the forces are in equilibrium

(c) if a polygon representing forces acting at a point is closed then forces are in equilibrium
(d) if any number of forces acting at a point can be represented in direction and magnitude by the sides of a polygon taken in order, then the forces are in equilibrium
(e) none of the above.
Ans: d

5. Which of the following do not have identical dimensions?
(a) Momentum and impulse
(b) Torque and energy
(c) Torque and work
(d) Kinetic energy and potential energy
(e) Moment of a force and angular momentum.
Ans: e

6. Which of the following is not the unit of distance?
(a) angstrom
(b) light year
(c) micron
(d) millimetre
(e) milestone.
Ans: e

7. The weight of a body is due to
(a) centripetal force of earth
(b) gravitational pull exerted by the earth
(c) forces experienced by body in atmosphere
(d) force of attraction experienced by particles
(e) gravitational force of attraction towards the center of the earth.
Ans: e

8. The forces, which meet at one point, but their lines of action do not lie in a plane, are called
(a) coplanar non-concurrent forces
(b) non-coplanar concurrent forces
(c) non-coplanar non-concurrent forces
(d) intersecting forces
(e) none of the above.
Ans: b

9. When trying to turn a key into a lock, following is applied
(a) coplanar force
(b) non-coplanar forces
(c) lever
(d) moment
(e) couple.
Ans: e

10. Which of the following is not a scalar quantity
(a) time
(b) mass
(c) volume
(d) density
(e) acceleration.
Ans: e

11. Which of the following is a vector quantity
(a) energy
(b) mass
(c) momentum
(d) angle

(e) speed.
Ans: c

12. Two non-collinear parallel equal forces acting in opposite direction
(a) balance each other
(b) constitute a moment
(c) constitute a couple
(d) constitute a moment of couple
(e) constitute a resultant couple.
Ans: c

13. According to principle of moments
(a) if a system of coplanar forces is in equilibrium, then their algebraic sum is zero
(b) if a system of coplanar forces is in equilibrium, then the algebraic sum of their moments about any point in their plane is zero
(c) the algebraic sum of the moments of any
two forces about any point is equal to moment of their resultant about the same point
(d) positive and negative couples can be balanced
(e) none of the above.
Ans: b

14. If a rigid body is in equilibrium under the action of three forces, then
(a) these forces are equal
(b) the lines of action of these forces meet in a point
(c) the lines of action of these forces are parallel
(d) (b) and (c) above
(e) none of the above.
Ans: d

15. D' Alembert's principle is used for
(a) reducing the problem of kinetics to equivalent statics problem
(b) determining stresses in the truss
(c) stability of floating bodies
(d) designing safe structures
(e) solving kinematic problems.
Ans: a

16. According to Lami's theorem
(a) three forces acting at a point will be in equilibrium
(b) three forces acting at a point can be represented by a triangle, each side being proportional to force
(c) if three forces acting upon a particle are represented in magnitude and direction by the sides of a triangle, taken in order, they will be in equilibrium
(d) if three forces acting at a point are in equilibrium, each force is proportional to the sine of the angle between the other two
(e) none of the above.
Ans: d

17. Two coplanar couples having equal and opposite moments
(a) balance each other
(b) produce a couple and an unbalanced force
(c) are equivalent
(d) produce a moment of couple
(e) cannot balance each other.
Ans: e

18. A trolley wire weighs 1.2 kg per meter length. The ends of the wire are attached to two poles 20 meters apart. If the horizontal tension is 1500 kg find the dip in the middle of the span
(a) 2.5 cm
(b) 3.0 cm
(c) 4.0 cm

(d) 5.0 cm
(e) 2.0 cm.
Ans: c

19. From a circular plate of diameter 6 cm is cut out a circle whose diameter is a radius of the plate. Find the c.g. of the remainder from the center of circular plate
(a) 0.5 cm
(b) 1.0 cm
(c) 1.5 cm
(d) 2.5 cm
(e) 0.25 cm.
Ans: a

20. Pick up the incorrect statement from the following :
(a) The C.G. of a circle is at its center
(b) The C.G. of a triangle is at the intersection of its medians
(c) The C.G. of a rectangle is at the
inter-section of its diagonals
(d) The C.G. of a semicircle is at a distance
of r/2 from the center
(e) The C-G. of an ellipse is at its center.
Ans: d

IES:

1. The product of either force of couple with the arm of the couple is called
(a) resultant couple
(b) moment of the forces
(c) resulting couple
(d) moment of the couple
(e) none of the above.
Ans: d

2. A heavy string attached at two ends at same horizontal level and when central dip is very small approaches the following curve
(a) catenary
(b) parabola
(c) hyperbola
(d) elliptical
(e) circular arc.
Ans: b

3. In the equation of virtual work, following force is neglected
(a) reaction of any smooth surface with which the body is in contact
(b) reaction of a rough surface of a body which rolls on it without slipping
(c) reaction at a point or an axis, fixed in space, around which a body is con-strained to turn
(d) all of the above
(e) none of the above.
Ans: d

4. If a suspended body is struck at the center of percussion, then the pressure on die axis passing through the point
of suspension will be
(a) maximum
(b) minimum
(c) zero
(d) infinity

(e) same as the force applied.
Ans: c

5. The resultant of the following three couples 20 kg force, 0.5 m arm, $ ve sense 30 kg force, 1 m arm, – ve sense 40 kg force, 0.25 m arm, + ve sense having arm of 0.5 m will be
(a) 20 kg, – ve sense
(b) 20 kg, + ve sense
(c) 10 kg, + ve sense
(d) 10 kg, – ve sense
(e) 45 kg, + ve sense.
Ans: a

6. On a ladder resting on smooth ground and leaning against vertical wall, the force of friction will be
(a) towards the wall at its upper end
(b) away from the wall at its upper end
(c) upwards at its upper end
(d) downwards at its upper end
(e) none of the above.
Ans: c

7. On the ladder resting on the ground and leaning against a smooth vertical wall, the force of friction will be
(a) downwards at its upper end
(b) upwards at its upper end
(c) perpendicular to the wall at its upper end
(d) zero at its upper end
(e) none of the above.
Ans: d

8. Frictional force encountered after commencement of motion is called
(a) post friction
(b) limiting friction
(c) kinematic friction
(d) frictional resistance
(e) dynamic friction.
Ans: e

9. Pick up wrong statement about friction force for dry surfaces. Friction force is
(a) proportional to normal load between the surfaces
(b) dependent on the materials of contact surface
(c) proportional to velocity of sliding
(d) independent of the area of contact surfaces
(e) none of the above is wrong statement.
Ans: c

10. If rain is falling in the opposite direction of the movement of a pedestrian, he has to hold his umbrella
(a) more inclined when moving
(b) less inclined when moving
(c) more inclined when standing
(d) less inclined when standing
(e) none of the above.
Ans: d

11. Limiting force of friction is the
(a) tangent of angle between normal-reaction and the resultant of normal reaction and limiting friction
(b) ratio of limiting friction and normal reaction
(c) the friction force acting when the body is just about to move
(d) the friction force acting when the body is in motion

(e) minimum force of friction.
Ans: c

12. Coulomb friction is the friction between
(a) bodies having relative motion
(b) two dry surfaces
(c) two lubricated surfaces
(d) solids and liquids
(e) electrically charged particles.
Ans: a

13. Dynamic friction as compared to static friction is
(a) same
(b) more
(c) less
(d) may be less of more depending on nature
of surfaces and velocity
(e) has no correlation.
Ans: c

14. Kinetic friction is the
(a) tangent of angle between normal reaction and the resultant of normal reaction and the limiting friction
(b) ratio of limiting friction and normal reaction
(c) the friction force acting when the body is just about to move
(d) the friction force acting when the body is in motion
(e) dynamic friction.
Ans: d

15. A semi-circular disc rests on a horizontal surface with its top flat surface horizontal and circular portion touching down. The coefficient of friction between semicircular disc and horizontal surface is i. This disc is to be pulled by a horizontal force applied at one edge and it always remains horizontal. When the disc is about to start moving, its top horizontal force
will
(a) remain horizontal
(b) slant up towards direction of pull
(c) slant down towards direction of pull
(d) unpredictable
(e) none of the above.
Ans: c

16. The algebraic sum of moments of the forces forming couple about any point in their plane is
(a) equal to the moment of the couple
(b) constant
(c) both of above are correct
(d) both of above are wrong
(e) none of the above.
Ans: a

17. A single force and a couple acting in the same plane upon a rigid body
(a) balance each other
(b) cannot balance each other
(c) produce moment of a couple
(d) are equivalent
(e) none of the above.
Ans: b

18. If three forces acting in one plane upon a rigid body, keep it in equilibrium, then they must either
(a) meet in a point
(b) be all parallel

(c) at least two of them must meet
(d) all the above are correct
(e) none of the above.
Ans: d

19. The maximum frictional force which comes into play when a body just begins to slide over another surface is called
(a) limiting friction
(b) sliding friction
(c) rolling friction
(d) kinematic friction
(e) dynamic friction.
Ans: a

XI. NPTEL WEB VIDEOS:

https://nptel.ac.in/courses/112103109/

https://nptel.ac.in/courses/112103109/1

XII. WEBSITES:

1. www.nptel.ac.in/downloads/112103109/
2. https://www.edx.org/course/engineering-mechanics
3. https://www.coursera.org/learn/engineering-mechanics-statics
4. https://www.udemy.com/myengineeringmechanics/
5. www.springer.com

XIII. EXPERT DETAILS:

1. Prof. Sriram Venkatesh, OU, Hyderabad
2. Mr. M.Chandra Sekhar Reddy, OU, Hyderabad
3. Dr. Jayaram S R, MCE, Hassan
4. Prof. V.V.Bongale, MCE, Hassan
5. Dr. B.KSridhara, NIE, Mysore
6. Prof. Y.M.Shashidhar, MCE, Hassan

XI. JOURNALS:

1. American standards of mechanical engineering(ASME)
2. Journal Of Engineering Mechanics
3. International Association of Structural Engineering and Mechanics(IASEM)
4. International Journal for Theoretical and Applied Mechanics
5. International Journal of Engineering Science and Technology
6. International Journal of Engineering Science and Research
7. International Journal of Engineering Science and Innovative Technology (IJEIT)

XII. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Force Systems
2. Friction
3. Moment of Inertia of Composite Sections
4. Work-Kinetic energy Principles

5. principles in dynamics
6. Kinetics of rigid body rotation

XIII. CASE STUDIES / SMALL PROJECTS:

1. Equilibrium of System of Forces of various engineering applications.
2. Differences between different types of screw jacks and their working principles
3. Work Energy principle and its applications.