Hall Ticket No | | | | | | | | | | | Question Paper Code: AMEB03

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

B.Tech III Semester End Examinations, November 2020

Regulations: IARE - R18

ENGINEERING MECHANICS

MECHANICAL ENGINEERING

Time: 3 hour Maximum Marks: 70

Answer ONE Question from each MODULE
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE-I

1. (a) Find the magnitude of two forces such that if they act at right angle, their resultant is $\sqrt{10}$, but they act at 60^0 their resultant is $\sqrt{13}$ [**7m**]

   (b) The five forces $20\,N, 30\,N, 40\,N, 50\,N$ *and* $60\,N$ are acting at one of the angular points of a regular hexagon, towards the other five angular points taken in order. Find the direction and magnitude of the resultant force. [**7m**]

2. (a) Determine the horizontal force P to be applied to a block of weight of 1800N to hold it in position on a smooth inclined plane, which makes an angle 300 with horizontal reference line. [**7m**]

   (b) Determine the resultant of system of forces acting as shown in **fig 1** [**7m**]

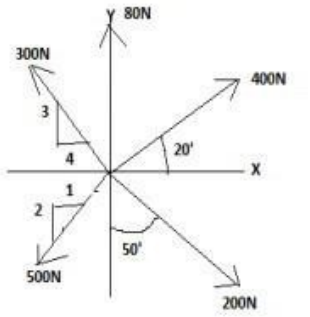


Figure 1: 2B

MODULE-II

3. (a) Derive an expression for the maximum force required along the horizontal plane to keep a body in equilibrium position when it is at point of sliding downwards on an inclined plane. [**7m**]

(b) Two 6^0 of wedges are used to push a block horizontally as shown **fig 2**. Calculate the minimum force reqiured to push the block of weight $10\,KN$. Take coefficient of friction as 0.25 for all contact surfaces [**7m**]

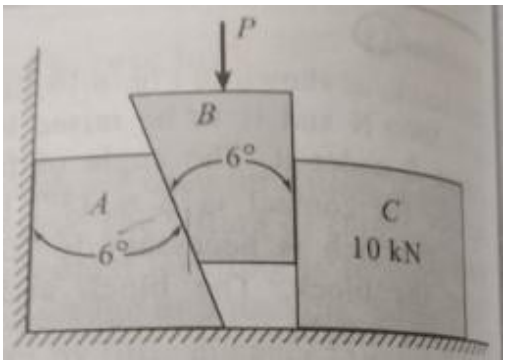


Figure 2: 3B

4. (a) Solve reactions at points A & Bas shown in **fig 3**. [**7m**]

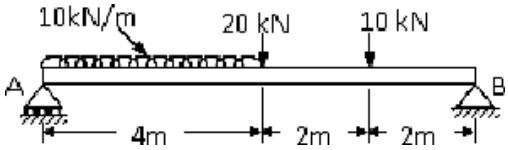


Figure 3: 4a

(b) A ladder of $7\,m$ length rests against a vertical wall with which it makes an angle of 45^0. The coefficient of friction for wall and the floor are 0.33 and 0.50 respectively. If a man whose weight is one- half of that of the ladder. How far he will be able to climb the ladder. [**7m**]

MODULE-III

5. (a) Design Moment of Inertia about the co-ordinate axes of plane area shown in **fig 4**. Also find Polar Moment of Inertia. [**7m**]

(b) A force of $500\,N$ is acting at 300 to the horizontal on a block of mass $50\,kg$ resting on a horizontal surface. Determine the velocity after the block has travelled a distance of $10\,m$. coefficient of kinetic friction is 0.5. [**7m**]

6. (a) A pump lifts $40\,m^3$ of water to a height of $50\,m$ and delivers it with a velocity of $5m/s$. what is the amount of energy spent during the process? If the job is done in half an hour, what is the input power of the pump which has an overall efficiency of 70%. [**7m**]

(b) Derive an expression for centroid of semi-circle and Moment of Inertia for a rectangle section. [**7m**]

MODULE-IV

7. (a) Derive the expression for range along an inclined plane. What is the necessary condition for obtaining maximum range along an inclined plane? [**7m**]

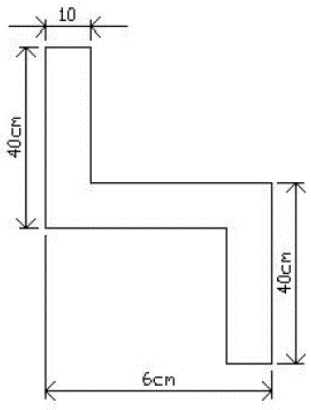


Figure 4: 5A

(b) For the system of connected bodies as shown in **fig 5** given below, calculate the force F required to make the motion impending to the left. Use the method of virtual work and take coefficient of friction for all contiguous surfaces except pulleys as 0.25. [**7m**]

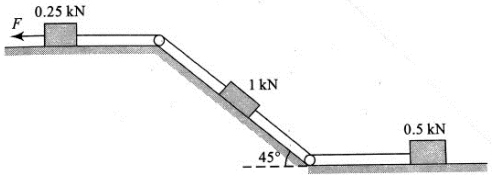


Figure 5: 7B

8. (a) A body A is projected vertically upwards from the top of a tower with a velocity of $40\,m/s$, the tower being $180\,m$ high. After t seconds, another body B is allowed to fall from the same point. Both the bodies reach the ground simultaneously. Calculate t and the velocities of A and B on reaching the ground. [**7m**]

(b) Two blocks A and B are connected by an inextensible string moving over a frictionless pulley as shown in **fig 5** . If the blocks are released from rest, determine the velocity of the system after the travel of $4s$. Take the masses of blocks A and B as 20 and $60\,kg$ respectively and coefficient of friction for all the contiguous surfaces as 0.3 [**7m**]

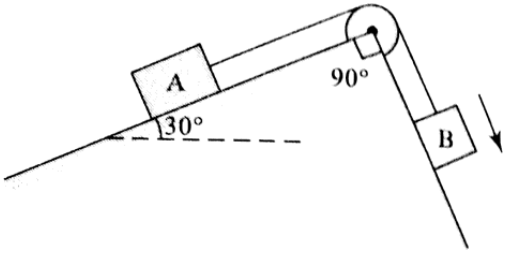


Figure 6: 8B

MODULE-V

9. (a) Derive an expression for the time period for a spring mass system subjected to free vibration. [**7m**]

   (b) A weight of 10 N attached to a spring oscillates at a frequency of 60 oscillations per minute. If the maximum amplitude is 30 mm, find the tension induced in the spring. Also find the spring constant and the maximum velocity in the spring. [**7m**]

10. (a) The frequency of free vibrations of a weight W with spring constant k is 12 cycles/s. When the extra weight of 20 N is coupled with weight W, the frequency reduced to 10 cycles/s. Find the weight W and stiffness k of the spring. [**7m**]

    (b) A body moving with SHM has amplitude of 50cm and the period of one complete oscillation is 3s. What will be the speed and acceleration of the body 1/5 of a second after passing the mid position. [**7m**]

****END OF EXAMINATION****

COURSE OBJECTIVES:

The course should enable the students to:

1	The application of mechanics laws to static and dynamic equilibrium conditions in a body for solving the field problems.
2	The importance of free body diagram for a given system and put in the knowledge of mathematics and science into the vast area of rigid body mechanics.
3	The effects of force and motion while carrying out the innovative design functions of engineering.

COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Determine the reactions and resultants for the system of forces in engineering applications with principles of mechanics.
CO 2	Analyze the unknown forces with the help of free body diagrams to a given force system.
CO 3	Identify the equilibrium equations for a planar and spatial force systems from the rest or motion condition of the body.
CO 4	Apply the static and dynamic friction laws for the equilibrium state of a wedge and ladder applications.
CO 5	Apply the friction laws to a standard and differential screw jack for conditions of self-locking and overhauling.
CO 6	Demonstrate the concepts of equilibrium for truss, beam, frames and machine applications.
CO 7	Identify the centroid, centre of gravity and moment of inertia for the simple plane sections from the first principles.
CO 8	Explore the theorems of moment and the mass moment of inertia of circular plate, cylinder, cone and sphere.
CO 9	Apply the concepts of virtual work and work-energy method for single and connected configured systems.
CO 10	Determine normal and tangential accelerations for a particle in rectilinear and curvilinear motion through kinematic equations.
CO 11	Derive the dynamic equilibrium of a body in motion by introducing inertia force through D Alemberts principle.
CO 12	Compute the time period and frequencies of simple, compound and torsional pendulums using the basics of free and forced vibrations.

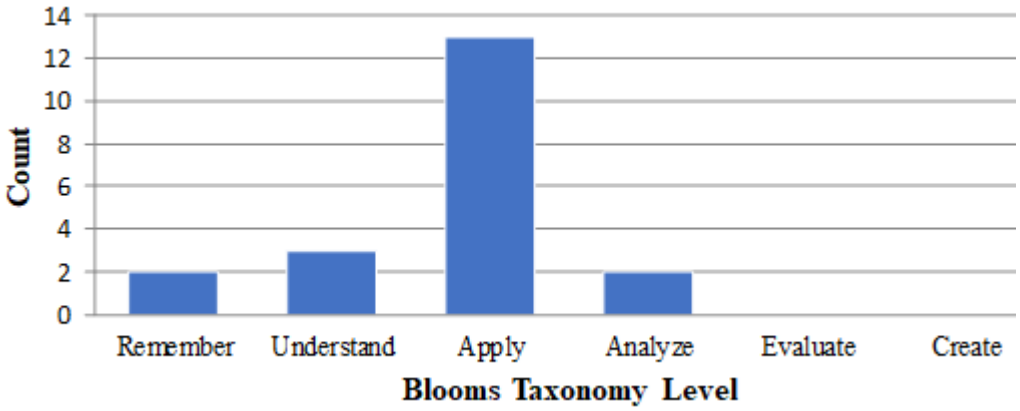
MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

Q.No		All Questions carry equal marks	Taxonomy	CO's	PO's
1	a	Find the magnitude of two forces such that if they act at right angle, their resultant is$\sqrt{10}$, but they act at 60^0 their resultant is $\sqrt{13}$	Analyze	CO 2	PO 2
	b	The five forces $20\,N, 30\,N, 40\,N, 50\,N\,and\,60\,N$ are acting at one of the angular points of a regular hexagon, towards the other five angular points taken in order. Find the direction and magnitude of the resultant force.	Apply	CO 1	PO 1
2	a	Determine the horizontal force P to be applied to a block of weight of 1800N to hold it in position on a smooth inclined plane, which makes an angle 300 with horizontal reference line.	Apply	CO 1	PO 2
	b	Determine the resultant of system of forces acting as shown in **fig 1**	Apply	CO 1	PO 1
3	a	Derive an expression for the maximum force required along the horizontal plane to keep a body in equilibrium position when it is at point of sliding downwards on an inclined plane.	Apply	CO 4	PO 1
	b	Two 6^0 of wedges are used to push a block horizontally as shown **fig 2**. Calculate the minimum force reqiured to push the block of weight $10\,KN$. Take coefficient of friction as 0.25 for all contact surfaces	Analyze	CO 2	PO 2
4	a	Solve reactions at points A & B as shown in **fig 3**..	Apply	CO 5	PO 1
	b	A ladder of $7\,m$ length rests against a vertical wall with which it makes an angle of 45^0. The coefficient of friction for wall and the floor are 0.33 and 0.50 respectively. If a man whose weight is one- half of that of the ladder. How far he will be able to climb the ladder.	Apply	CO 4	PO 1
5	a	Design Moment of Inertia about the co-ordinate axes of plane area shown in **fig 4**. Also find Polar Moment of Inertia.	Understand	CO 6	PO 2

	b	A force of $500\,N$ is acting at 300 to the horizontal on a block of mass $50\,kg$ resting on a horizontal surface. Determine the velocity after the block has travelled a distance of $10\,m$. coefficient of kinetic friction is 0.5.	Understand	CO 6	PO 4
6	a	A pump lifts $40\,m^3$ of water to a height of $50\,m$ and delivers it with a velocity of $5m/s$. what is the amount of energy spent during the process? If the job is done in half an hour, what is the input power of the pump which has an overall efficiency of 70%.	Apply	CO 8	PO 1
	b	Derive an expression for centroid of semi-circle and Moment of Inertia for a rectangle section.	Apply	CO 7	PO 2
7	a	Derive the expression for range along an inclined plane. What is the necessary condition for obtaining maximum range along an inclined plane?	Apply	CO9	PO 1
	b	For the system of connected bodies as shown in **fig 5** given below, calculate the force F required to make the motion impending to the left. Use the method of virtual work and take coefficient of friction for all contiguous surfaces except pulleys as 0.25.	Apply	CO 9	PO 1
8	a	A body A is projected vertically upwards from the top of a tower with a velocity of $40\,m/s$, the tower being $180\,m$ high. After t seconds, another body B is allowed to fall from the same point. Both the bodies reach the ground simultaneously. Calculate t and the velocities of A and B on reaching the ground.	Apply	CO 9	PO 1
	b	Two blocks A and B are connected by an inextensible string moving over a frictionless pulley as shown in **fig 5** . If the blocks are released from rest, determine the velocity of the system after the travel of $4s$. Take the masses of blocks A and B as 20 and $60\,kg$ respectively and coefficient of friction for all the contiguous surfaces as 0.3	Apply	CO 9	PO 1
9	a	Derive an expression for the time period for a spring mass system subjected to free vibration.	Understand	CO 12	PO 1

	b	A weight of 10 N attached to a spring oscillates at a frequency of 60 oscillations per minute. If the maximum amplitude is 30 mm, find the tension induced in the spring. Also find the spring constant and the maximum velocity in the spring.	Apply	CO 12	PO 4
10	a	The frequency of free vibrations of a weight W with spring constant k is 12 cycles/s. When the extra weight of 20 N is coupled with weight W, the frequency reduced to 10 cycles/s. Find the weight W and stiffness k of the spring.	Apply	CO 11	PO 2
	b	A body moving with SHM has amplitude of 50cm and the period of one complete oscillation is 3s. What will be the speed and acceleration of the body 1/5 of a second after passing the mid position.	Analyze	CO 12	PO 4

KNOWLEDGE COMPETENCY LEVELS OF MODEL QUESTION PAPER



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Signature of Course Coordinator **HOD, ME**
Dr. BDY Sunil, Associate Professor