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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

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) Explain the procedure to find the resultant of several forces acting at a point **[7m]**

   (b) The force of magnitudes $10KN$, $20KN$, $25KN$ &40 KN are concurrent in space and are directed through the points $A(3,2,5), B(1,7,4), C(4,-2,4)$ & $D(-2,4,-3)$ respectively. Determine the resultant of the force system of forces. Given that system of forces are concurrent at the origin. **[7m]**

2. (a) Determine the magnitude and the direction of the resultant of two forces 7 N and 8 N acting at a point with an included angle of 60^0 with between them. The force of 7 N being horizontal. **[7m]**

   (b) A system of connected flexible cables as shown in **fig 1** is supporting two vertical forces $240\,N$ and $300\,N$ at points **B** and **D**. Determine the forces in various segments of the cable. **[7m]**

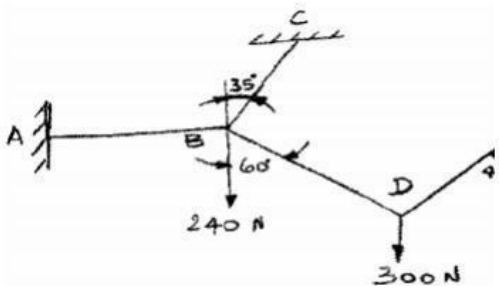

Figure 1: 2B

MODULE-II

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

(b) Find the force and its nature in member **AD** and **BC** for given cantilever truss loaded by 40 KN as shown in **fig 2** [**7m**]

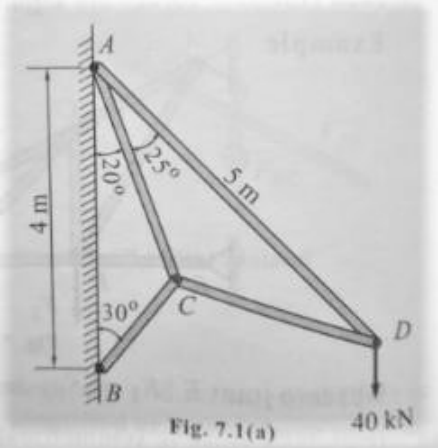

Figure 2: 3B

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

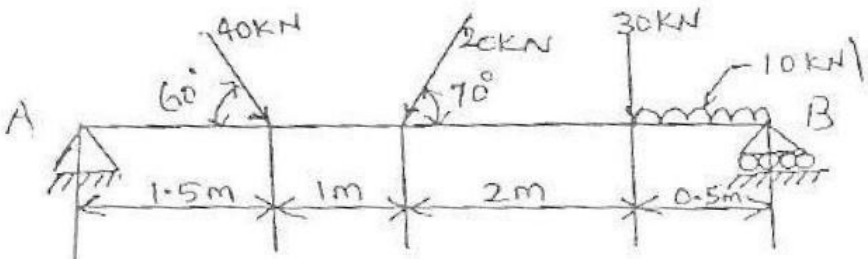

Figure 3: 4A

(b) A mean radius of the screw of a square threaded screw jack is 25 mm. the pitch of thread is 7.5 mm. if the coefficient of the friction is 0.12, what effort applied at the end of the lever 60 cm length is needed to raise a weight of 2 KN [**7m**]

MODULE-III

5. (a) Determine the coordinates of centroid of the shaded area shown in **fig 4** [**7m**]

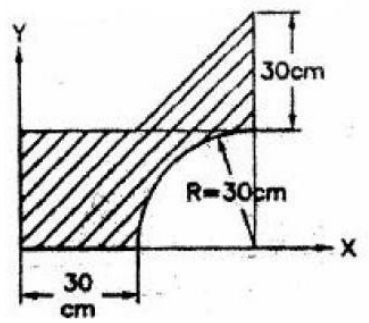

Figure 4: 5A

(b) A pump lifts 40 m^3 of water to a height of 50 m and delivers it with a velocity of 5 m/s. what is the amount of energy spent during the process If the job is done [**7m**]

6. (a) A block of mass 50 kg slides down a 35^0 incline and strikes a spring 1.5 m away from it as shown in **fig 5**. The maximum compression of the spring is 300 mm when the block comes to rest. If the spring constant is 1 kN/m, Solve the coefficient of kinetic friction between the block and the plane. [**7m**]

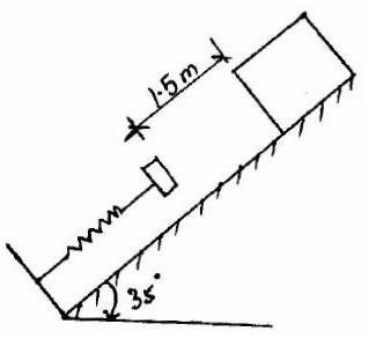

Figure 5: 6B

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

MODULE-IV

7. (a) A body A is projected vertically upwards from the top of a tower with a velocity of 40m/s, the tower being 180m 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) Determine the tension in the inextensible string of the system as shown in **fig 6** while $m_1 = 200\,Kg$ and $m_2 = 100\,Kg$. Consider the pulley as massless and coefficient of friction as 0.2. [**7m**]

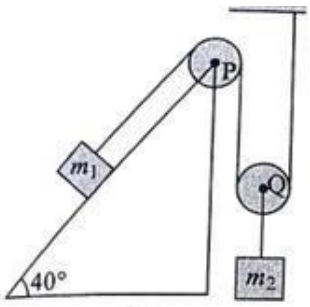

Figure 6: 7B

8. (a) An elevator weighing 4900 N is ascending with an acceleration of $3m/s^2$. During the ascent its operator whose weight is $686N$ is standing on the scales placed on the floor. What is the scale reading? What will be total tension in the cable of the elevator during this motion? [**7m**]

   (b) Find the velocity of **Block B** shown in **fig 7**, after $5seconds$ starting from rest the axis of the cam shaft.

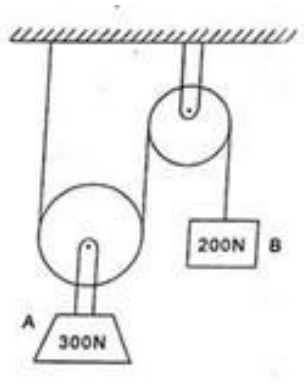

Figure 7: 8B

[**7m**]

MODULE-V

9. (a) Determine the period of vibration of a weight P attached to springs of stiffness k1 and k2 in two different cases as shown in **fig 6** [**7m**]

   (b) A vertical shaft $5\,mm$ in diameter and $1\,mm$ in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter $200\,mm$ and weight $20\,N$. The modulus of rigidity for the rotor is $0.85x105N/mm^2$. Calculate the frequency of torsional vibration for the system. [**7m**]

10. (a) A body performing simple harmonic motion has a velocity $20\,m/s$ when the displacement is $40\,mm$ and $3\,m/s$ when the displacement is $120\,mm$, the displacement measured from the mid-point. Calculate the frequency and amplitude of the motion. What is the acceleration when displacement is $85\,mm$. [**7m**]

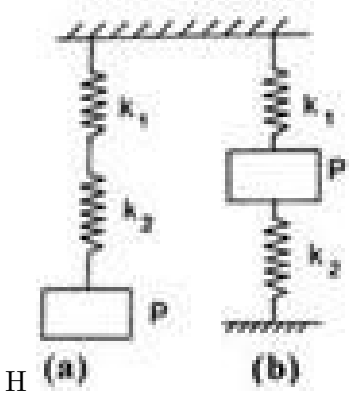

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Figure 8: 9A

(b) A conical pendulum rotates at $100\,rev/min$. The cord is $150\,mm$ long and the mass of bob $1.35\,Kg$. Find [**7m**]

(i) The amount of which the bob rises above its lowest position

(ii) The period

(iii) The tension in the cord.

****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.

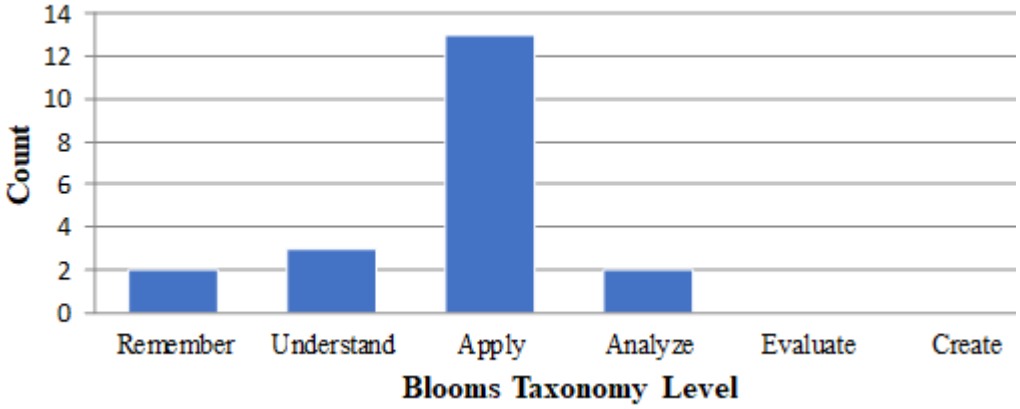
MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

Q.No		All Questions carry equal marks	Taxonomy	CO's	PO's
1	a	Explain the procedure to find the resultant of several forces acting at a point	Analyze	CO 2	PO 2
	b	The force of magnitudes $10KN,\ 20KN,\ 25KN$ &$40\ KN$ are concurrent in space and are directed through the points $A(3,2,5), B(1,7,4), C(4,-2,4)$ & $D(-2,4,-3)$ respectively. Determine the resultant of the force system of forces. Given that system of forces are concurrent at the origin.	Apply	CO 1	PO 1
2	a	Determine the magnitude and the direction of the resultant of two forces 7 N and 8 N acting at a point with an included angle of 60^0 with between them. The force of 7 N being horizontal	Apply	CO 1	PO 2
	b	A system of connected flexible cables as shown in **fig 1** is supporting two vertical forces 240 N and 300 N at points **B** and **D**. Determine the forces in various segments of the cable.	Apply	CO 1	PO 1
3	a	Derive an expression for the minimum effort required along the inclined plane to keep a body in equilibrium position when it is at point of sliding downwards on a inclined plane.	Apply	CO 4	PO 1
	b	Find the force and its nature in member **AD** and **BC** for given cantilever truss loaded by 40 KN as shown in **fig 2**	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 mean radius of the screw of a square threaded screw jack is 25 mm. the pitch of thread is 7.5 mm. if the coefficient of the friction is 0.12, what effort applied at the end of the lever 60 cm length is needed to raise a weight of 2 KN.	Apply	CO 4	PO 1
5	a	Determine the coordinates of centroid of the shaded area shown in **fig 4**	Understand	CO 6	PO 2
	b	A pump lifts 40 m^3 of water to a height of 50 m and delivers it with a velocity of 5 m/s. what is the amount of energy spent during the process If the job is done	Understand	CO 6	PO 4

6	a	A block of mass 50 kg slides down a 35^0 incline and strikes a spring 1.5 m away from it as shown in **fig 5**. The maximum compression of the spring is 300 mm when the block comes to rest. If the spring constant is 1 kN/m, Solve the coefficient of kinetic friction between the block and the plane.	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	A body A is projected vertically upwards from the top of a tower with a velocity of 40m/s, the tower being 180m 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	CO9	PO 1
	b	Determine the tension in the inextensible string of the system as shown in **fig 6** while $m_1 = 200\,Kg$ and $m_2 = 100\,Kg$. Consider the pulley as massless and coefficient of friction as 0.2.	Apply	CO 9	PO 1
8	a	An elevator weighing 4900 N is ascending with an acceleration of $3m/s^2$. During the ascent its operator whose weight is $686N$ is standing on the scales placed on the floor. What is the scale reading? What will be total tension in the cable of the elevator during this motion?	Apply	CO 9	PO 1
	b	Find the velocity of **Block B** shown in **fig 7**, after $5seconds$ starting from rest the axis of the cam shaft.	Apply	CO 9	PO 1
9	a	Determine the period of vibration of a weight P attached to springs of stiffness k1 and k2 in two different cases as shown in **fig 6**	Understand	CO 12	PO 1
	b	A vertical shaft 5 mm in diameter and 1 mm in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 200 mm and weight 20 N. The modulus of rigidity for the rotor is $0.85x105N/mm^2$. Calculate the frequency of torsional vibration for the system.	Apply	CO 12	PO 4

10	a	A body performing simple harmonic motion has a velocity 20 m/s when the displacement is 40 mm and 3 m/s when the displacement is 120 mm , the displacement measured from the mid-point. Calculate the frequency and amplitude of the motion. What is the acceleration when displacement is 85 mm.	Apply	CO 11	PO 2
	b	A conical pendulum rotates at 100 rev/min. The cord is 150 mm long and the mass of bob 1.35 Kg. Find (i) The amount of which the bob rises above its lowest position (ii) The period (iii) The tension in the cord.	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