Hall Ticket No | | | | | | | | | | | Question Paper Code: AMEB17

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

B.Tech V Semester End Examinations, November 2020

Regulations: IARE - R18

DYNAMICS OF MACHINERY

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 angle of heel in the case of a two wheeler negotiating a curve. [**7m**]

   (b) The mass of the motor cycle along with the rider is $180kg$. The height of the centre of gravity of total mass is $600mm$ above the ground when it moves straight. Each wheel has a diameter of $700mm$ and mass moment of inertia of $2kgm$ The engine rotates at a speed of 5 times the road wheel 2and engine rotating parts have mass moment of inertia of $0.2kgm$. Find the angle of heel if it is travelling at $50km/h$ and is taking a turn of 30 meters radius. [**7m**]

2. (a) Explain the effect of gyroscopic couple on an automobile taking left turn. [**7m**]

   (b) A uniform disc having a mass of 8 kg and radius of gyration $150mm$ is mounted on one end of a horizontal arm of length $200mm$. The other end rotates freely in a bearing. The disc is given a clockwise spin of $240rpm$. Determine the motion of the disc if its arm remains horizontal. [**7m**]

MODULE-II

3. (a) Deduce expression for the friction torque for a flat collar bearing considering uniform wear. [**7m**]

   (b) A conical pivot supports a load of $10kN$, cone angle is 1100 and intensity of pressure normal to the cone is $0.3N/mm^2$. The outer diameter is twice the inner diameter. Find the outer and inner radii of bearing surface if the shaft rotates at $300rpm$ and $\mu = 0.1$. Find the power absorbed in friction assuming uniform wear. [**7m**]

4. (a) Deduce expression for the friction torque for a flat collar bearing considering uniform pressure.

   [**7m**]

   (b) A band brake acts on 3/4th of a circumference of a brake drum of $450mm$ diameter which is keyed to a shaft. The band brake provides a braking torque of $225Nm$. One end of the

lever is attached to a fulcrum pin of the lever and the other end is attached to a pin 100 mm from the fulcrum. If the operating force is applied at $500mm$ from the fulcrum and coefficient of friction is 0.25, find the operating force when the drum rotates in Clock-wise direction and anti- clockwise direction. [**7m**]

MODULE-III

5. (a) Describe the graphical method of determining the inertia of the connecting rod of reciprocating engine. [**7m**]

   (b) The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1mm to $500Nm$ of torque and 1mm to 60 of crank displacement The intercepted areas between the output torque curve and the mean resistance line taken in order from one end of the engine are $-30, +410, -280, +320, -330, +250, -360, +280, -260mm^2$ when the engine runs at 800 rpm. The engine has a stroke of $300mm$ and the fluctuation of speed is not to exceed 2% of mean speed. Determine suitable diameter and cross section of the flywheel rim for a limiting value of safe centrifugal stress of $7MP$. The material density is $720kg/m^3$. Width of the rim is 5 times the thickness. [**7m**]

6. (a) Derive an expression for the angular acceleration of the connecting rod of a reciprocating engine. [**7m**]

   (b) The effective turning moment exerted by a two stroke engine at the crank shaft is $T = 800 + 100\sin 2\theta - 200\cos\theta$ where θ is the inclination of the crank to inner dead center. The mass of the flywheel is $400kg$ and radius of gyration is $550mm$. The engine speed is $200rpm$. Determine the power developed, the total percentage fluctuation of speed and maximum angular retardation. [**7m**]

MODULE-IV

7. (a) Explain the balancing of reciprocating masses with a neat sketch. [**7m**]

   (b) A rigid rotor has its unbalance in one plane and can be considered to consist of three masses $m_1 = 5kg$ at an angle of 300 from mass m1 in anti clockwise direction, $m_2 = 3kg$ at an angle of 1650 *counterclockwise* from m_1 and $m_3 = 8kg$ at angle 85^0 *clockwise* from m_1. The radii $r_1 = 200mm$, $r_2 = 80mm$ and $r_3 = 140mm$. Determine the balancing mass required at a radius of $100mm$. Specify the location of this mass with respect to m_1.[**7m**]

8. (a) Derive the expression for hammer blow in locomotive balancing. [**7m**]

   (b) The cranks of a three cylinder locomotive are set at 1000. The stroke is $110mm$, the length of the connecting rod is $140mm$, the mass of the reciprocating parts per cylinder is $1Kg$ and the speed of the crank shaft is $2400rpm$. Determine the magnitude of primary and secondary balancing. [**7m**]

MODULE-V

9. (a) Derive an expression for the natural frequency of forced longitudinal vibrations. [**7m**]

   (b) A shaft $100mm$ diameter and $1000\,mm$ long is fixed at one end and the other end carries a flywheel of mass $90\,kg$. The radius of gyration of the flywheel is $500\,mm$. Find the frequency of torsional vibration, if the modulus of rigidity for the shaft material is $80\,GN/m^2$. [**7m**]

10. (a) What is meant by the term critical damping? [**7m**]

(b) A cantilever shaft of 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Youngs modulus of the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft. [**7m**]

****END OF EXAMINATION****

COURSE OBJECTIVES:

The course should enable the students to:

1	The concepts of precision, static and dynamic forces of planer mechanisms by neglecting friction of aero planes, sea vessels, auto mobiles and various force members.
2	The knowledge of engineering mechanics for identifying the coefficient of friction and engine speed of the various contact bodies (Clutches and Brakes) and speed controlled devices, variations of torques and fluctuation of speeds of IC engines.
3	The magnitude and direction of balanced mass for unbalanced rotary and reciprocating engines with the fundamentals of applied physics.
4	Mathematical modeling of various degree of freedom systems to interpret the various vibration parameters.
5	The affluence of real world engineering problems and examples towards gaining the experience for how dynamics of machinery is applied in engineering practice.

COURSE OUTCOMES:

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

CO 1	Discuss the Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aeroplanes and ships.
CO 2	Determine the angle of heel to avoid upside down of a two wheeler vehicle while taking in left and right turns.
CO 3	Illustrate the static and dynamic force analysis of two and three force members by graphical super position method.
CO 4	Apply the laws of friction on clutches, brakes and dynamometers to reduce the power losses for the effective torque transmission.
CO 5	Justify the importance of torque and fluctuation of speeds for single and multi cylindered engines to increase the mechanical efficiency.
CO 6	Estimate the height of a governor to regulate the speed of a prime mover at various load conditions.
CO 7	Determine the balanced mass for unbalanced rotary and reciprocating engines by analytical and graphical methods.
CO 8	Develop a mathematical modelling of free and forced vibration systems under damped and un-damped conditions to avoid the vibratory damages of aero-mechanical-civil structures and electrical and electronic components at various operated frequencies.
CO 9	Use the resonance phenomenon to predict the critical or whirling or whipping speeds of various structures under vibrations to avoid catastrophic failures.
CO 10	Apply the principles of dynamics of machinery to a real world problems for obtaining optimum solutions.

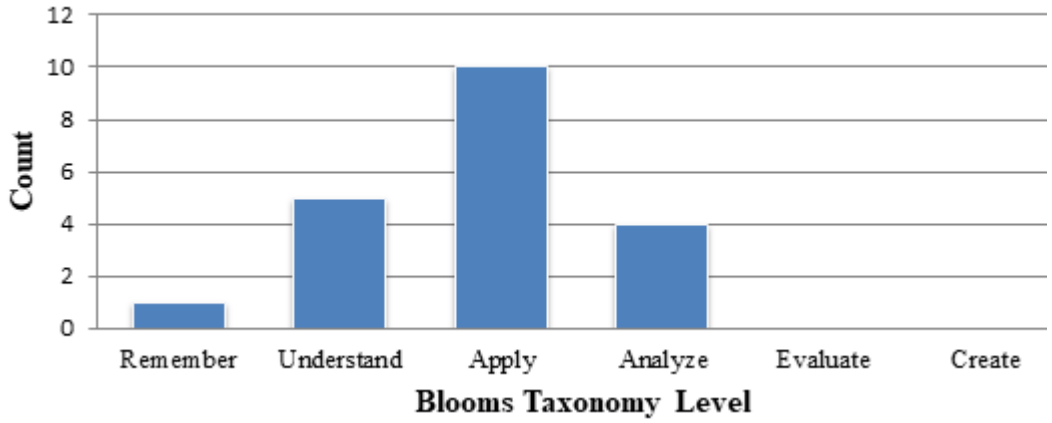
MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

Q.No		All Questions carry equal marks	Taxonomy	CO's	PO's
1	a	Explain the angle of heel in the case of a two wheeler negotiating a curve.	Understand	CO 1	PO 1
	b	The mass of the motor cycle along with the rider is 180 kg. The height of the centre of gravity of total mass is 600 mm above the ground when it moves straight. Each wheel has a diameter of 700 mm and mass moment of inertia of 2 kgm The engine rotates at a speed of 5 times the road wheel 2and engine rotating parts have mass moment of inertia of 0.2 kgm . Find the angle of heel if it is travelling at 50 km/h and is taking a turn of 30 meters radius.	Apply	CO 2	PO 2
2	a	Explain the effect of gyroscopic couple on an automobile taking left turn.	Understand	CO 2	PO 1,2
	b	A uniform disc having a mass of 8 kg and radius of gyration 150 mm is mounted on one end of a horizontal arm of length 200 mm. The other end rotates freely in a bearing. The disc is given a clockwise spin of 240 rpm. Determine the motion of the disc if its arm remains horizontal.	Apply	CO 1	PO 1
3	a	Deduce expression for the friction torque for a flat collar bearing considering uniform wear.	Understand	CO 4	PO 1
	b	A conical pivot supports a load of 10kN, cone angle is 1100 and intensity of pressure normal to the cone is $0.3N/mm_2$. The outer diameter is twice the inner diameter. Find the outer and inner radii of bearing surface if the shaft rotates at 300 rpm and $\mu = 0.1$. Find the power absorbed in friction assuming uniform wear.	Apply	CO 4	PO 1
4	a	Deduce expression for the friction torque for a flat collar bearing considering uniform pressure.	Understand	CO 4	PO 1

	b	A band brake acts on 3/4th of a circumference of a brake drum of 450 mm diameter which is keyed to a shaft. The band brake provides a braking torque of 225 Nm. One end of the lever is attached to a fulcrum pin of the lever and the other end is attached to a pin 100 mm from the fulcrum. If the operating force is applied at 500 mm from the fulcrum and coefficient of friction is 0.25, find the operating force when the drum rotates in Clock-wise direction and anti-clockwise direction.	Apply	CO 4	PO 2,4
5	a	Describe the graphical method of determining the inertia of the connecting rod of reciprocating engine.	Understand	CO 4	PO 1
	b	The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1mm to 500 Nm of torque and 1mm to 60 of crank displacement The intercepted areas between the output torque curve and the mean resistance line taken in order from one end of the engine are $-30, +410, -280, +320, -330, +250, -360, 280mm^2$ when the engine runs at 800 rpm. The engine has a stroke of 300mm and the fluctuation of speed is not to exceed 2% of mean speed. Determine suitable diameter and cross section of the flywheel rim for a limiting value of safe centrifugal stress of 7 Mega Pascal. The material density is $720kg/m^3$. Width of the rim is 5 times the thickness.	Apply	CO 5	PO 1
6	a	Derive an expression for the angular acceleration of the connecting rod of a reciprocating engine.	Understand	CO 4	PO 2
	b	The effective turning moment exerted by a two stroke engine at the crank shaft is $T = 800 + 100 \sin 2\theta - 200 \cos \theta$ where θ is the inclination of the crank to inner dead center. The mass of the flywheel is $400\,kg$ and radius of gyration is $550\,mm$. The engine speed is $200\,rpm$. Determine the power developed, the total percentage fluctuation of speed and maximum angular retardation.	Apply	CO 5	PO 2,4
7	a	Explain the balancing of reciprocating masses with a neat sketch.	Understand	CO 7	PO 1

	b	A rigid rotor has its unbalance in one plane and can be considered to consist of three masses $m_1 = 5kg$ at an angle of 300 from mass m1 in anti clockwise direction, $m_2 = 3kg$ at an angle of 1650 *counterclockwise* from m_1 and $m_3 = 8kg$ at angle 850 *clockwise* from m_1. The radii $r_1 = 200mm$, $r_2 = 80\,mm$ and $r_3 = 140\,mm$. Determine the balancing mass required at a radius of $100\,mm$. Specify the location of this mass with respect to m_1.	Apply	CO 7	PO 2,4
8	a	Derive the expression for hammer blow in locomotive balancing.	Understand	CO 7	PO 1
	b	The cranks of a three cylinder locomotive are set at 1000. The stroke is $110\,mm$, the length of the connecting rod is $140\,mm$, the mass of the reciprocating parts per cylinder is $1\,Kg$ and the speed of the crank shaft is $2400\,rpm$. Determine the magnitude of primary and secondary balancing.	Apply	CO 7	PO 2,4
9	a	Derive an expression for the natural frequency of forced longitudinal vibrations	Understand	CO 8	PO 1
	b	A shaft $100mm$ diameter and $1000\,mm$ long is fixed at one end and the other end carries a flywheel of mass $90\,kg$. The radius of gyration of the flywheel is $500\,mm$. Find the frequency of torsional vibration, if the modulus of rigidity for the shaft material is $80\,GN/m^2$.	Apply	CO 8	PO 1
10	a	What is meant by the term critical damping?	Understand	CO 9	PO 1
	b	A cantilever shaft of 50 mm diameter and $300\,mm$ long has a disc of mass $100\,kg$ at its free end. The Youngs modulus of the shaft material is $200\,GN/m^2$. Determine the frequency of longitudinal and transverse vibrations of the shaft.	Apply	CO 8	PO 2

KNOWLEDGE COMPETENCY LEVELS OF MODEL QUESTION PAPER



Signature of Course Coordinator **HOD, ME**
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