Hall Ticket No | | | | | | | | | | | Question Paper Code: AME011

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R16

DYNAMICS OF MACHINERY

Time: 3 Hours **(ME)** **Max Marks: 70**

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

UNIT – I

1. (a) Explain the effects of gyroscopic couple on the reaction of the wheels of a four-wheeler negotiating a curve. **[7M]**

   (b) The rotor in a ship has a mass of 3500 kg and a radius of gyration of 0.45 m. It rotates at a speed of 3000 rpm anticlockwise when looking from the bow. Find the gyroscopic couple and its effect upon the ship:

   i. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.

   ii. when the ship is pitching in simple harmonic motion, the bow falls with maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. **[7M]**

2. (a) State D'Alembert's principle and explain how it simplifies a dynamic problem into an equivalent static one. **[7M]**

   (b) The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has moved 60^0 from the inner dead center, load on the piston is 68730N. The connecting rod length between centers is 1.2m and the cylinder bore is 0.5 m. If the engine runs at 250 rpm and the effect of piston rod diameter is neglected, Find: **[7M]**

   i. Pressure on slide bars
   ii. Tangential force on the crank-pin
   iii. Turning moment on the crank shaft.

UNIT – II

3. (a) With the help of a neat sketch, describe the construction and working of a centrifugal clutch. **[7M]**

   (b) A single plate clutch, both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point on the contact surface should not exceed 0.1 N/mm^2. Take the coefficient of friction as 0.3, and find the power transmitted by the clutch at a speed of 2500 rpm. **[7M]**

4. (a) With a neat sketch, explain the working of an internal expanding brake. **[7M]**

(b) A band brake shown in Figure 1 laps around 270^0 of a drum of 450 mm diameter which is keyed to the shaft. The brake provides a braking torque of 225 N-m. One end of the band is fixed to a fulcrum pin of the lever and the other end to a pin 100 mm from the fulcrum. An operating force is applied at 500 mm from the fulcrum and the coefficient of friction is 0.25. Find the operating force when the drum rotates in the

i. Clockwise direction **[7M]**

ii. Anticlockwise direction.

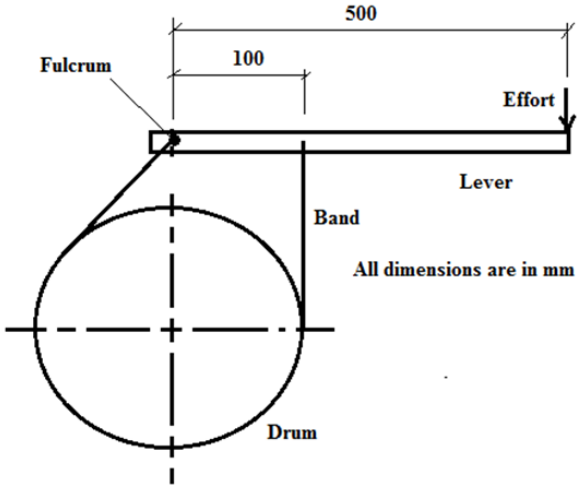

Figure 1

UNIT – III

5. (a) Draw a turning moment diagram for a four-stroke compression ignition internal combustion engine and explain it. **[7M]**

(b) The turning moment diagram shown in Figure 2 for a multi-cylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3^0 horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows: + 52, – 124, + 92, – 140, + 85, – 72 and + 107 mm^2, when the engine runs at a speed of 600 rpm. If the total fluctuation of speed is not to exceed ± 1.5% of the mean, find the mass of the flywheel whose radius of gyration is0.5 m. **[7M]**

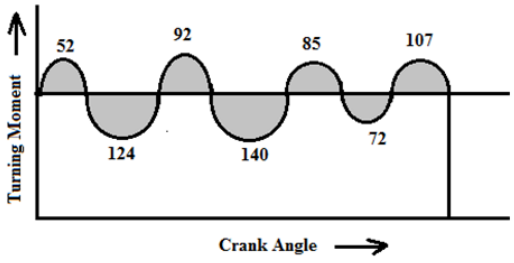

Figure 2

6. (a) With the help of a neat sketch, explain the construction and working of a Hartnell governor. **[7M]**

   (b) A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. **[7M]**

UNIT – IV

7. (a) Explain the 'direct and reverse crank' method for determining unbalanced forces in radial engines. **[7M]**

   (b) Four masses m1, m2, m3 and m4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45^0, 75^0 and 135^0. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. **[7M]**

8. (a) Explain the method of balancing of different masses revolving in the same plane. **[7M]**

   (b) The cranks of a four-cylinder marine oil engine are arranged at angular intervals of 90^0. The engine speed 70 rpm and the reciprocating mass per cylinder is 800 kg. the inner cranks are 1 m apart and are symmetrically arranged between the outer cranks which are 2.6 m apart. Each crank is 400 mm long. Determine the firing order of the cylinders for the best balance of reciprocating masses and also the magnitude of the unbalanced primary couple for that arrangement. **[7M]**

UNIT – V

9. (a) Discuss briefly with neat sketches the longitudinal, transverse and torsional free vibrations **[7M]**

   (b) An instrument vibrates with a frequency of 1 Hz when there is no damping. When the damping is provided, the frequency of damped vibrations was observed to be 0.9 Hz. Find the damping factor and logarithmic decrement. **[7M]**

10. (a) Derive the equation for natural frequency of free torsional vibration of three rotor systems **[7M]**

    (b) Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is 40 Mg/m^3, and Young's modulus is 200 GN/m^2. Assume the shaft to be freely supported. **[7M]**

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Supplementary) - January, 2019

Regulation: IARE – R16

DYNAMICS OF MACHINERY

Time: 3 Hours **(ME)** **Max Marks: 70**

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

UNIT – I

1. (a) Derive a formula to determine the magnitude and direction of gyroscopic couple. **[7M]**

   (b) A four-wheeled motor car of mass 2000 kg has a wheel base of 2.5 m, trackwidth of 1.5 m and its centre of gravity 500 mm above the ground level. Weight on both front wheels put together is 11770N and that on the rear wheels is 7874N.Each wheel has an effective diameter of 0.8 m and a moment of inertia of 0.8 kg-m^2.The drive shaft, engine flywheel and transmission are rotating at four times the speed of road wheel, in anticlockwise direction when viewed from the rear, and are equivalent to a mass of 75 kg having a radius of gyration of 100 mm. If the car is taking a right turn of 60 m radius at 60 km/h, find the load on each wheel. **[7M]**

2. (a) Explain the effect of gyroscopic couple on a ship pitching upward. With a neat sketch explain gyroscopic effect in a four wheeler. **[7M]**

   (b) The dimensions of 4 link mechanism are AB = 500 mm, BC = 660 mm, CD= 560 mm and AD= 1000 mm. The link AB has an angular velocity of 10.5 rad/sec counter clock wise and an angular retardation of 26 rad/sec^2 at the instant when it makes an angle of 60^0 with AD, the fixed link. The mass of the link BC and CD is 4.2 kg/m length. The link AB has a mass of 3.54 kg the center of which lies at 200 mm from A and a moment of inertia of 88550 kg.mm^2. Neglecting gravity and friction effects determine instantaneous value of the drive torque required to be applied on AB to overcome the inertia forces. **[7M]**

UNIT – II

3. (a) Describe with a neat sketch a centrifugal clutch and deduce an equation for the total torque transmitted. **[7M]**

   (b) A single block brake is shown in Figure 1. The diameter of the drum is 250 mm and the angle of contact is 90^0. If the operating force of 700 N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.35, determine the torque that may be transmitted by the block brake. **[7M]**

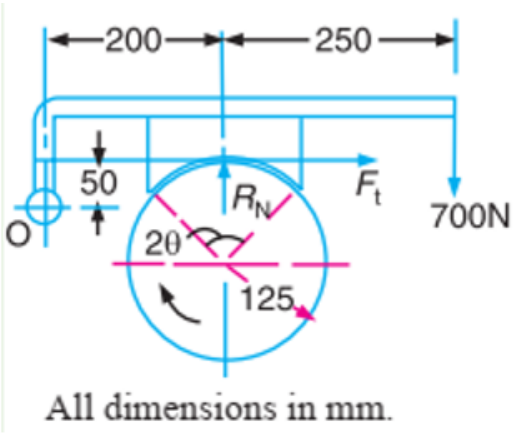

Figure 1

4. (a) Describe the construction and functioning of a transmission type dynamometer. **[7M]**

   (b) Figure 2 shows a winch stopping a weight 'W' with a differential band brake acting on a drum 800 mm diameter. The two ends of the bands are attached to pins on opposite sides of the fulcrum of the brake lever and at distances of 25 mm and 100 mm from the fulcrum. The angle of lap of the brakeband is 250^0 and the coefficient of friction is 0.25. Determine the braking torque when a force of 750 N is applied to the lever at a distance of 3000 mm from the fulcrum. **[7M]**

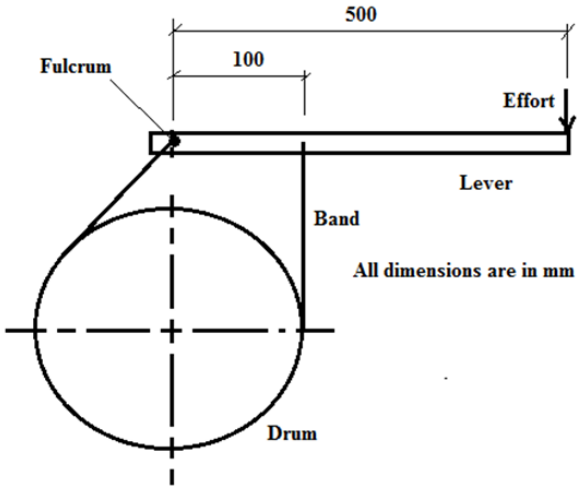

Figure 2

UNIT – III

5. (a) Define the terms coefficient of fluctuation of energy and coefficient of fluctuation of speed. Derive the relation for the coefficient of fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the flywheel at mean speed. **[7M]**

   (b) The turning moment diagram for a four stroke gas engine may be assumed for simplicity to be represented by four triangles, the areas of which from the line of zero pressure are as follows: Suction stroke = $0.45 \times 10^{-3} m^2$; Compression stroke = $1.7 \times 10^{-3}\ m^2$; Expansion stroke = $6.8 \times 10^{-3}\ m^2$; Exhaust stroke = $0.65 \times 10^{-3} m^2$. Each m^2 of area represents 3 MN-m of energy.

Assuming the resisting torque to be uniform, find the mass of the rim of a flywheel required to keep the speed between 202 and 198 r.p.m. The mean radius of the rim is 1.2 m. **[7M]**

6. (a) What are centrifugal governors? How do they differ from inertia governors? Describe the function of a Proell governor with a neat sketch. **[7M]**

   (b) Each arm of a porter governor is 250 mm long. The upper and lower arms are pivoted to links of 40 mm and 50 mm respectively from the axis of rotation. Each ball has mass of 5 kg and the sleeve mass is 50 kg. The force of friction on the sleeve of the mechanism is 40 N. Determine the range of speed of the governor for extreme radii of rotation of 125 mm and 150 mm. **[7M]**

UNIT – IV

7. (a) Write a short note on primary and secondary balancing. **[7M]**

   (b) Four masses A, B, C and D are completely balanced. Masses C and D makes an angle of 90^0 and 195^0 respectively with B in the same sense. The rotating masses have the following properties. M_b= 25Kg, r_a=150 mm, m_c=40 kg, r_b=200 mm, m_d=35 kg, r_c= 100mm, r_d=180 mm planes B and C are 250 mm apart. Determine **[7M]**

   i) The mass A and its angular position

   ii) The position of planes A and D

8. (a) Explain balancing of radial engines using direct and reverse crank methods. **[7M]**

   (b) A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400 mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. **[7M]**

UNIT – V

9. (a) Explain Dunkerley's method to determine the natural frequency of a shaft carrying a number of point loads and a uniformly distributed load along its entire span. **[7M]**

   (b) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass100 kg at its free end. Young's modulus for the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft. **[7M]**

10. (a) Explain the following: **[7M]**

    i. Forced vibration

    ii. Vibration isolation

    iii. Vibration transmissibility.

    (b) A mechanical vibrating system has amass of 8 kg and a spring whose stiffness is 5.4 N/mm. If the vibrating system has a dashpot exerting a force of 40 N when the mass moves at a velocity of 1 m/s, find:

    i. Critical damping coefficient **[7M]**

    ii. Damping factor

    iii. Logarithmic decrement.

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