Code : 102602

B.Tech 6th Semester Exam., 2022

(New Course)

DYNAMICS OF MACHINERY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

1. Choose the correct answer (any *seven*) : 2×7=14

(a) In a slider-crank mechanism, at which crank angle the connecting rod has zero angular velocity?

(i) 0°

(ii) 30°

(iii) 45°

(iv) 90°

(v) 180°

(b) The follower normally used in aircraft engine is

(i) roller

(ii) flat-faced

(iii) spherical-faced

(iv) knife-edged

(v) Not specific

(c) The point on the cam having maximum pressure angle is known as

(i) pitch point

(ii) prime point

(iii) pressure point

(iv) trace point

(v) track point

(d) For the member under the action of two forces, which of the following conditions must be satisfied for the equilibrium?

(i) Forces should be of same magnitude

(ii) Forces should act along same line

(iii) Forces should act in opposite direction

(iv) Both *(i)* and *(ii)*

(v) *(i)*, *(ii)* and *(iii)*

(e) The radius of disc is r and is spinning with angular velocity of ω. The axis of spin changes its angular position by θ. What shall be the angular acceleration of disc?

(i) $d\omega / dt$

(ii) $\omega(d\theta / dt)$

(iii) $r\omega^2$

(iv) $r(d\omega / dt)$

(v) $\omega(d\omega / dt)$

(f) In case of rotating mass, how does the magnitude of balancing mass change when speed of the shaft is increased by two?

(i) Halved

(ii) Remains same

(iii) Doubled

(iv) Quadrupled

(v) None of the above

(g) Which of the following four-stroke in-line engines is completely balanced inherently?

(i) 2-cylinder

(ii) 3-cylinder

(iii) 4-cylinder

(iv) 5-cylinder

(v) 6-cylinder

(h) At resonance, the amplitude of vibration is

(i) large

(ii) very large

(iii) small

(iv) zero

(v) Cannot say

(i) The rotor of the turbine is usually rotated

(i) at the critical speed

(ii) near the critical speed

(iii) much below the critical speed

(iv) slightly above the critical speed

(v) much above the critical speed

(j) A torsional vibratory system with two rotors connected at extremities of the shaft has

(i) one node

(ii) two nodes

(iii) three nodes

(iv) four nodes

(v) no node

2. (a) Discuss the condition of the equilibrium of body under actions of two forces and torque with suitable figures. 4

(b) State the procedure for the dynamic analysis of four-link mechanism. 4

(c) Draw and discuss (i) knife-edge follower and (ii) flat-faced follower. 3

(d) Classify followers, according to the constraint. 3

3. (a) Explain turning moment diagram for 2-stroke and 4-stroke single cylinder IC engine. 4

(b) A mass of the steam engine flywheel is 1500 kg and radius of gyration is 0·6 m. For the engine starting from the rest, determine the angular acceleration, speed and kinetic energy after 20 seconds. Take the constant starting torque of the engine as 1400 N-m. 4

(c) Discuss flywheel and its uses. 3

(d) Define coefficient of fluctuation of energy and coefficient of fluctuation of speed. 3

4. (a) Draw the cam profile for the following particulars : 4

Disc cam, knife-edge follower, radial and reciprocating follower, uniform motion during out-stroke (first-half) and return-stroke (second-half), minimum radius of cam is 30 mm, and follower lift is 40 mm

(b) Construct the displacement diagram of cam that gives simple harmonic motion to the follower with the following particulars : 4

Out-stroke = 50 mm, division on harmonic semicircle = 12, cam displacement = 360°

(c) What is offset follower? How is it different from radial follower? 3

(d) Sketch typical displacement and velocity diagrams for the follower moving with constant velocity during out-stroke. 3

5. (a) Draw spinning top and show spin axis, input axis and output axis clearly. Also show all three major planes. Use the centre of gravity of top as the origin of reference frame. 4

(b) Discuss the effect of the gyroscopic couple on the ship. 4

(c) Derive gyroscopic couple equation. 3

(d) What is spin and precession in gyroscopic motion? 3

6. (a) The turbine rotor of the ship is rotating at 1200 r.p.m. clockwise when viewed from stern. It has mass of 8 tonnes and radius of gyration as 0·6 m. Determine the gyroscopic couple, if ship is moving at 30 km/h and steers to the left in a curvature of 100 m radius. 4

(b) A four-wheeled trolley car is 2000 kg. Each axle has two wheels and a gear set with combined moment of inertia of 30 kg m^2. Each wheel has 0·5 m radius. The centre distance between wheels on each axle is 1·5 m and driven by dedicated motor with speed ratio 1:2·5. Each motor and corresponding gear set has a moment of inertia of 15 kg m^2 and rotates in the opposite direction to that of the axle. Assume that the centre of mass of car is at 1 m from rail. Calculate the limiting speed of the car when it has to travel around a curve of 200 m radius safely. 4

(c) Show with neat sketches, the effect of gyroscopic couple on the motion of an aeroplane while taking turn. 3

(d) Derive the equation of the angle of heel for two-wheeled vehicle to avoid skidding. 3

7. (a) An engine runs at 2000 r.p.m. and has three cylinders at 120°. The connecting rods are coupled to the single crank. Each reciprocating part is of 3 kg, length of each connecting rod is 0·32 m and stroke of 0·15 m. Determine the primary forces using direct and reverse crank. 4

(b) For the one-cylinder reciprocating engine, rotating mass is 10 kg at the crank radius, reciprocating mass 12 kg, crank is 150 mm, connecting rod is 450 mm, and the speed of engine is 210 r.p.m. If 62% of reciprocating mass and complete rotating mass is to be balanced, determine the balance mass required at a distance of 1·2 times crank radius and an unbalanced force at 45° position of crank from top-dead centre. 4

(c) Derive an expression for swaying couple. 3

(d) Describe in brief the balancing of inline engine. 3

8. (a) Determine the equivalent spring constant for the following cases : 4

(i) Two springs with stiffness k_1 and k_2 in series

(ii) Two springs with stiffness k in parallel

(b) A harmonic motion is expressed by $x = 10^* \sin(25^* \pi^* t - \pi/2)$ with x as displacement in m and t as time in second. Determine *(i)* frequency of motion, *(ii)* period of motion, and *(iii)* displacement, velocity, and acceleration of motion at 0·5 sec. 4

(c) What is damped vibration? How can the external damping to the system be increased? What shall be damping ratio (ξ) for critical damping, over-damping and under-damping? 3

(d) What is magnification factor? Write its equation and list all parameters in it. 3

9. (a) A 2 m long and 0·1 m diameter shaft has one end fixed and its other end is attached with the disc of mass 1000 kg. The radius of gyration of the disc is 0·5 m. Determine the frequency of the torsional vibration. Assume the modulus of rigidity of the shaft as 100 GN/m^2. 4

(b) A freely supported shaft of diameter 25 mm and length 1 m is carrying a mass of 5 kg at the mid-point. Calculate its whirling speed. Assume Young's modulus and density of shaft material as 210 GPa and 7800 kg/m^3. 4

(c) Derive an equation of the natural frequency of the free longitudinal vibration by energy method. 3

(d) Derive an expression for the natural frequency of the free longitudinal vibration by equilibrium method. 3

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