



B.E./B.Tech. (Full Time) DEGREE END SEMESTER EXAMINATIONS NOV/DEC 2011  
MECHANICAL ENGINEERING BRANCH  
FOURTH SEMESTER

ME-9253 DYNAMICS OF MACHINES

Time: 3 hr

Max Mark: 100

Answer ALL Questions  
Part-A (10 x 2 = 20 mark)

- 1) State what do you understand by the term dynamic equilibrium
- 2) What is meant by dynamically equivalent systems?
- 3) Define the following terms
  - a) Coefficient of fluctuation of speed
  - b) Coefficient of fluctuation of energy
- 4) Define the following in locomotive engines
  - (i) Hammer blow
  - (ii) Swaying couple
- 5) What is meant by D'Alembert's principle? What is the use of this principle
- 6) Differentiate between balancing of rotating masses and reciprocating masses?
- 7) What is meant by primary and secondary unbalance in reciprocating engines?
- 8) Define the following : i. Natural frequency of vibration ii. Logarithmic decrement
- 9) Write down the differential equation for the single degree free torsional vibration ' $\theta(t)$ ' of a simple shaft rotor system having rotor inertia  $J_o$ , shaft torsional stiffness  $q$ . What is the nature of the solution of ' $\theta(t)$ '?
- 10) Derive an expression for the gyroscopic torque experienced by spinning disc executing precessional motion.

Part – B (5 x 16 = 80 Mark)

11. (i) A crank of an engine, having mass 1 kg, rotates at 2400 rpm at a particular time. If the mass centre is located at 200 mm from the bearing centre on which the crank is supported, find the inertia force transmitted to the bearing. (6 mark)
- (ii) A two cylinder engine is having a flywheel of mass 906 kg and its radius of gyration is 675 mm. The engine develops 26.5 kW of power and the mean speed is 270 rpm. If the allowable coefficient of energy fluctuation is 1.93, find the maximum and minimum speed of the flywheel. (10 mark)
12. a) A shaft carries four masses A, B, C and D of magnitude 200kg, 300kg, 400kg and 200 kg respectively and revolving at radii 80mm, 70mm, 60mm and 80mm in plane measured from A at 300mm, 400mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45 degree, B to C 70 degree, and C to D 120 degree. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100mm, between X and Y is 400mm and between Y and D is 200mm. If the balancing masses revolve at a radius of 100mm, find their magnitudes and angular positions. (16 mark)

(or)

(b) The cylinders of a twin V-engine are set at  $60^\circ$  angle with both pistons connected to a single crank through their respective connecting rods. Each connecting rod is 600mm long and the crank radius is 120mm. The total rotating mass is equivalent to 2kg at the crank radius and the reciprocating mass is 1.2kg per piston. A balance mass is also fitted opposite to the crank equivalent to 2.2kg at a radius of 150mm. Determine the maximum and minimum values of the primary and secondary forces due to inertia of the reciprocating and the rotating masses if the engine speed is 800rpm. (16 mark)

13) (a) A 500 kg vehicle is mounted on springs such that the springs deflects under the weight by 1.5 mm. If a damper is to be attached parallel to the springs in such a way that the vehicle is critically damped, find the damping constant of the damper. (6 mark)

b) a steel shaft 1.5 m long is 95 mm in diameter for the first 0.6 m of its length, 60 mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining 0.4 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 kg and 0.85 m radius of gyration located at the 95 mm diameter end and the second having a mass of 700 kg and 0.55 m radius of gyration located at the other end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as  $80 \text{ GN/m}^2$  (10 marks)

(or)

A shaft 25 mm in diameter with a span of 900 mm has simply supported ends. It carries a disc 125 N midspan. The eccentricity of the disc is 0.25mm. What is the lateral critical speed of the shaft? If the bending stress of the shaft is not to exceed 100 MPa. Determine the range of speed in which it is unsafe to run this rotor. (16 mark)

14) (a) A 500 kg vehicle is mounted on springs such that the springs deflects under the weight by 1.5 mm. If a damper is to be attached parallel to the springs in such a way that the vehicle is critically damped, find the damping constant of the damper. (6 mark)

(b) A weight of 55 N suspended by a spring of stiffness 1.1 k N /m is forced to vibrate by a harmonic force of amplitude 9 N. Taking viscous damping constant as  $77 \text{ N.s/m}$ , find (i) Resonant frequency (ii). Amplitude at resonance (iii). Phase angle at resonance (iv) Amplitude of vibration if the frequency of the excitation force 180 c/ min. (10 mark)

(or)

A single cylinder vertical engine weighing half a tonne with a vertical line of stroke has a predominant exciting frequency of 6000 rpm. It is supported by four helical springs. Transmissibility of the isolator is 1/10. What should be the natural frequency of the system? What is the required stiffness of each helical spring? Each helical spring has a number of active coils  $n=10$ . What is the mean diameter  $D$  of the coils?  $G$  for spring steel 80,000 MPa. Stiffness of spring =  $Gd^4/8D^3n$  ( $D/d=1/2$ ) (16 mark)

15 (a) A motorcycle and its rider together have a mass of 200kg and their combined centre of gravity is 0.6m above ground level when the motorcycle is up right. Each road wheel is 0.6m diameter and has  $M.I$   $1.0\text{kgm}^2$ . The rotating parts of the engine have a  $M.I$

$0.17\text{kgm}^2$ . Engine speed is 5.5 times the speed of the wheels and in the same sense. When the motor cycle is turning a curve of 30m radius at a speed of 55km/hr, find 1. Gyroscopic couple 2. Couple due to centrifugal force 3. balancing couple 4. angle of heel (16 mark)

(or)

(b) (a) What is meant by controlling force curve of a governor? Sketch the controlling force curve of a gravity controlled governor. (4 mark)

(b) A Porter governor has all the four arms of 30cm each and are pivoted on the axis of the of rotation. The mass of the each governor ball is 1kg and the mass of the sleeve is 20kg. Find the speed of the governor when the balls rotate at a radius of 15cm. If the friction is equivalent to 12 N. Find the coefficient of insensitivity at this speed (12 mark)