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Question Paper Code: 55071

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2017

Fifth Semester

Mechanical Engineering

15UME501 - DYNAMICS OF MACHINERY

(Data books are may be permitted)

(Regulation 2015)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

- In an engine, the work done by inertia forces in a cycle is
 - positive
 - negative
 - zero
 - both (a) and (b)
- When the crank is at the inner dead centre, in a horizontal reciprocating steam engine, then the velocity of the piston will be
 - zero
 - minimum
 - maximum
 - infinity
- The balancing of rotating and reciprocating parts of an engine is necessary when it runs at
 - slow speed
 - medium speed
 - high speed
 - a range of speed
- In order to have a complete balance of the several revolving masses in different planes
 - the resultant force must be zero
 - the resultant couple must be zero
 - both the resultant force and couple must be zero
 - none of these
- The factor which affects the critical speed of a shaft is
 - diameter of the disc
 - span of the shaft
 - eccentricity
 - all the above

calculate : i. pressure on slide bars, ii. thrust in the connecting rod, iii. tangential force on the crank-pin, and iv. turning moment on the crank shaft. (16)

Or

(b) (i) The flywheel of a steam engine has a radius of gyration of 1 m and mass 2500 kg. The starting torque of the steam engine is 1500 N-m and may be assumed constant. Determine: i. the angular acceleration of the flywheel, and ii. the kinetic energy of the flywheel after 10 seconds from the start. (8)

(ii) A horizontal cross compound steam engine develops 300 kW at 90 r. p. m. The coefficient of fluctuation of energy as found from the turning moment diagram is to be 0.1 and the fluctuation of speed is to be kept within $\pm 0.5\%$ of the mean speed. Find the weight of the flywheel required, if the radius of gyration is 2 metres. (8)

17. (a) Four masses m_1 , m_2 , m_3 and m_4 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° , 75° and 135° . Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. (16)

Or

(b) A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190° , both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine : 1. The magnitude of the masses at A and D ; 2. The distance between planes A and D ; and 3. the angular position of the mass at D. (16)

18. (a) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Young's modulus for the shaft material is 200 GN/m^2 . Determine the frequency of longitudinal and transverse vibrations of the shaft. (16)

Or

(b) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75%

of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. $E = 200 \text{ GN/m}^2$. (16)

19. (a) The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine : 1. stiffness of the spring, 2. logarithmic decrement and 3. damping factor, i.e. the ratio of the system damping to critical damping. (16)

Or

- (b) The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the five springs. Determine 1. stiffness of each spring; 2. dynamic force transmitted to the base at the operating speed; and 3. natural frequency of the system. (16)

20. (a) The arms of a Porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 mm from the axis of rotation. The mass of the load on the sleeve is 70 kg and the mass of each ball is 10 kg. Determine the equilibrium speed when the radius of rotation of the balls is 200 mm. If the friction is equivalent to a load of 20 N at the sleeve, what will be the range of speed for this position? (16)

Or

- (b) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 r.p.m. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions:
- (i) The ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius
 - (ii) The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds
 - (iii) The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern.

Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case. (16)