b) A governor of the Hartnell type has equal balls of weight 29.43 N set initially at a radius of 20 cm. The arms of the bell crank lever are 12 cm vertically and 15 cm horizontally. Find
   i) the initial compressive force on the spring, if the speed for an initial ball radius of 20 cm is 240 r.p.m. and
   ii) the stiffness of the spring required to permit a sleeve movement of 0.4 cm on a fluctuation of 7 percent in the engine speed.

15. a) A shaft of 8 cm diameter and 80 cm length has one of its ends fixed and the other end carries a disc of weight 4800 N. The Young's modulus of elasticity for the material of the shaft is 196.2 kN/mm². Determine the frequency of the longitudinal and traverse vibrations.

(OR)

b) A vertical steel shaft 15 mm diameter is held in long bearing 100 cm apart and carries at its middle a disc weighing 147.15 N. The eccentricity of the center of gravity of the disc from the center of the rotor is 0.30 mm. The modulus of elasticity for the shaft material is 19.6×10^6 N/cm² and the permissible stress is 6867 N/cm². Determine
   i) the critical speed of the shaft
   ii) the range of speed over which it is unsafe to run the shaft. Neglect the weight of the shaft.

PART – C **(1×15=15 Marks)**

16. a) A shaft running at 100 r.p.m. is to drive another shaft at 250 r.p.m. and transmit 11 kw. The driving and driven shafts are positioned vertically. The belt is 11.5 cm wide and 12 mm thick and the coefficient of friction between the belt and the pulley is 0.25. The distance between the shafts is 2.8 m and smaller pulley is 60 cm in diameter.
   i) Which type of flat belt drive do you prefer ? Open or cross. Justify.
   ii) Calculate the stress in the belt.

(OR)

b) A reciprocating I.C. engine is coupled to a centrifugal pump through gearing. The shaft from the flywheel of the engine to the gear wheel is 4.5 cm diameter and 95 cm long. Shaft from the pinion to the pump is 3 cm diameter and 30 cm long. Engine speed is ¼ the pump speed. Other particulars are as follows. Moment of inertia of the flywheel A = 800 kg.m², Moment of inertia of the gear wheel G = 15 kg.m², Moment of inertia of the pinion P = 4 kg.m², Moment of inertia of the pump impeller B = 17 kg.m². Determine the natural frequency of the torsional oscillation of the system. Take $G = 84 \times 10^4$ bar.

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Question Paper Code : 90519

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019
Fourth Semester
Aeronautical Engineering
PR 8451 – MECHANICS OF MACHINES
(Common to Automobile Engineering/Industrial Engineering/Manufacturing Engineering/Mechanical and Automation Engineering/Production Engineering)
(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

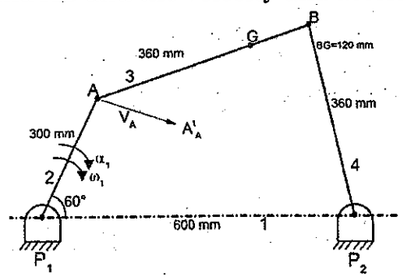
Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Define the term mechanism.
2. List the types of cam followers.
3. State any two laws of frothed gearing.
4. Define gear trains.
5. List the types of friction.
6. Classify belt drives.
7. Why balancing of dynamic forces are necessary ?
8. Explain the gyroscopic effect.
9. What is vibration isolation ?
10. What is critical speed ?

PART – B (5×13=65 Marks)

11. a) The dimensions and configuration of the four bar mechanism are shown in figure below P_1A = 300 mm, P_2B = 360 mm, AB = 360 mm. BG = 120 mm. P_1P_2 = 600 mm. The angle between $\angle AP_1P_2$ = 60°. The crank P_1A has an angular velocity of 10 rad/s and angular acceleration of 30 rad/s², both clockwise. Determine the angular velocities and angular acceleration of P_2B and AB and the velocity and acceleration of the points B and G.



(OR)

b) Draw the cam profile for a knife-edge follower with the following data :
   i) Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion,
   ii) Dwell for the next 30°,
   iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion,
   iv) Dwell during the remaining 180°.

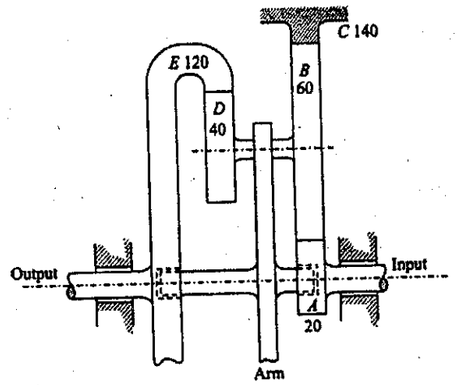
   The radius of the base circle of cam is 40 mm. Determine the maximum velocity of the follower during its ascent and descent, if the cam rotates at 240 r.p.m.

12. a) Two equal involute gear wheels of 20° pressure angle have 20 teeth each. Calculate length of arc of contact if the addendum was standard and equal to one module. Pitch of teeth is 6 mm of diameter per tooth. What should be the addendum, if the arc of contact is to be maximum possible ? What is the length of arc of contact ?

(OR)

b) In the planetary gear train shown in below figure, gear A is the driver and gears B and D are compounded. Gears E and C are internal gears with C as the fixed gear. Number of teeth on gears are : T_A = 20; T_B = 60; T_C = 140;

T_D = 40; T_E = 120. If the driver gear rotates at 720 rpm CCW when seen from the right, find out the speed at which driven gear rotates.



13. a) Two tie rods are connected by a turn-buckle having right and left handed threads. The threads are V-type (metric) and have a pitch of ½ cm (i.e., 2 threads per cm) on a mean diameter of 3 cm and thread angle of 60°. Assuming μ = 0.18, find the torque required to produce a pull of 39 kN
   i) when the rods are tightened
   ii) when the rods are loosened.

(OR)

b) A single plate friction clutch, with both sides of the plate being effective, is used to transmit power of an engine at 2400 r.p.m. It has outer and inner radii 4.5 and 3.5 cm respectively. The pressure is applied axially by means of springs and the maximum intensity of pressure is 7.85 N/cm². If the coefficient of friction is 0.3, find
   i) the total axial pressure exerted by the springs, and
   ii) power transmitted.

14. a) A shaft carries four masses of A, B, C and D placed in parallel planes perpendicular to the shaft axis and in this order along the shaft. The masses of B and C are 353 N and 245.4 N respectively and both are assumed to be concentrated at a radius of 15 cm, while the masses in planes A and D are both at a radius of 20 cm. The angle between the radii of B and C is 100° and that between B and A is 190°, both angles being measured in the same sense. The planes containing A and B are 25 cm apart and those containing B and C are 50 cm apart. If the shaft is to be in complete dynamic balance, determine
   i) Masses of A and D
   ii) Distance between the planes containing C and D
   iii) Angular position of the mass D.

(OR)