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Question Paper Code : X 11004

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2021

Fourth Semester

Aeronautical Engineering

PR 8451 – MECHANICS OF MACHINES

(Common to Aerospace Engineering/Automobile Engineering/Industrial Engineering/Manufacturing Engineering/Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three Hours

Maximum : 100 Marks

Answer ALL questions.

Use of Drawing sheets is permitted.

1. Name any three kinematic inversions of double slider crank chain mechanism.
2. Classify cams according to the shape of the cam.
3. State the law of gearing.
4. Differentiate between cycloidal gears and involute gears.
5. Define the angle of friction and angle of repose with respect to friction.
6. Write the expression for length of belt for open belt drive and cross belt drive.
7. Compare between the function of flywheel and governor.
8. Define hammer blow in the effect of balancing of locomotives.
9. Write the natural frequency expressions of transverse vibrations in multi degree of freedom system in Dunkerley's method.
10. Write the equation of motion of spring mass damper system when it is subjected to harmonic force.



11. a) Mechanism of planar mechanism with three sliding pairs is shown in Figure 1. All the dimensions are in cm. The crank O_2B rotates at 200 rad/min in clockwise direction. For the given specifications, determine the linear velocity of slider link 2 and the angular velocity of links 4, 6 and 7.

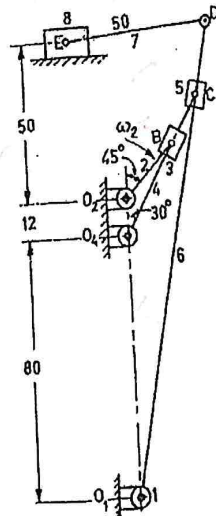


Figure 1

(OR)

- b) It is required to set out the profile of a cam to give the following motion to the reciprocating follower with a flat faced follower with a mushroom contact face :
- Follower to have a stroke length of 20 mm during 120° of cam rotation.
 - Follower to dwell for 30° of cam rotation.
 - Follower to return its initial position during 90° of cam rotation.
 - Follower to dwell for remaining 90° of cam rotation.
- The minimum radius of the cam is 25 mm. Outstroke and return of the follower is performed with simple harmonic motion.

12. a) i) A pinion having 15 teeth involute profile meshes with gear wheel of 60 teeth involute profile of module of 10 mm and pressure angle 20°. The addendum is 1 module. Determine the (i) if the interference takes place or not. (ii) and in case of interference takes place, how it can be prevented by increasing the pressure angle. (8)
- ii) A pinion and gear wheel in mesh have 20 and 40 involute teeth respectively. If the pressure angle is 20 and tooth module is 10 mm, discuss the status whether the interference takes place. (5)

(OR)



- b) An epicyclic gear train is shown in Figure 2. It comprises a fixed annular wheel A has 150 teeth. Wheel B meshes with wheel A and drives wheel D through an idler C. The wheels A and D are concentric. Arm F carries wheels B and C and rotates clockwise about the axis of A and D. If the wheels B and D have 25 and 40 teeth respectively, determine the number of teeth on C and its the speed and the direction of rotation and the speed of gear wheel D. Arm F rotates at 100 rpm clockwise.

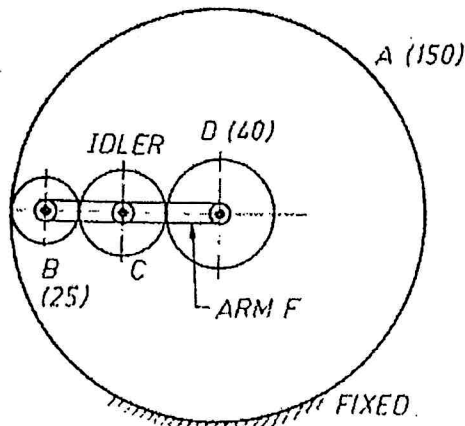


Figure 2

13. a) A single dry plate clutch transmits 15 kW at 1800 rpm. The axial pressure is limited to $0.8 \times 10^5 \text{ N/m}^2$. For the coefficient of friction of 0.3, determine (i) mean radius and width of friction lining assuming the ratio of mean radius to the face width as 4. (ii) external and internal radii of the clutch plate.

(OR)

- b) The following particulars refer to screw jack. Vertical load on the screw is 20 kN.
 Force applied at the lever end whose length 80 cm
 Mean radius of the screw 2.5 cm
 Pitch of the screw 1 cm
 Mean radius of contact surface between the swivel and head 4 cm
 Coefficient of friction between the screw thread and bearing 0.15
 Coefficient of friction between the swivel head and bearing surface 0.1
 Determine the force on the lever end while raising the load and lowering the load. Also determine the efficiency of the screw jack in both cases. Also determine all the values ignoring the frictional resistance at swivel head.

14. a) A shaft carries four rotating A, B, C and D in order as shown in Figure 3 along the axis. The mass A may be assumed concentrated at radius of 12 cm, B at 15 cm, C at 14 cm and D at 18 cm. The masses A, C and D are 15 kg, 10 kg and 8 kg respectively. The planes of rotation of A and B are 15 cm apart and of B and C are 18 cm apart. The angles between radii of A and C are 90° . If the shaft is in complete dynamic balance, determine

- The angles between the radii of A, B and D.
- The distance between the planes of revolution of C and D.
- and the mass B.

(OR)



b) Each arm of a porter governor is 200 mm long. The upper arm is pivoted to link at 30 mm from the axis and the lower arm is pivoted to link at 40 mm from the axis. Each ball has a mass of 5 kg and the mass of the sleeve is 50 kg. The force of friction and the opening gear of the mechanism is equivalent to a weight of 30 N at the sleeve. Determine the speed range of governor for extreme radii of 120 mm and 140 mm.

15. a) A single cylinder engine has an out of balance force of 500 N at an engine speed of 300 rpm. The complete mass of the engine is 150 kg and it is carried on a set of springs of total stiffness 300 N/cm. Find the amplitude of the study motion of the mass and the maximum oscillating force transmitted to the foundation. If a visous damper is interposed between the mass and the foundation, the damping force being 1000 N at 1 m/sec of velocity, find the amplitude of the forced damped oscillation of the forced damped oscillations of the mass and its angle of lag with disturbing force.

(OR)

b) A reciprocating internal combustion is coupled to centrifugal pump through gearing. The shaft from the flywheel of the engine to the gear wheel is 6 cm diameter and 95 cm long. Shaft from the pinion to the pump is 4 cm diameter and 30 cm long. Engine speed is $1/4^{\text{th}}$ pump speed. Other particulars are following :

Moment of inertia of the flywheel	800 kg-m ²
Moment of inertia of the gear wheel	15 kg-m ²
Moment of inertia of the pinion gear	4 kg-m ²
Moment of inertia of the pump impeller	17 kg-m ²

Determine the natural frequency of the torsional oscillations of the system.

PART – C

(1×15=15 Marks)

16. a) The following data apply to an outside cylinder uncoupled locomotives

Mass of rotating parts per cylinder	350 kg
Mass of reciprocating parts per cylinder	285 kg
Angle between cranks	90°
Crank radius	0.3 m
Cylinder centres apart	1.8 m
Radius of balance masses	0.8 m
Wheel Centres apart	1.4 m

If the whole of rotating and two-third of reciprocating parts are to be balanced in plane of the driving wheels, determine

- i) Magnitude and angular position of balance masses
- ii) Speed in km/hr which the wheels will lift off rails when load on each driving wheel is 50000 N.

(OR)

b) Power is transmitted by an open belt drive from a pulley 30 cm diameter running at 200 rpm to a pulley 50 cm in diameter. Angle of lap on smaller pulley is 160°. The belt is on the point of slipping when 2.6 kW is being transmitted if μ as 0.25. It is desired to increase the power to be transmitted. State which of the following two methods suggested would be more effective.

- i) Initial tension in the belt is increased by 10 percent
- ii) Suitable dressing is given to the friction surface of the belt to increase the coefficient of friction by 10 percent.

Specify the conveyor rated capacity, conveyor speed, the highest tension, tensions in the individual section and drive motor power.