QP Code : 1604

(3 Hours) Total Marks: 100

N.B. : (1) Question No. 1 is compulsory.
(2) Attempt any four questions out of the remaining six.
(3) Assume suitable data if necessary but justify the same.
(4) Figures to the right indicate full marks.

Q1. Attempt any four (20)

A. What do you understand by gyroscopic couple? Derive a formula for its magnitude.

B. What is a dynamometer? How does it differ from a brake?

C. What do you mean by Inertia governor?

D. Classify Cams in detail.

E. Which of the two assumptions – uniform intensity of pressure or uniform rate of wear, would you make use of in designing friction clutch and why?

Q2 A. A four wheeled trolley car of mass 2500 kg runs on rails, which are 1.5 m apart and (10)
travels around a curve of 30 m radius at 24 km/h. The rails are at the same level. Each wheel of the trolley is 0.75 m in diameter and each of the two axles is driven by a motor running in the direction opposite to that of the wheels at a speed of five times the speed of rotation of the wheels. The moment of inertia of each axle with gear and wheels is 18 kg-m^2. Each motor with shaft and gear pinion has a moment of inertia 12 kg-m^2. The center of gravity of the car is 0.9 m above the rail level. Determine the vertical force exerted by each wheel on the rails taking into consideration the centrifugal and gyroscopic effects. State the centrifugal and gyroscopic effects on the trolley.

B. A cam is to give the following motion to a knife edged follower:- (10)

    i) to raise the follower through 30 mm during 120^0 rotation of the cam
    ii) dwell for next 30^0 of the cam rotation
    iii) to lower the follower during the next 90^0 rotation of the cam
    iv) dwell for the rest of the cam rotation.

The motion takes place with uniform acceleration and retardation. The cam has a minimum radius of 30 mm and rotates counter clockwise at a uniform speed of 800 rpm. Draw the displacement, velocity and acceleration diagram for the motion of the follower for one complete revolution of the cam indicating main values.

Q3 A. In an epicyclic gear of sun and planet type shown in the figure, the pitch circle diameter (10)
of the internally toothed ring is to be 224 mm and the module is 4 mm. When the ring D is stationary, the spider A, which carries three planet wheels C of equal size, is to make one revolution in the same sense as the sunwheel B for every five revolutions of the driving spindle carrying the sunwheel B. Determine the suitable numbers of teeth for all the wheels.

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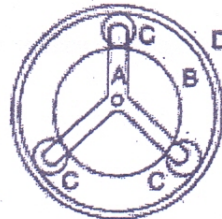
B. A multi plate disc clutch transmits 55 kW of power at 1800 rpm. Coefficient of friction   **(10)** for the friction surfaces is 0.1. Axial intensity of pressure is not to exceed 160 kN/m². The internal radius is 80 mm and is 0.7 times the external radius. Find the number of plates needed to transmit the required torque.

Q4 A. Derive the equation for the braking of a vehicle, when the vehicle is moving up the plane   **(10)** and the brakes are applied to front wheels only.

B. The arms of a porter governor are 300 mm long. The upper arms are pivoted on the axis   **(10)** 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?

Q5 A. Explain the construction and working of a centrifugal clutch and derive the equation for   **(10)** the torque transmitted by it.

B. Derive the equation for the stability of a two wheel vehicle taking a turn considering   **(10)** gyroscopic and centrifugal effect.

Q6 A. The lengths of the ball and sleeve arms of the bell crank lever of a Hartnell governor are   **(10)** 140 and 120 mm respectively. The mass of each governor ball is 5 kg. The fulcrum of the bell crank lever is at a distance of 160 mm. At the mean speed of the governor which is 270 rpm, the ball arms are vertical and the sleeve arms are horizontal. The sleeve moves up by 12 mm for an increase of speed of 4%. Neglecting friction determine,
   i) spring stiffness
   ii) minimum equilibrium speed when the sleeve moves by 24 mm
   iii) sensitiveness of the governor
   iv) spring stiffness for the governor to be isochronous at the mean speed.

B. A band and block brake, having 14 blocks each of which subtends an angle of 15⁰ at the   **(10)** center is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find, i) maximum braking torque ii) angular retardation of the drum iii) time taken by the system to come to rest from the rated speed of 360 rpm. Take $\mu = 0.25$.

Q7 Write short notes on:-   **(20)**

A. Differentiate between governor and flywheel

B. Belt transmission dynamometer.

C. Flexural Mechanism

D. Pressure angle in cams and methods to control it.

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