FINAL EXAMINATION PAPER

(COVER PAGE)

SESSION : APRIL 2000

PROGRAMME : DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME

COURSE : EGM 260 : MECHANICS OF MACHINE

DATE OF EXAMINATION : 7 August, 2000

TIME : 12.00 NOON – 3.00 P.M   READING TIME : NIL

DURATION : 3 HOURS

SPECIAL INSTRUCTIONS :

THIS PAPER CONSIST OF TEN QUESTIONS. ATTEMPT ANY SEVEN QUESTIONS IN THE

ANSWER BOOKLET PROVIDED. ALL QUESTIONS CARRY EQUAL MARKS.

MATERIALS PERMITTED : NIL

MATERIALS PROVIDED : NIL

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This paper consists of 6 printed pages, including the cover page.
This paper consists of TEN (10) questions. Answer any SEVEN (7) questions. All questions carry equal marks.

1. An over drive for a vehicle consists of an epicyclic gear train, as shown in Figure Q1, with compound planets B-C in which B has 15 teeth and meshes with an annulus which has 60 teeth, and C has 20 teeth meshes with the sunwheel D which is fixed. The annulus is keyed to the propeller shaft Y which rotates at 740 rad./sec. The spider which carries the pins upon which the planets revolve, is driven directly from main gear box by shaft X, this shaft being relatively free rotate with respect to wheel D.

(a) Find the speed of shaft X, when all the teeth have the same module. (6 marks)

(b) When the engine develops 130kW, what is the holding torque on the wheel D?
Assume 100 percent efficiency throughout. (4 marks)

Figure Q1
2. In the quadric cycle chain shown in Figure Q2. AB = 100mm and is rotating at 300 rpm, BC = 300mm, and CD = 140mm. For the position shown,

(a) find the speed of rotation of CD, (4 marks)

(b) the angular velocity of the BC, and (4 marks)

(c) the linear velocity of G. (2 marks)

![Diagram of quadric cycle chain]

Figure Q2

3. A machine of mass 100kg is supported on springs which deflect 20mm under the load. The machine vibrates in a vertical plane and a dash pot is fitted to reduce the amplitude of free vibration to one quarter of its initial value in two complete oscillations.

Calculate,

(a) the damping coefficient and (6 marks)

(b) compare the frequencies of the damped and undamped vibration of the system.

For the vertical deflection \( \delta = \frac{WL^3}{48EI} \) (4 marks)
4. A steel strip 10mm wide and 0.8mm thick rests on supports 200 mm apart and a mass of 0.15kg is fixed to the strip at mid-span.

(a) Find the frequency of the transverse vibration

(b) if the greatest bending stress in the strip is 100MN/m², calculate the amplitude of movement of the mass and also the force on the supports. Neglect the mass of strip. E = 200 GN/m².

5. A single-cylinder internal combustion engine working on the four-stroke cycle develops 75 kW at 360 rpm. The fluctuation of energy can be assumed to be 0.9 times the energy developed per cycle. If the coefficient of fluctuation of speed is not to exceed 1% and the maximum centrifugal stress in the fly wheel is to be 5.5 MN/m², estimate

(a) the mean diameter and

(b) the cross-sectional area of the rim.
Cast iron has a density of 7.2 Mg/m³.

6. A shaft 1.3m long carries three eccentric loads A, B, and C, spaced at 0, 0.7 and 1.3m from one end respectively. The loads are 8, 10 and 6 kg and the eccentricities are 60, 50 and 40mm respectively. The directions of the eccentricities of B and C relative to A are 60° and 270° respectively. The shaft is supported in bearings X and Y which are 0.2 m and 1 m from A. Determine,

(a) the magnitude and direction of the forces on the bearings, when the shaft rotates at 90 rpm,

(b) a mass to be added to the wheel C at a radius of 100 mm to make the forces on the bearing equal and opposite.

7. A spring of stiffness 2 kN/m. is suspended vertically and two equal masses of 4 kg each are attached to the lower end. One of these masses is suddenly removed and the system oscillates. Determine,

(a) the amplitude and frequency of the vibration

(b) the velocity and acceleration of the mass, when passing through the half amplitude position and

(c) the energy of vibration in joules.
8. When two gears in mesh, one with 89 teeth and another with 18 teeth of involute form rotation with a pressure angle of 25°, a module 4 mm and contact ratio of 1.5. The arc of recess is 1.5 times the arc of approach. The pinion runs at 1800 rev/min and transmits 5kW to the larger wheel. Find:

(a) the addenda of the two wheels,
(b) the greatest speed of sliding between mating teeth, and
(c) the greatest force between a pair of mating teeth, if the effects of friction between the teeth are neglected. (10 marks)

9. The band brake in Figure Q2 is applied to a shaft carrying a flywheel of 400kg mass, with a radius of gyration of 500mm, and running at 400 rev/min. Find:

(a) the torque applied due to a hand load of 100N given that \( \mu = 0.2 \), and
(b) the number of turns of the wheel before it is brought to rest. (10 marks)

Figure Q9
10. A Porter governor has 300mm arms and the rotating balls each have a mass of 1.8kg. At the mean speed of 120 rev/min, the arms make 30° to the vertical. Determine the central dead load and the sensitivity of the governor if the sleeve moves 2.5mm.

(10 marks)