B. Tech Degree VI Semester Examination, April 2009

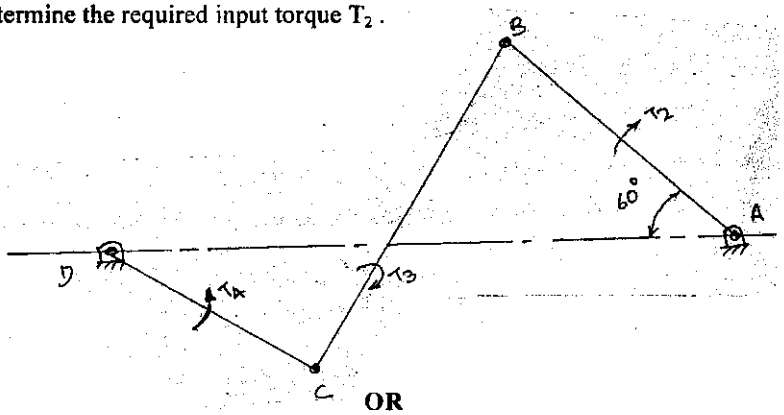
ME 601 DYNAMICS OF MACHINERY

(2002 Scheme)

Time : 3 Hours Maximum Marks : 100

I. (a) State and explain D'Alemberts principle. (5)

(b) In a four link mechanism shown in figure, torque T_3 and T_4 have magnitudes of 30 Nm and 20 Nm respectively. The link lengths are AD = 800 mm, AB = 300 mm, BC = 700 mm and CD = 400 mm. For the static equilibrium of the mechanism, determine the required input torque T_2. (15)



OR

II. The dimensions of a four link mechanism are AB = 500 mm, BC = 660 mm, CD = 560 mm and AD = 1000 mm. The link AB has an angular velocity of 10.5 rad/s counter clock wise and an angular retardation of 26 rad/s^2 at the instant when it makes an angle of 60^0 with the fixed link AD. The mass of links BC and CD is 4.2 Kg/m length. The link AB has a mass of 3.54 Kg, the centre which lies at 200 mm from A and a moment of inertia of 88500 Kgmm^2.

Neglecting the friction and gravity efforts, determine the instantaneous value of the drive torque required to be applied on AB to over come the inertia forces. (20)

III. (a) Explain the turning moment diagram of a 4 stroke cycle internal combustion engine. (6)

(b) The turning moment diagram for a multicylinder engine has been drawn to a scale of 1mm to 500 Nm torque and 1 mm to 6^0 of crank displacement. The intercepted areas between output torque curve and mean resistance line taken in order from one end, in sq.mm are –30, +410, -280,+320, -330, +250, -360, +280, -260 sqmm when the engine is running at 800rpm.

The engine has a stroke of 300mm and fluctuation of speed not to exceed ± 2% of the mean speed. Determine a suitable diameter and cross section of flywheel rim for a limiting valve of the safe centrifugal stress of 7 MPa. The material density may be assumed as 7200 Kg/m^3. The width of the rim is to be 5 times the thickness. (14)

OR

IV. (a) What do you understand by gyrdscopic couple? Derive the formula for the same. (6)

(b) Explain the application of gyroscopic principles of aircraft. (4)

(c) A four wheel trolley car of total mass 2000 Kg running on rails of 1.6m gauge, rounds a curve of a 30 m radius at 54 Km/h. The track is banked at 8^0. The wheels have an external diameter of 0.7m and each pair with axle has a mass of 200 kg, The radius gyration for each pair is 0.3m. The height of centre of gravity of the car above the wheel base is 1m. Determine, allowing for centrifugal force and gyroscopic couple actions, the pressure on each rail. (10)

V. (a) Explain the terms 'Static Balancing' and 'Dynamic balancing. State the necessary conditions to achieve them. (8)

(b) A shaft carries masses A,B,C and D of magnitude 200 Kg, 300 Kg, 400 Kg and 200 Kg respectively and revolving at radii 80mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45^0, B to C 70^0 and C to D 120^0. The balancing masses are to be placed in planes X and Y. The distance between planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses resolve at a radius of 100 mm find their magnitudes and angular positions. (12)

OR

(Turn Over)

VI. The following particulars relate to a two cylinder locomotive with two coupled wheels on each side.

Stroke : 650 mm

Mass of reciprocating parts per cylinder	=	240 Kg
Mass of revolving parts per cylinder	=	200 Kg
Mass of each coupling rod	=	250 Kg
Radius of centre of coupling rod pin	=	250 mm
Distance between cylinders	=	0.6m
Distance between wheels	=	1.5 m
Distance between coupling rods	=	1.8 m

The main cranks are at right angles and the coupling rod pins are at 180^0 to their respective main cranks. The balance masses are to be placed in the wheel at a mean radius of 675mm in order to balance whole of the revolving and ¾ th of the reciprocating masses. The balance mass for the reciprocating masses is to be divided equally between the driving wheels and the coupled wheels. Find :

(i) The magnitudes and angular positions of masses required for the driving and trailing wheels

(ii) The hammer blow at 120 Km/h if the wheels are 1.8 m diameter. (20)

VII. (a) Write short notes on :

(i) Free vibrations (ii) Forced vibrations

(iii) Damped vibrations (6)

(b) Explain the term transmissibility. (4)

(c) 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 5 oscillations.

Determine : (i) Stiffness of the spring

(ii) Logarithmic decrement

(iii) Damping factor. (10)

OR

VIII. (a) Explain the term whirling speed of a shaft. Prove that the whirling speed of a rotating shaft is same as the frequency of natural transverse vibration. (5)

(b) With neat sketches, explain the working of seismometer. (5)

(c) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50Kg is attached to the centre of shaft. Neglecting any increase in stiffness due to 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 disc is 0.25 mm from the geometric axis of the shaft $E = 200\ GN/m^2$. (10)

IX. (a) Explain with neat sketches, the working of vibration absorber. (6)

(b) Determine the natural frequencies of torsional oscillation for the following system. The system is a reciprocating IC engine coupled to a centrifugal pump through a pair of gears. The shaft from the fly wheel of engine to the gear wheel is of 60 mm dia and 950 mm length. The shaft from the pinion to the pump is of 40 mm diameter and 300 mm length. The engine speed is $1/4^{th}$ of the pump speed.

Moment of inertia of the fly wheel - 800 Kg-m^2

Moment of inertia of the gear wheel - 15 Kg-m^2

Moment of inertia of the pinion - 4 Kg – m^2

Moment of inertia of the pump - 17 Kg – m^2

Modulus of rigidity for shaft material is 84 GN/m^2. (14)

OR

X. (a) Explain the following

(i) Semi definite systems (ii) Co-ordinate coupling. (8)

(b) An automobile weighing 2000 N has a wheel base of 3.0 meters. Its centre of gravity is located 1.4 m behind the front wheel axis and has a radius of gyration about its CG as 1.1m. The front springs have a combined stiffness of 6000 Kg/cm and rear springs 6500 Kg/cm. Find the principal mode of vibration of the automobile and locate the nodal points for each mode. (12)

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