BTS(C) – VI – 09 – 006 – G

B. Tech Degree VI Semester Examination, April 2009

ME 601 DYNAMICS OF MACHINERY

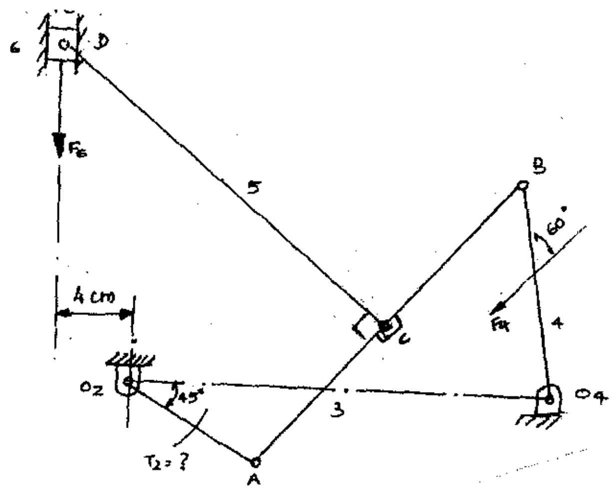
(1999 Scheme)

Time : 3 Hours | Maximum Marks : 100

I. (a) With neat sketches explain how forces are acting on
(i) gears (ii) pins
(iii) sliding members (3)

(b) Explain the role of friction in force analysis. (2)

(c) Two known forces. F_4 and F_6 are applied to link 4 and 6 of a mechanism as shown below. What couple must be applied to link 2 for equilibrium?

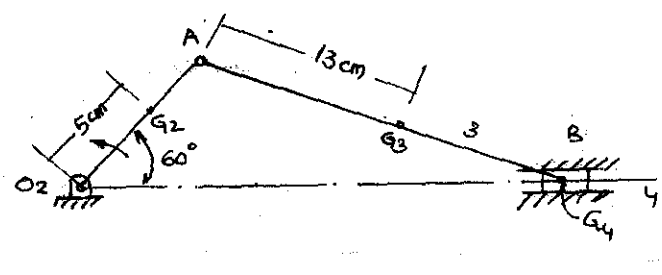


Data given :
$F_4 = 600$ N, $F_6 = 400$ N, $O_2A = 15$ cm, AB = 42 cm, O4B = 20 cm and AC = 23 cm. (15)

OR

II. (a) Explain the term 'Kinematically Equivalent Systems' with example. (5)

(b) A single cylinder diesel engine is shown below. Determine the couple that must be applied to link 2 to cause the prescribed motion. Consider the inertia force of each link.



$O_2A = 7.6$ cm	$W_2 = 2.27$ Kg	$I_2 = 0.2711$
AB = 28.6 cm	$W_3 = 17.6$ Kg	$I_3 = 2.03$
	$W_4 = 13.2$ Kg	

(15)

(Turn Over)

III. (a) Explain the terms inertia force and inertia torque. (4)

(b) A vertical engine running at 1200 rpm with a stroke of 110 mm has a connecting rod of 250 mm between centers and mass 1.25 Kg. The mass center of the connecting rod is 75mm from the big end centre and when suspended as a pendulum from the gudgeon pin axis makes 21 complete oscillations in 20 seconds.

(i) Calculate the radius of gyration of the connecting rod about an axis through its mass centre.

(ii) When crank is at 40^0 from the top dead centre and the piston is moving downwards, find analytically, the acceleration of the piston and angular acceleration of the connecting rod. Hence find the inertia torque exerted on the crank shaft. (16)

OR

IV. (a) Define the term gyroscopic couple. Derive the formula for its magnitude. (5)

(b) A four wheeled motor car of mass 2000 Kg has a wheel base 2.5 m, track width 1.5m and height of centre of gravity 500 mm above the ground level and lies at 1m from the front axle. Each wheel has an effective diameter of 0.8m and a moment of inertia of 0.8 Kg m^2. The drive shaft, engine fly wheel and transmission are rotating at 4 times speed of the road wheel, in a clockwise direction when viewed from the front, and is equivalent to a mass of 75 Kg, having a radius of gyration of 100 mm. If the car is taking a right turn of 60 m radius at 60 Km/h find the load on each wheel. (15)

V. (a) Explain the terms Static balancing and Dynamic balancing. What are the conditions to achieve them? (6)

(b) A shaft carries four masses in parallel planes A,B,C and D in this order along its length. The masses B and C are 18 Kg and 12.5 Kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm, the angle between the masses B and C is 100^0 and that between the masses at B and A is 190^0, both being measured in some direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine :

(i) the magnitude of the masses at A and D
(ii) the distance between planes A and D
(iii) the angular position of the mass at D. (14)

OR

VI. (a) Write short notes on

(i) Primary balancing (ii) Secondary balancing (5)

(b) A two cylinder uncoupled locomotive with cranks at 90^0 has a crank radius of 325 mm. The distance between the centers of driving wheels is 1.5 m. The pitch of cylinders is 0.6 m. the diameter of treads of driving wheels is 1.8 m. The radius of centers of gravity of balance mass is 0.65 m. The pressure due to dead load on each wheel is 40 KN. The masses of reciprocating and rotating parts per cylinder are 330 Kg and 300 Kg respectively. The speed of the locomotive is 60 kmph find :

(i) The balancing masses both in magnitude and position required to be placed if the planes of driving wheels to balance whole of revolving and 2/3 rd of reciprocating masses
(ii) The swaying couple
(iii) The variation of tractive force
(iv) The maximum and minimum pressure on rails
(v) The maximum speed at which it is possible to run the locomotive in order that the wheels are not lifted from rails. (15)

VII. (a) Explain the terms with examples

(i) free vibrations (ii) forced vibrations
(iii) damped vibrations (iv) vibration isolation
(v) transmissibility (10)

(Contd....3)

(b) A machine of mass 75 Kg is mounted on springs and is fitted with a dash pot to damp out vibrations. There are three springs each of stiffness 10 N/mm and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine :

(i) the resistance of dash pot at unit velocity
(ii) the ratio of the frequency of the damped vibration to the frequency of the undamped vibration.
(iii) periodic time of the damped vibration. (10)

OR

VIII. (a) Explain the term whirling speed of shaft. Obtain the expression for whirling speed. (8)

(b) A machine has a mass of 100 kg and unbalanced reciprocating parts of mass 2 Kg which move through a vertical stroke of 80 mm with SHM. The machine is mounted on four springs, symmetrically arranged with respect to centre of mass, in such a way that the machine has one degree of freedom and can undergo vertical displacements only.

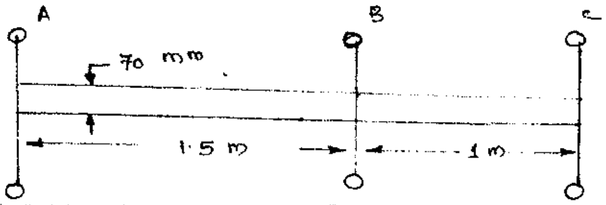
Neglecting damping, calculate the combined stiffness of the spring in order that the force transmitted to the foundation is $1/25^{th}$ of the applied force, when the speed of rotation of machine crank shaft is 1000 rpm.

When the machine is actually supported on the springs, it is found that the damping reduces the amplitude of successive free vibrations by 25%.

Find : (i) The force transmitted to foundation at 1000 rpm.
(ii) The force transmitted to the foundation at resonance
(iii) The amplitude of the forced vibration of machine at resonance. (12)

IX. (a) Derive the expression to determine the frequency of torsional vibrations of a geared system. (8)

(b) A single cylinder oil engine drives directly a centrifugal pump. The rotating mass of the engine, fly wheel and the pump with the shaft is equivalent to a three rotor system as shown below :



The mass moment of inertia of the rotors A, B and C are 0.15, 0.3 and 0.09 Kgm^2. Find the natural frequency of torsional vibration. Take modulus of rigidity of shaft material is 84 kN/mm^2. (12)

OR

X. For a three degrees of freedom system shown below,

(a) Write the differential equations of motion in matrix form
(b) Obtain the principal modes of vibration for
$k_1 = k,\ k_2 = 2k,\ k_3 = 3k$
$m_1 = m\ \ m_2 = 2m,\ m_3 = 3m$
(c) Establish the orthogonality relation for the principal modes for
$k_1 = 3k,\ k_2 = k_3 = k.\ m_1 = 3m,\ m_2 = m_3 = m.$ (20)

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