Fifth Semester B.E. Degree Examination, January/February 2006

Mechanical

Dynamics of Machinery

(Max.Marks : 100

Time: 3 hrs.)

Note: *1. Answer any FIVE full questions.*
2. Use of drawing sheets is permitted.

1. (a) What is a free body diagram? List any two advantages of free body diagram. **(4 Marks)**

(b) State the conditions for a link to be in equilibrium

i) When two forces act

ii) When three forces act

iii) When two forces and a torque acts **(6 Marks)**

(c) In a four bar mechanism shown in fig. Q1. C, torque T_3 and T_4 have magnitudes 30N.m and 20N.m respectively. Link lengths are MN = 800mm NA = 300mm AB =700mm and MB 400mm. Determine the input torque T_2 for the static equilibrium of the mechanism. **(10 Marks)**

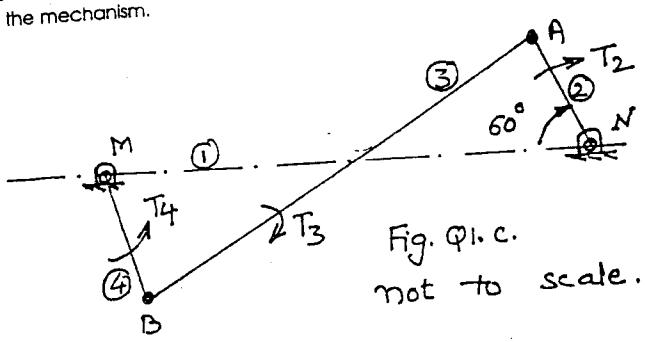

Fig. Q1. c.
not to scale.

2. (a) Show that condition for maximum power transmission of flat belt with centrifugal tension accounted is

$$V = \left[\frac{T}{3m}\right]^{0.5}$$

where, V - speed of belt, m - mass of belt/ unit length, T-maximum belt tension. **(10 Marks)**

(b) A V-belt of $600mm^2$ cross section has a groove angle of 40^0 and angle of lap of $150^0, \mu = 0.1$. The mass of belt is 1.2kg/m. The maximum allowable stress is $9 \times 10^3 N/mm^2$. Calculate the power that can be transmitted at a belt speed of 30m/s. **(10 Marks)**

Contd.... 2

(a) List only two uses of turning moment diagram. (4 Marks)

(b) How is turning moment diagram determined? List the steps to be followed. (6 Marks)

(c) The torque delivered by a two-stroke engine is represented by

$T = (1000 + 300\ sin\ 2\theta - 500\ cos\ 2\theta)$ N.m

where, θ, is angle turned by the crank from inner dead centre. The engine speed is 250rpm. The mass of flywheel is 400kg and radius of gyration is 0.4m. Determine :

i) the power developed

ii) the total percentage fluctuation of speed (10 Marks)

4. (a) Explain how masses $m_i(i = 1 \cdots n)$ rotating in the same plane with radii $r_i(i = 1 \cdots n)$ with same angular speed ω rad/sec can be balanced. (5 Marks)

(b) An inside cylinder locomotive has its cylinder centre lines 0.8m apart and has a stroke of 0.6m. The rotating masses are equivalent to 150kg at the crank pin, and the reciprocating masses per cylinder are 300kg. The wheel centre lines are 1.8m apart. The cranks are at right angles. The whole of rotating and 2/3rd of the reciprocating masses are to be balanced by masses placed at a radius of 0.5m. Find:

i) the magnitude and direction of balancing masses

ii) the variation of tractive effort (15 Marks)

5. (a) The three cylinders of an air compressor have their axis 120^0 to one another, and their connecting rods are coupled to a common crank. The stroke is 100mm and length of each connecting rod is 150mm. The mass of reciprocating parts per cylinder is 2 kg. Find the maximum primary force acting on the frame of the compressor when running at 3000 rpm. Assume $\theta = 0^0$ for cylinder 1. (10 Marks)

(b) A V-twin engine has the cylinder axes at right angles and connecting rods operate a common crank. The reciprocating mass per cylinder is 10kg and the crank radius is 80mm. The length of connecting rod is 0.4m. If the engine speed is 600 rpm, what is the value of maximum resultant secondary force? (10 Marks)

6. (a) The arms of a porter governor are 250mm long. The upper arms are pivoted on the axis of revolution, but lower arms are attached to a sleeve at a distance of 50mm from the axis of rotation. The weight on the sleeve is 600N and the weight of each ball is 80N. Determine the equilibrium speed when the radius of rotation of balls is 150mm. If the friction is equivalent to a load of 25N at the sleeve, determine the range of speed for this position. (10 Marks)

(b) A Hartnell governor moves between 300 rpm and 320 rpm for a sleeve lift of 20mm. The sleeve arms and the ball arms are 80mm and 120mm respectively. The levers are pivoted at 120mm from the governor axis. The weight of each ball is 25N. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine the stiffness of the spring. (10 Marks)

Contd... 3

7. (a) Derive an expression for limiting angle of a motor cycle to avoid skidding. (10 Marks)

(b) A ship is propelled by a turbine rotor of mass 500kg and has a speed of 2400 rpm. The rotor has a radius of gyration of 0.5m and rotates in clockwise direction when viewed from stern. Find the gyroscopic couple when

i) the ship travells at a speed of 28km/hr and steers to the left in a curve of 60m radius.

ii) the ship rolls with angular velocity of 0.04 rad/s colckwise when viewed from stern. (10 Marks)

8. For a circular cam operating flat faced follower with the following geometry.

r = distance between cam and nose centers

r_1 = least circle radius

r_2 = nose circle radius

r_3 = flank circle radius

α = angle of ascent

ϕ is angle of contact on circular flank

What is the displacement, velocity and acceleration of the follower, when

i) follower is in contact with circular flank

ii) follower is in contact with circular nose (20 Marks)

Also, what is the maximum velocity in each case.

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NEW SCHEME

USN

Fifth Semester B.E. Degree Examination, July/August 2005

Common to ME/IP/IM/MA/AU

Dynamics of Machinery

Time: 3 hrs. [Max.Marks : 100

Note: 1. *Answer any FIVE full questions.*
2. *Missing data if any may suitably be assumed.*

1. (a) With help of an engine mechanism as an example, explain the usefulness of freebody diagrams in the static force analysis of machinery. **(6 Marks)**

(b) For the mechanism shown in Fig.1, find the required input torque for the static equilibrium. The lengths OA and AB are 250mm and 650mm respectively. F=500N. **(14 Marks)**

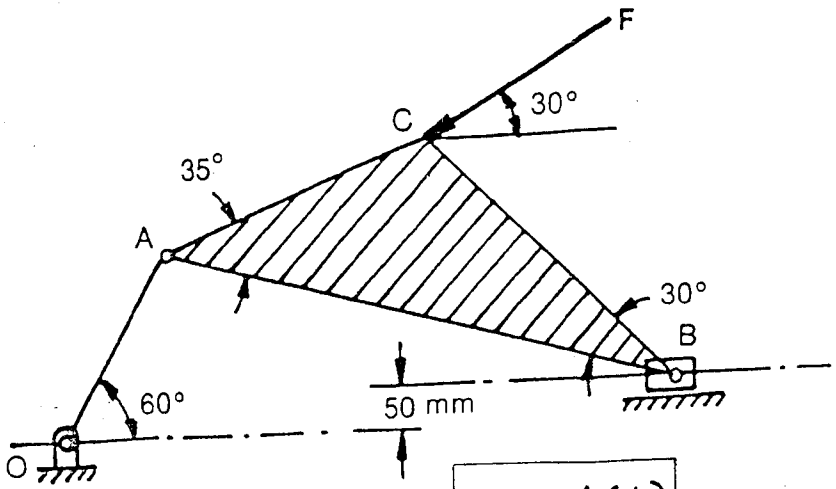

Fig. Q.No. 1(b)

2. (a) Derive an expression for the maximum power transmitted by a belt drive. (6 Marks)

(b) Prove that a V belt can transmit more power than a flat belt when "all other conditions are identical". (6 Marks)

(c) A belt drive is required to transmit 10kW from a motor running at 600 rpm. The belt is 12mm thick and has a mass density of 0.001 grams/mm^3. Safe stress in the belt is not to exceed 2.5 N/mm^2. Diameter of the driving pulley is 250mm whereas the speed of the driven pulley is 220 rpm. Two shafts are 1.25m apart. The coefficient of friction is 0.25. Determine the width of the belt. (8 Marks)

3. (a) Explain how is the size of the flywheel arrived at, in case of IC engine, for a given amount of fluctuation of energy. (6 Marks)

(b) A machine shaft running at a mean speed of 200 rpm requires at a torque, which varies uniformly from 1200 Nm to 3600Nm during the first half revolution, remains constant for next one revolution, decrease uniformly to 1200 Nm, during the next one revolution and then remains constant for the next two revolutions, thus completing a cycle of operation. It is driven by a constant speed motor and a fly wheel of radius of gyration 0.6m is fitted to this shaft. If the fluctuation of speed is ±2% of the mean speed, find the mass of flywheel required. (14 Marks)

4. (a) With the help of a suitable example, explain why it is not possible to completely balance the "reciprocating mass causing unbalance', using a resoling mass. (6 Marks)

(b) Four masses A,B,C and D are in complete balance. Masses C and D are at angles 80^0 and 200^0 from mass A in the same direction. The masses A,B,C and D revolve at radii 30mm, 25mm, 40mm and 50mm respectively. The masses B,C and D are 10kg, 20 kg and 15kg respectively. Determine :

i) The mass A and its angular position.

ii) The positions of planes A and D given the distance between planes B and C is 200mm. (14 Marks)

5. (a) Derive an expression for the unbalanced primary force in a 90^0 V-engine. (8 Marks)

(b) A three cylinder air compressor has an angle between each cylinder equal to 120^0 and all the connecting rods are coupled to a single crank. The stroke is 10cm and length of each connecting rod is 15cm. The mass of the reciprocating part per cylinder is 0.15 kg. Find the maximum primary and secondary forces acting on the frame of the compressor when running at 300 rpm. (12 Marks)

6. (a) Derive an expression for the equilibrium speed of a porter governor. (6 Marks)

(b) In a spring controlled Hartnell governor, the mass of each ball is 1.6 kg. Distance of fulcrum from the axis of rotation is 60mm. The bell crank lever has a vertical arm 120 mm long and a horizontal arm 50mm long. The mass of the sleeve is 6.5kg. The sleeve begins to raise at 200 rpm and the raise of sleeve for 5% increase in 9mm. Determine the initial thrust in the spring and its stiffness. (14 Marks)

ntd.... 3

7. (a) Explain the stability of a four wheeler automobile negotiating a curve and derive the necessary conditions for stability. (10 Marks)

(b) Each road wheel of a motor cycle is of 600mm diameter and has a moment of inertia of 1.1 kg-m^2. The motor cycle and a rider together weigh 220 kg and the combined centre of mass is 620mm above the ground level when the motor cycle is upright. The moment of inertia of the rotating parts of the engine is $0.18kg-m^2$. The engine rotates at 4.5 times the speed of the road wheels in the same sense. Find the angle of heel necessary when, the moor cycle is taking a turn of 35m radius at a speed of 72 km/hr. (10 Marks)

8. (a) Derive expressions for the velocity and accelerations of a flat faced follower touching the circular flank portion as well as nose portion of a circular arc Cam. (8 Marks)

(b) The following particulars refer to a symmetrical tangent Cam having a roller follower : Maximum radius of the Cam = 40mm, lift = 20m, speed = 360rpm, roller diameter = 44mm, angle of ascent = 60^0. Calculate the acceleration of the follower at the beginning of the lift. Also find its values when the roller just touches the nose and is at the apex of the circular nose. Sketch the variation of displacement, velocity and acceleration during ascent. (12 Marks)

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NEW SCHEME

USN

Fifth Semester B.E. Degree Examination, January/February 2005

Common to ME/IP/IM/MA/AU

Dynamics of Machinery

Time: 3 hrs.] [Max.Marks : 100

Note: 1. *Answer any FIVE full questions.*
2. *Use of drawing sheets is permitted.*

1. (a) Draw the free body diagram of a slider crank mechanism subjected to gas pressure P on the piston of area of cross section A. **(5 Marks)**

(b) A four bar mechanism shown in fig.Q1.b is acted by a force $F = 2000N$. Calculate the forces on the links and the required torque on link $AB(T_2)$ for equilibrium of the mechanism. **(15 Marks)**

AB=200mm
BC=370mm
DC=250mm
AD=215mm
CE=100mm
$L\ DAB = 110^0$
$L\ CEF = 45^0$

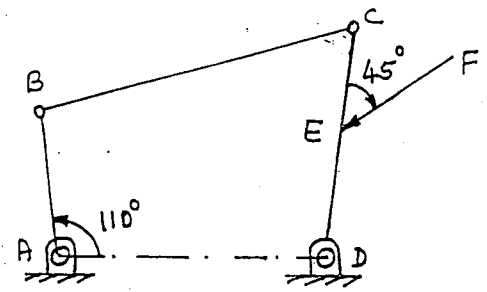

Fig. Q1.b

2. (a) Derive an equation for length of belt in open configuration connecting two pulleys of radius R and r located at distance C between their centers. **(10 Marks)**

(b) A compressor requires 100 kW to run at 240 rpm from an electric motor of speed 750 rpm, by means of a V-belt drive. The diameter of the compressor shaft pulley should not be more than 1m while the center distance between the shaft is 2m. The belt speed should not exceed 25 m/s.

Determine the number of V-belts to transmit the power, given
Cross sectional area of belt = 375 mm^2
Density = 1000 kg/m^3, allowable stress of 2.5 MPa, Pulley groove angle is 40^0 and friction coefficient is 0.25. **(10 Marks)**

3. (a) The variation of torque for intermittent operation of a machine is shown in Fig.Q3.(a). The machine is directly coupled to a motor which exerts a constant torque at a mean speed of 200 rpm. The flywheel has a moment of inertia 2000 $kg - m^2$

Determine the mean power of the motor. **(10 Marks)**

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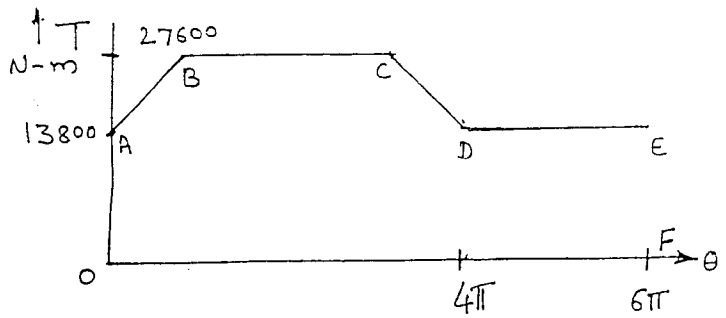


Fig. Q3.a

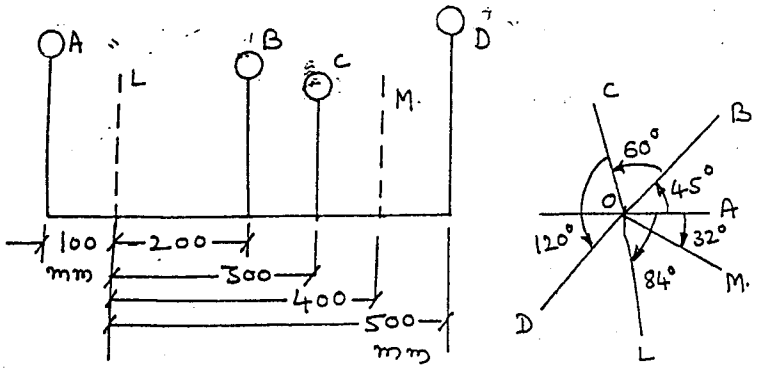
(b) A punching machine carries out 6 holes per minute. Each hole of 40mm diameter in 35mm thick plate requires 8 N.m of energy/mm^2 of the sheared area. The punch has a stroke of 95mm.

i) Find the power of the motor required if the mean speed of the fly wheel is 20m/s

ii) If total fluctuation of speed is not to exceed 3% of mean speed, determine the mass of the flywheel. **(10 Marks)**

4. (a) What is hammer blow? Write an equation for maximum magnitude of hammer blow. **(5 Marks)**

(b) A shaft carries four masses as shown in Fig.Q4(b). The balancing masses are to be placed in planes L and M. If balancing masses revolve at a radius of 100mm, find their magnitude and angular positions. **(15 Marks)**



$r_A = 70\ mm \quad m_A = 150\ kg$
$r_B = 60\ mm \quad m_B = 200\ kg$
$r_C = 50\ mm \quad m_C = 300\ kg$
$r_D = 80\ mm \quad m_D = 250\ kg$

5. (a) Four masses 150 kg, 250 kg, 200 kg and 300 kg are rotating in the same plane at radii 0.25m, 0.2m, 0.3m and 0.35m respectively. Their angular location is 40^0, 120^0 and 250^0 from the mass 150 kg respectively measured in counterclockwise direction. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.25m. **(10 Marks)**

(b) A V-twin engine has the cylinder axes at right angles and the connecting rods operate a common crank. The reciprocating mass per cylinder is 10 kg and the crank radius is 80mm. The length of the connecting rod is 400 mm. If engine speed is 600 rpm, what is the value of maximum resultant secondary forces? **(10 Marks)**

6. (a) Draw the controlling force diagram for spring controlled governor and discuss the stable, unstable and isochronous operating conditions. Write the equations for controlling force in each case. **(5 Marks)**

(b) The arms of a porter governor are each 200mm long. The weight of each ball is 40N and that of the Sleeve is 200 N. The radius of rotation of the balls is 125mm when the sleeve begins to rise and reaches a value of 150mm for maximum speed.

i) Determine the speed range of the governor (neglect friction)

ii) If the friction is equivalent to 20N at the sleeve, determine the speed range of the governor. **(15 Marks)**

7. (a) A boat is propelled by steam engine. The moment of inertia of the rotor, shaft and propeller is $60kg - m^2$. The turbine runs at 3000 rpm in clockwise direction looking from the front. The boat describes a circular path towards right making one revolution in 10 seconds. Find the magnitude of the couple acting on the boat hull. Also determine its direction. **(10 Marks)**

(b) Show that for a circular disk, $C = I\ \omega\ \omega_p$

where

C - applied couple
I - moment of inertia
ω - angular velocity of the disk
ω_p - precession velocity. **(10 Marks)**

8. For a tangent cam with roller follower

r - distance between cam and nose center
r_1 - least radius of cam
r_2 nose radius,
r_3 roller radius.
$l = r_2 + r_3$
α - angle of ascert
ϕ - angle of contact of cam with straight flank.

Compute the velocity and acceleration

i) When roller is in contact with flank. Also, compute their maximum values.

ii) When roller is in contact with nose. **(20 Marks)**

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ME52

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NEW SCHEME

Fifth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
IP/IM/MA/AU
Dynamics of Machinery

Time: 3 hrs.] [Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Use of drawing sheets is permitted.
3. Missing data if any may be suitably assumed.

1 a. What are the conditions for a body to be in equilibrium under the action of two forces, three forces, and two forces and a torque? **(06 Marks)**

b. For the static equilibrium of the mechanism shown in fig.1(b), find the required input torque. Given: AB = 150 mm, BC = AD = 500 mm, DC = 300 mm, CE = 100 mm and EF = 450 mm. **(14 Marks)**

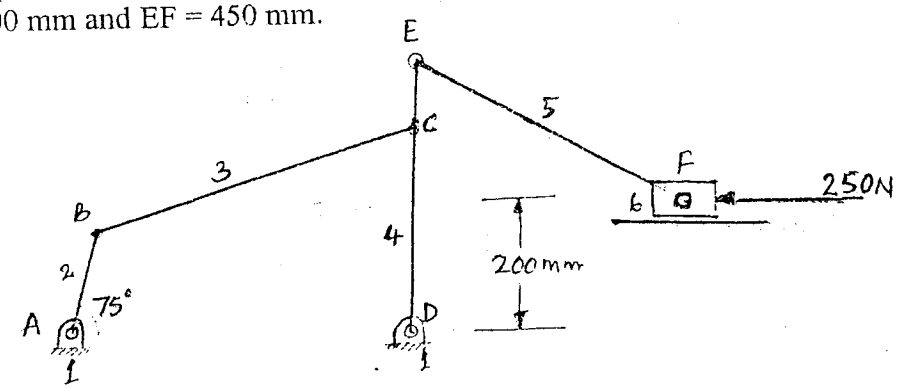

Fig.1(b)

2 a. Derive an expression for the ratio of belt tensions in case of a V-belt drive. **(08 Marks)**

b. A leather belt is required to transmit 8 kW from a pulley 1.5 m diameter running at 240 rpm. The angle of contact is 160^0C and the coefficient of friction between belt and pulley is 0.25. The safe working stress for the belt is 1.5 MPa, and density of the belt material is 1000 kg/m^3. Determine the width of the belt if its thickness is 10 mm. The effect of centrifugal tension is to be taken into account. **(12 Marks)**

3 a. Find a relation for the coefficient of fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the flywheel at mean speed. **(04 Marks)**

b. The turning moment diagram for a multicylinder engine has been drawn to a vertical scale of 1 mm = 650 Nm and a horizontal scale of 1 mm = 4.5^0. The areas above and below the mean torque line are -28, +380, -260, +310, -300, +242, -380, +265, and -229 mm^2. The fluctuation of speed is limited to ±1.8% of the mean speed which is 400 rpm. Density of the rim material is 7000 kg/m^3 and width of the rim is 4.5 times its thickness. The centrifugal stress in the rim material is limited to 6 N/mm^2. Neglecting the effect of the boss and arms, determine the diameter and cross section of the flywheel. **(16 Marks)**

Contd.... 2

4 A shaft carries 3 masses A, B and C. Planes B and C are 600 mm and 1200 mm from plane A. A, B and C are 50, 40, and 60 kgs respectively at a radius of 25 mm. The angular position of mass B and C with A are 90^0 and 210^0 respectively. Find the unbalanced force and couple. Also find the position and magnitude of balancing mass required at 100 mm radius in planes L and M midway between A and B and between B and C. (20 Marks)

5 The stroke of each piston of a six cylinder two stroke inline engine is 320 mm and the connecting rod is 800 mm long. The cylinder centre lines are spaced at 500 mm. The cranks are at 60^0 apart and the firing order is 1-4-5-2-3-6. The reciprocating mass per cylinder is 100 kg and the rotating part is 50 kg per crank. Determine the out of balance forces and couples about the mid plane if the engine rotates at 200 rpm. (20 Marks)

6 a. What is the function of a governor? How does it differ from that of a flywheel? (05 Marks)

b. In a porter governor, each of the four arms is 400 mm long. The upper arms are pivoted on the axis of the sleeve, whereas the lower arms are attached to the sleeve at a distance of 45 mm from the axis of rotation. Each ball has a mass of 8 kg and the load on the sleeve is 60 kg. Determine the range of speed of the governor for extreme radii of rotation of 250 mm and 300 mm of rotation of the governor balls. (15 Marks)

7 a. Describe the effect of the gyroscopic couple on pitching, rolling and steering of a ship with neat sketches. (06 Marks)

b. An aeroplane flying at 240 km/hr turns towards left and completes a quarter circle of 60 m radius. The mass of the rotary engine and the propeller of the plane amounts to 450 kg, with a radius of gyration of 320 mm. The engine speed is 2000 rpm clockwise when viewed from the rear. Determine the gyroscopic couple on the aircraft and state its effect. In what way the effect is changed when the aeroplane turns towards right? (14 Marks)

8 A tangent cam with straight working faces tangential to a base circle of 120 mm diameter has a roller follower of 48 mm diameter. The line of stroke of the roller follower of [illegible] mm diameter. The line of stroke of the roller follower passes through the axis of the cam. The nose circle radius of cam is 12 mm and the angle between the tangential faces of the cam is 90^0. If the speed of the cam is 180 rpm, determine the acceleration of the follower when,

a. During the lift, the roller just leaves the straight flank.

b. The roller is at the outer end of its lift, i.e., at the top of the nose. (20 Marks)

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06ME53

Fifth Semester B.E. Degree Examination, Dec 08 / Jan 09
Dynamics of Machines

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions, , selecting at least TWO from each part.***

PART – A

1 a. In a Four bar Mechanism shown in Fig.Q1(a) Torque T_3 and T_4 have magnitudes of 3000 Nm and 2000 Nm respectively. If links AD = 800 mm, AB = 300mm, BC = 700mm and CD = 400mm, find the required torque on the crank for static equilibrium of the mechanism. **(15 Marks)**

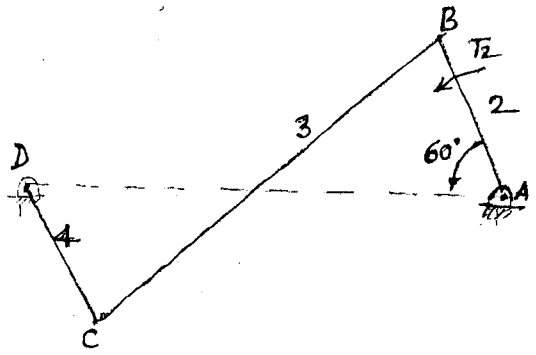

Fig. 1(a)

b. What are the implications of considering friction in static force analysis? **(05 Marks)**

2 a. Explain D'Alemberts Principle and state why it is used. **(06 Marks)**

b. A punching press is required to punch 40mm diameter holes in a plate of 30mm thickness at the rate of 4 holes per minute. It required 6Nm of energy per mm^2 of sheared area. The punch has a stroke of 100mm. The rpm of the Flywheel varies from 320 to 280. If the radius of gyration of flywheel is 1m, find i) the power of the motor and ii) mass of the Flywheel. **(14 Marks)**

3 a. State the Laws of Dry friction. **(06 Marks)**

b. A leather belt is required to transmit 9kW from a pulley 120cm in diameter running at 200 rpm. The angle embraced is 165^0 and the co-efficient of friction between leather belt and pulley is 0.3. If the safe working stress for the leather belt is $140N/cm^2$, the mass of the leather is 1 gm/cm^3 and the thickness of the belt is 10mm, determine the width of the belt taking centrifugal tension into account. **(14 Marks)**

4 a. Explain Static Balancing and Dynamic Balancing. **(06 Marks)**

b. Four masses A, B, C and D having 200kg, 300kg, 240kg and 260kg respectively, revolve at a radius of rotation 270mm, 210mm, 300mm and 360mm respectively. The distance of planes B, C and D measured from A are 270mm, 420mm and 720mm respectively. The angular positions of masses B, C and D measured from A are 45^0, 120^0 and 255^0 respectively. Two balancing masses are placed in planes L and M, which are 500mm apart. The distance of Plane L from A is 120mm and M from D is 100mm. If the balancing masses revolve at a radius of 72mm, find their magnitude and angular position. **(14 Marks)**

PART – B

5 a. Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses i.e. $C = \frac{1}{2}$. (06 Marks)

b. A V – 90 engine has two cylinders which are placed symmetrically. The two connecting rods operate a common crank. The length of the connecting rods are 320mm each and crank radius is 80mm. The reciprocating mass per cylinder is 12kg. If the engine speed is 600 rpm, find the resultant primary and secondary forces. Also find the maximum resultant secondary force. (14 Marks)

6 a. Explain the terms Sensitiveness, Isochronism and Effort and Power of a Governor. (04 Marks)

b. The length of upper arm and lower arms of a Porter Governor are 200mm and 250mm respectively. Both the arms are pivoted to the axis of rotation. The central load is 150N, the weight of each ball is 20N and the friction of the sleeve together with the resistance of the operating gear is equivalent to a force of 30N at the sleeve. If the limiting inclinations of the upper arm to the vertical are 30^0 and 40^0, determine the range of speed of the Governor. (16 Marks)

7 a. Explain the effect of Gyroscopic couple of a ship under i) Steering ii) Pitching and iii) Rolling. (10 Marks)

b. Analyze the stability of a two wheel vehicle turning left. Derive the necessary equation. (10 Marks)

8 For a symmetrical tangent cam operating roller follower, the least radius of cam is 30mm and roller radius is 15mm. The angle of ascent is 60^0, the total lift is 15mm and the speed of the cam is 300 rpm. Calculate.

a. Principal dimensions of the cam.

b. Acceleration of the follower at the beginning of lift, where the roller just touches the nose and at the apex of circular nose. Assume that there is no dwell between ascent and descent. (20 Marks)

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USN | | | | | | | | | | |

06ME53

Fifth Semester B.E. Degree Examination, June-July 2009
Dynamics of Machines

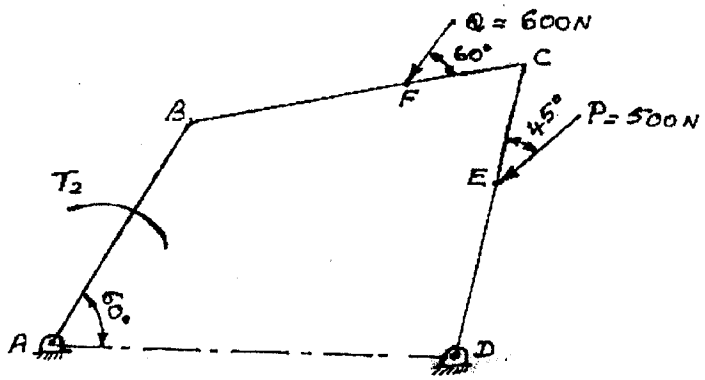
Time: 3 hrs. Max. Marks:100

Note:1. ***Answer any FIVE full questions, choosing at least two questions from each part.***
2. Use of drawing sheets is permitted.

Part A

1 a. State the conditions for a member to be in equilibrium,
i) when two forces act.
ii) when three forces act.
iii) when two forces and a torque act. **(06 Marks)**

b. A four bar mechanism under the action of two external forces is shown in figure Q1 (b). Determine the torque to be applied on the link AB for static equilibrium of the mechanism. **(14 Marks)**



AB = 50 mm; BC = 66 mm;
CD = 55 mm; CE = 25 mm;
CF = 30 mm; AD = 100 mm
$\hat{BAD} = 60^\circ$

Fig. Q1 (b)

2 a. What are the requirements of an equivalent dynamical system? **(05 Marks)**

b. Obtain an expression for the Hoop stress developed in the rim of a flywheel. **(05 Marks)**

c. During one revolution of the crank of a multicylinder engine, the areas above and below the mean turning moment line taken in order are +0.36, -0.81, +0.75, -0.64, +0.92, -0.58 cm^2. Scale of the diagram, turning moment 1 cm^2 = 7200 Nm, Crank angle, 1 cm = 45°. The engine runs at 150 rpm and the total fluctuation of speed is 2% of the mean speed. Find i) Mass of flywheel ii) Area of cross section of rim. Neglect the effect of arms and boss and take the density of rim material as 7260 kg/m^3. Mean peripheral velocity of rim is 1000 m/min. **(10 Marks)**

3 a. Derive an expression for the ratio of tensions in flat belt drive. **(08 Marks)**

b. In a thrust bearing the external and internal radii of contact surfaces are 210 mm and 160 mm respectively. The total axial load is 60 kN and coefficient of friction is 0.05. The shaft is rotating at 380 rpm. Intensity of pressure is not to exceed 0.35 N/mm^2. Calculate
i) Number of collars required for the thrust bearing.
ii) Power lost due to friction. **(12 Marks)**

4 a. Explain briefly static and dynamic balancing of rotating masses. (04 Marks)

b. A 3.6 m long shaft carries three pulleys, two at its two ends and the third pulley at the mid point. The two end pulleys have masses 79 kg and 40 kg respectively and their C_g are 3 mm and 5 mm from the axis of shaft respectively. The middle pulley has a mass of 50 kg and its C_g is 8 mm from the shaft axis. The pulleys are so keyed to the shaft that the assembly is in static balance. The shaft rotates at 300 rpm in two bearings, 2.4 m apart, with equal overhang on either side. Determine,

i) Relative angular position of the pulleys.

ii) Dynamic reaction on the two bearings. (16 Marks)

Part B

5 a. Prove that for a 90° V-engine the primary forces due to reciprocating parts can be balanced by rotating parts. (06 Marks)

b. The pistons of a four cylinder vertical inline engine reach their uppermost position at 90° interval in order of their axial position. The cylinder centre lines are spaced at 0.35 m. Length of crank = 0.12 m. Length of connecting rod = 0.42 m. The reciprocating mass per cylinder is 2.5 kg and the engine runs at 600 rpm. Determine the out of balance primary and secondary forces and couples on this engine taking the central plane of engine as reference plane. (14 Marks)

6 a. Define the following terms with reference to a governor, i) Sensitiveness ii) Governor effort iii) Power iv) Isochronism. (08 Marks)

b. The arms of a porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 35 mm from the axis of rotation. The mass of sleeve is 54 kg and the mass of each ball is 7 kg. Determine the equilibrium speed when the radius of rotation of the ball is 225 mm. What will be the range of speed for this position, if the frictional resistance to the motion of the sleeve is equivalent to a force of 30 N at the sleeve? (12 Marks)

7 a. Derive an expression for heel angle of a motor cycle to avoid skidding. (10 Marks)

b. The rotor of the turbine of a ship has a mass of 5000 kg and rotates at a speed of 2100 rpm clockwise when viewed from stern. The rotor has a radius of gyration of 0.5 m. Determine the gyroscopic couple and its effect when,

i) The ship steers to the left in a curve of 60 m radius at a speed of 16 knots (1 knot = 1860 m/hr).

ii) The ship pitches 6° above and 6° below the horizontal position and the bow is descending with its maximum velocity. The pitching motion is simple harmonic with a periodic time of 20 seconds. (10 Marks)

8 For a symmetrical tangent cam operating a roller follower, the least radius of cam is 30 mm and roller radius is 15 mm. The angle of ascent is 60°, the total lift is 15 mm and the speed of the cam shaft is 300 rpm. Calculate

i) Principal dimensions of cam.

ii) Acceleration of the follower at the beginning of the lift, when the roller just touches the nose (i.e. flank merges into the nose) and at the apex of the circular nose. Assume that there is no dwell between ascent and descent. (20 Marks)

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06ME53

Fifth Semester B.E. Degree Examination, Dec.09-Jan.10
Dynamics of Machines

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, choosing atleast TWO questions form each part.***
2. ***Use of drawing sheets is permitted.***

PART – A

1 a. A body shown in fig.Q1(a) is subjected to three forces F_1, F_2 and F_3. State the conditions for the static equilibrium of the body. If force F_1 is completely known, F_2 known in direction only and F_3 is completely unknown, explain how the problem can be solved. **(05 Marks)**

b. For the mechanism shown in fig.Q1(b), find the magnitude and direction of input torque T_2 for the static equilibrium. Take AB = 70mm, BC = 150mm, BD = 100mm and CD = 70mm, $\angle ABC = 90^0$. Also determine the forces at pinjoints A, B and C. **(15 Marks)**

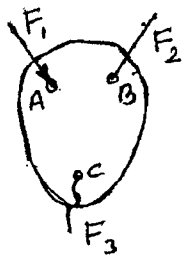

Fig. Q1(a)

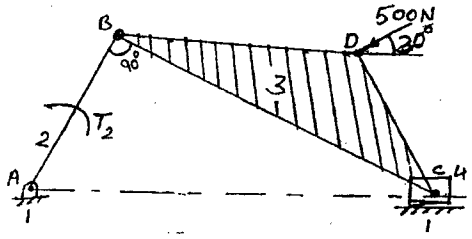

Fig. Q1(b)

2 a. Derive an expression for the maximum fluctuation of energy of a flywheel in terms of mean kinetic energy and coefficient of fluctuation of speed. **(05 Marks)**

b. The torque delivered by a two stroke engine is represented by
$T = (1000 + 300 \sin 2\theta - 500 \cos 2\theta)$ N – m,
where θ is the angle turned by the crank from inner dead center. The engine speed is 250 rpm. The mass of the fly wheel is 400kg and radius of gyration is 400mm. Determine i) the power developed ii) the total percentage fluctuation of speed iii) the angular acceleration of flywheel when the crank has turned through an angle of 60^0 from IDC. **(15 Marks)**

3 a. Define static and dynamic friction and state the laws of dry friction. **(06 Marks)**

b. A leather belt is required to transmit 9 kW from a pulley 1.2m in diameter running at 200 rpm. The angle embraced is 165^0 and the coefficient of friction between leather belt and pulley is 0.3. The safe working stress for the leather belt is $1.4 N/mm^2$, the mass of leather is $0.001 gm/mm^3$ and the thickness of the belt is 10mm. Determine the width of the belt taking centrifugal tension into account. **(14 Marks)**

4 a. What do you mean by static balancing and dynamic balancing? **(06 Marks)**

b. A shaft carries four rotating masses A, B, C and D which are completely balanced. The masses B, C and D are 50kg, 80kg and 70kg respectively. The masses C and D make angles of 90^0 and 195^0 respectively with mass B in the same sence. The masses A, B, C and D are concentrated at radius 75mm, 100mm, 50mm and 90mm respectively. The plane of rotation of masses B and C are 250mm apart. Determine i) mass A and its angular position
ii) Position of planes of A and D. **(14 Marks)**

PART – B

5 A four cylinder vertical engine has cranks 300mm long. The planes of rotation of the first, third and fourth cranks are 750mm, 1050mm and 1650mm respectively from that of the second crank and their reciprocating masses are 150kg, 400kg and 250kg respectively. Find the mass of the reciprocating parts for the second cylinder and the relative angular positions of the crank in order that the engine may be in complete primary balance. If each connecting rod of all four cylinders is 1.35m long and the speed is 300rpm, find the maximum unbalanced secondary force and couple. **(20 Marks)**

6 a. Define the following terms in connection with governors : i) Sensitiveness ii) Isochronism iii) Governor effort and iv) Governor power. **(08 Marks)**

b. The mass of each ball of a Hartnell type governor is 1.4kg. The length of ball arm of the bell – crank lever is 100mm whereas the length of arm towards sleeve is 50mm. The distance of the fulcrum of bell – crank lever from the axis of rotation is 80mm. The extreme radii of rotation of the balls are 75mm and 112.5mm. The maximum equilibrium speed is 6% greater than the minimum equilibrium speed which is 300rpm. Determine i) stiffness of the spring and ii) equilibrium speed when radius of rotation of the ball is 90mm. Neglect the obliquity of the arms. **(12 Marks)**

7 a. With neat sketches, explain the effect of gyroscopic couple on pitching, steering and rolling of a ship. **(06 Marks)**

b. A four – wheeled trolley car has a total mass of 3000 kg. Each axle with its two wheels and gears has a total M.I of 32 kgm^2. Each wheel is of 450mm radius. The centre distance between two wheels is 1.4m. Each axle is driven by a motor with speed ratio of 1:3. Each motor along with its gear has a moment of inertia of 16 $kg\text{-}m^2$ and rotates in the opposite direction to that of axle. The center of mass of the car is 1m above the rails. Calculate the limiting speed of the car when it has to travel around a curve of 250m radius without the wheels leaving the rails. **(14 Marks)**

8 The following particulars relate to a symmetrical tangent cam having a roller follower : Minimum radius of the cam = 40mm ; Lift = 20mm ; Speed = 360 rpm ; Roller diameter = 44mm ; Angle of ascent = 60^0. Calculate the acceleration of the follower : i) at beginning of lift ii) when the roller just touches the nose. **(20 Marks)**

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06ME53

Fifth Semester B.E. Degree Examination, May/June 2010
Dynamics of Machines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is "principle of virtual work"? Explain. **(04 Marks)**

b. For the mechanism shown in Fig. Q1(b), determine the torque on the link AB for static equilibrium of the mechanism. Given, AB = 20 mm, BC = 60 mm, CD = 35 mm, AD = 50 mm, BE = 45 mm, CE = 20 mm and DG = 25 mm. **(16 Marks)**

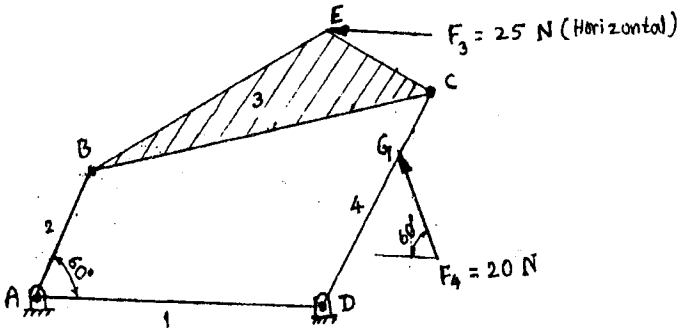

Fig. Q1(b)

2 a. State and explain D'Alembert's principle. **(04 Marks)**

b. Show that the coefficient of fluctuation of speed in a fly wheel is given by $k\frac{e}{Iw^2}$, where, e is the fluctuation of energy, I is the moment of inertia and w is the mean speed. **(04 Marks)**

c. The turning moment diagram of a four-stroke engine is assumed to be represented by four triangles, the areas of which from the line of zero pressure are :
Suction stroke = 440 mm^2 (Negative)
Compression stroke = 1600 mm^2 (Negative)
Expansion stroke = 7200 mm^2 (Positive)
Exhaust stroke = 660 mm^2(Negative)
Each sq. mm. of area represents 3N – m of energy. If the resisting torque is uniform, determine the mass of rim of the flywheel to keep the speed between 218 and 222 rpm. Mean radius of the rim is 1.25 m. **(12 Marks)**

3 a. Derive an expression for frictional torque in a flat pivot bearing. Assume uniform pressure across the bearing surface. **(06 Marks)**

b. Show that the linear velocity of the belt in a belt drive, for maximum power transmission, is given by $v = \sqrt{\frac{T}{m}}$, where, T = maximum allowable tension in the belt, and m = mass per unit length of the belt. **(04 Marks)**

c. An open belt drive is required to transmit 10 kW from a motor running at 600 rpm. Diameter of the driving pulley is 250 mm and speed of driven pulley is 220 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^3. Safe stress in the belt is not to exceed 2.5 N/mm^2 The two shafts are 1.25 m apart. The coefficient of friction is 0.5. Determine the width of belt. **(10 Marks)**

4 a. Explain static and dynamic balance of a system of revolving masses. (06 Marks)

b. Why two masses in different planes are necessary to rectify dynamic unbalance? (04 Marks)

c. A system of four revolving masses A, B, C and D is completely balanced. Masses C and D make angles 90° and 195° respectively, with B in the same sense. Planes B and C are 250 mm apart. The radius of rotation of the four masses are 150 mm, 200 mm, 100 mm, and 180 mm respectively. Masses B, C and D are 25 kg, 40 kg and 35 kg respectively. Determine : i) Mass A and its angular position with mass B, ii) Axial positions of planes A and D. (10 Marks)

PART – B

5 a. Explain the direct and reverse crank method of analysis of radial engines for primary and secondary forces. (06 Marks)

b. Derive an expression for resultant unbalanced force in a partially balanced single cylinder engine. (04 Marks)

c. A v-twin engine has the cylinder axes at right angles and the connecting rods operate a common crank. The reciprocating mass per cylinder is 11.5 kg and the crank radius is 75 mm. Length of connecting rod is 0.3m. Show that the engine may be balanced for primary force by means of a revolving mass. Also find the maximum secondary force if the engine speed is 500 rpm. (10 Marks)

6 a. Establish a relationship between speed and height of a porter governor, taking friction on the sleeve into account. (08 Marks)

b. In a porter governor, each of the four arms is 400 mm long. The upper arms are pivoted on the axis of the sleeve, whereas the lower arms are attached to the sleeve at a distance of 45 mm from the axis of rotation. Each ball has a mass of 8 kg and the load on the sleeve is 60 kg. Determine the range of speed of the governor for extreme radii of rotation of 250 mm and 300 mm. (12 Marks)

7 a. Derive an expression relating the angle of heel and linear velocity for dynamic stability of a two wheel vehicle, negotiating a curve. (10 Marks)

b. The turbine rotor of a ship has a mass of 2200 kg and rotates at 1800 rpm clockwise when viewed from the stern. The radius of gyration of rotor is 320 mm. Determine the gyroscopic couple and state its effect when :

i) The ship steers to the right at a speed of 25 kmph in a curve of radius 250 m

ii) The ship pitches, with the bow rising at an angular velocity of 0.8 rad/s. (10 Marks)

8 a. Find the velocity and acceleration of a roller follower operated by a tangent cam when the roller is making contact :

i) On the flank, ii) With the nose. (12 Marks)

b. A tangent cam with straight working faces tangential to a base circle of 120 mm diameter has a roller follower of 48 mm diameter. The nose circle radius of the cam is 12 mm and the angle between the tangential faces of the cam is 90°. If the speed of the cam is 180 rpm, determine the acceleration of the follower when :

i) During lift, the roller just leaves the straight flank

ii) The roller is at the top of the nose. (08 Marks)

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