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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec. - 2019

Dynamics of Machinery

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. State the conditions for a body to be in equilibrium under the action of two forces, two forces with a torque and three forces systems. 6

b. The driving moment applied on link 2 is as shown in Fig. 1(b). Determine the force on link 4 that is necessary to be applied for equilibrium. 14

2 a. Explain the principle of virtual work, considering a slider crank mechanism. 6

b. Determine the required torque and forces on the links for a four bar mechanism as shown in Fig. 2 (b). 14

F = 2000 N, AD = 215 mm AB = 200 mm BC = 370 mm DC = 350 mm CE = 100 mm

UNIT - II

3 a. State and explain D'Alembert's principle. 4

b. A four bar mechanism is shown in Fig. 3(b) where the crank AB rotates at an uniform speed of 200 rpm in clockwise sense, from the data given below, determine the inertia forces of each of the links in respect of their magnitude and direction. Indicate them on the mechanism

AB = 75 mm, BC = 300 mm, CD = 150 mm, AD = 250 mm, Ag_2= 25 mm, Bg_3 = 100 mm, Cg_4 = 50 mm. 16

Mass of links: AB = 2.5 kg BC = 5.0 kg CD = 8.0 kg

Mass moment of inertia of links AB = 0.001 kgm^2

BC = 0.025 kgm^2, CD = 0.012 kgm^2

4. The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 60 mm and 270 mm respectively the diameter of the piston is 100mm and the mass of the reciprocating parts is 1.2 kg. Derive the expansion stroke when the crank has turned 20º from top dead centre, the gas pressure is 650 kN/m^2. Determine; 20

i) The net force on the piston

ii) The net load on the gudgeon pin

iii) The thrust on the cylinder walls

iv) The speed at which the gudgeon pin load is reversed in direction

Contd…2

UNIT - III

5. The TMD of a 2 stroke engine at the crank shaft is represented by,
   $T = 14700 + 2260 \sin 2\theta - 1980 \cos 2\theta$ Nm,
   Where θ is the crank angle displacement from inner dead centre? Assuming the external resisting torque to be constant determine,
   i) Power of the engine when the speed is 150 rpm
   ii) MI of the fly wheel if the speed variation is not to exceed ± 0.5% of mean speed
   iii) Angular acceleration of fly wheel when the crank has turned through 30º from IDC
   iv) Maximum angular acceleration and retardation — 20

6 a. Compare the functions of fly wheel with those of Governor. — 6

b. With a neat sketch, explain the working principle of porter Governor. — 6

c. A punching press is required to punch 40 mm dia holes in a plate of 15mm thick at the rate of 30 holes per min. It requires 6 Nm of energy per mm^2 of sheared area. If the punching takes 1/10 of second and the angular velocity of the fly wheel varies from 160 rpm to 140 rpm determine the mass of the fly wheel having radius of gyration of 1 meter. — 8

UNIT - IV

7 a. Explain the balancing of single revolving mass by two masses on either side. — 6

b. Masses M_1, M_2, M_3 and M_4 are rotating in planes as shown in Fig. 7(b). Masses M_2 and M_3 are rotating in the same plane, if M_1 = 4 kg, M_2 = 10 kg and radii of rotation r_1 = 150 mm, r_2 = 200 mm, r_3 = 100 mm and r_4 = 100 mm. Determine masses M_3 and M_4 and angular position of M_2, M_3 and M_4. — 14

8 a. Mention the conditions to be satisfied for static balancing and dynamic balancing of rotating masses. — 4

b. Compare Inline engine with a radial engine. — 4

c. Fig. 8(c) shows the arrangement of the cranks in a 4-crank symmetrical engine in which the mass of reciprocating parts at cranks 1 & 4 are equal to M1 and at cranks 2 and 3 are equal to M_2. Show that the arrangement is balanced for primary forces, couples and for secondary forces provided that, — 12

$$\frac{M_1}{M_2} = \frac{\cos\theta_2}{\cos\theta_1}; \frac{a_1}{a_2} = \frac{\tan\theta_2}{\tan\theta_1}; \cos\theta_1 \times \cos\theta_2 = \frac{1}{2}$$

UNIT – V

9 a. Define Gyroscopic effect and explain Gyroscopic couple with a neat sketch. — 6

b. A one ton marine motor having a radius of gyration 300 mm rotates at 1550 rpm clockwise when looking from the bow. Determine the gyroscopic couple and its effects on the ship in the following cases: — 14

Contd…3

i) When the ship pitches with an angular velocity of 1 rad/s as the bow rises?

ii) When the ship is speeding at 40 km/hr and takes a right turn in a circular path of 200m radius?

iii) When the ship rolls at a certain instant, it has an angular velocity of 0.5rad/s when viewed from the stern?

10 a. Explain the stability of a motor cycle and derive an expression for heel angle to avoid skidding. 10

b. A disc weighing 50 N and of diameter 300 mm is mounted on one end of a arm of length 600 mm, the other end of the arm is fixed to rotate in a universal bearing. The disc spins at 300 rpm clockwise looking from universal bearing and the axis of spin is horizontal. Determine angular speed of precession of disc and about which axis does the precision takes place? 10

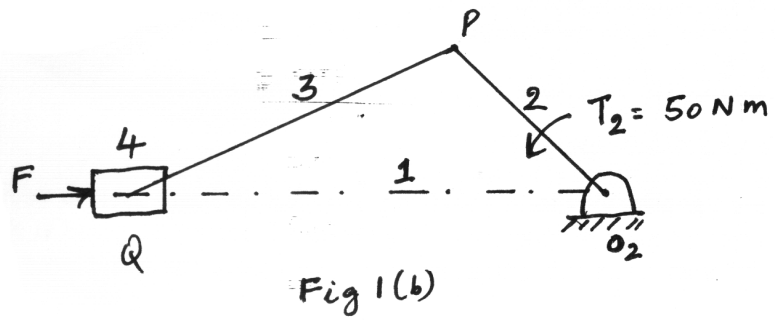


Fig 1(b)

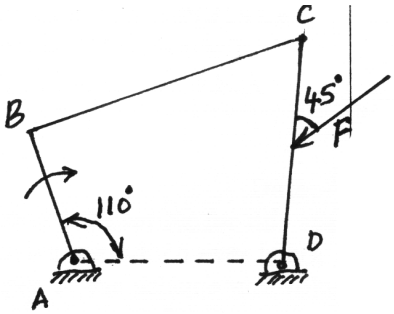


Fig 2(b)

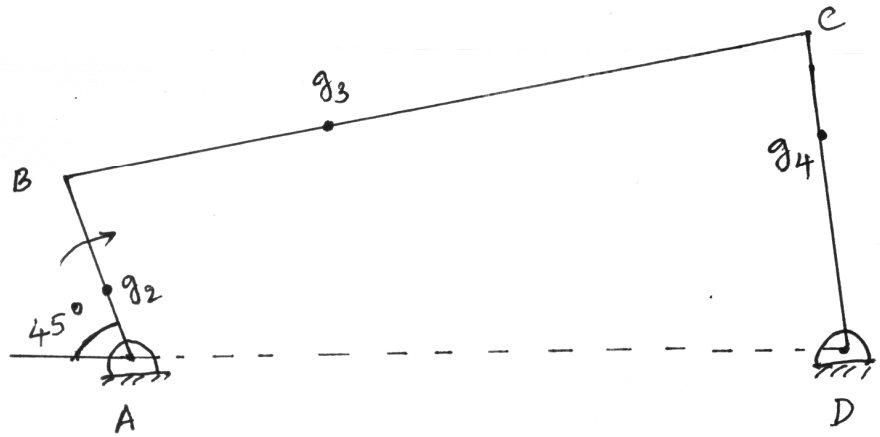
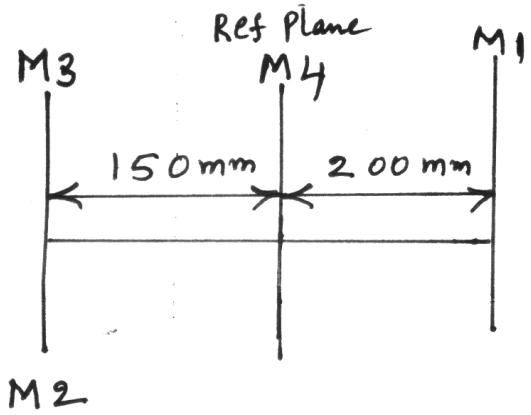


Fig 3(b)


Ref Plane
M3
M4
M1
150mm
200mm
M2

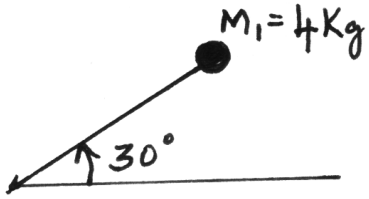

M1 = 4Kg
30°

Fig 7(b)

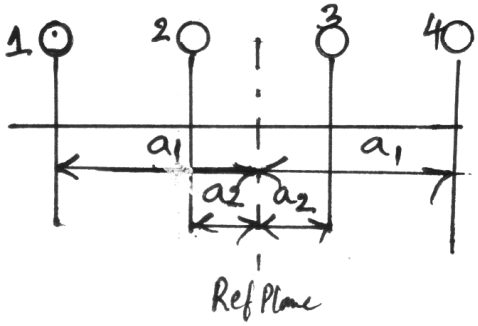
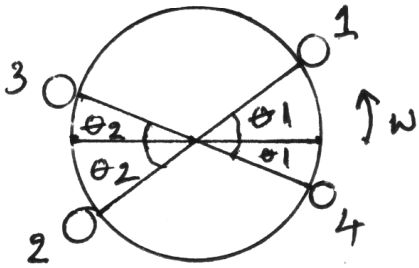

1
2
3
40
a1
a1
a2
a2
Ref Plane

Fig 8(c)


1
3
θ2
θ1
θ1
θ2
W
2
4

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