VASAVI COLLEGE OF ENGINEERING (Autonomous), HYDERABAD
B.E. (Mech. Engg.) III Year I-Semester Main & Backlog Examinations, December-2017

Dynamics of Machines

Time: **3 hours**   Max. Marks: **70**

Note: Answer ALL questions in Part-A and any FIVE from Part-B

Part-A (10 × 2 = 20 Marks)

1. A crank of radius 20cm and mass 1kg rotates uniformly at 100r.p.m. Calculate inertia force acting on the crank.

2. Develop general expression for gyro couple.

3. List the equations of motion for inter connected 3-D rigid bodies.

4. List the equilibrium equations when 3-D rigid body is subjected to external forces and moments.

5. The centre of mass(COM) of a disc of mass 5kg and radius 0.5m is at a radial distance of 0.01m from center of rotation(COR)(See the Fig-1). Estimate the mass required to balance the disc when it rotates at 1000 rpm.
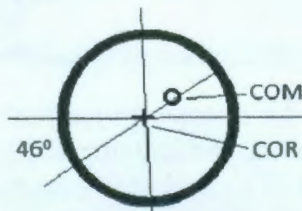

Fig.1

6. Define firing order in a multi cylinder engine. What is the best firing order for a four cylinder in line engine?

7. Calculate the frictional torque in a flat collar bearing having OD: 400 mm, ID: 300 mm, coefficient friction:0.3 and axial load:1 kN.

8. In a single block frictional brake, the line of action of friction force passes through the fulcrum of the lever. If the length of arm of applied load is double the arm of the normal reaction, calculate the ratio between normal reaction and applied load.

9. List the conditions under which hunting takes place and suggest a method for reduction of it.

10. The maximum energy fluctuation of a double acting steam engine is 1000 Nm at mean speed of 5000 rpm. To restrict the fluctuation of speed within ± 2%, a 300 mm radius of gyration flywheel is used. Estimate the weight of fly wheel.

Part-B (5 × 10 = 50 Marks)

11. a) Determine the torque required (assuming no friction in the bearing) for the static   [7]
    equilibrium of an in-line slider crank mechanism in the position when crank angle (from
    the inner dead center) is 45^0. The dimensions are, crank length = 300 mm, connecting
    rod length = 700 mm and the piston force = 40N. Also estimate the torque required
    assuming that the coefficient of friction for all bearings is equal to 0.1. The three journal
    bearings all have radii of 10 mm, and the crank is rotating in the clockwise direction.

    b) Discuss the effect of gyro couple on stability of two wheeler automobile.   [3]

12. a) Explain the Newton-Euler approach to derive equations of motion for mechanisms. [4]

b) Consider the two link 2R planar manipulator moving in a vertical plane as shown in [6]
Fig.2. Sketch the free body diagrams and formulate equations of motion for the two
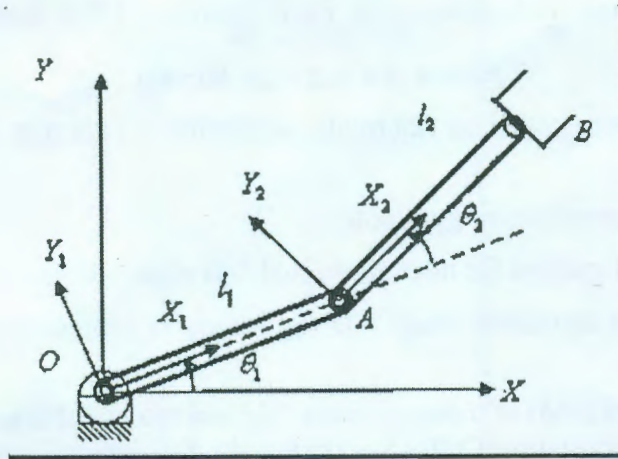moving links with Newton-Euler approach.

Fig-2

13. a) Discuss direct and reverse crank method of balancing in radial engines. [3]

b) A shaft supported in bearings 1.6 m apart projects 400 mm beyond bearings at each end. [7]
It carries three pulleys one at each end and one at the centre of its length. The masses of
the end pulleys are 40 kg and 22 kg and their centers of mass are at 12 mm and 18 mm
respectively from the shaft axes. The mass of the centre pulley is 38 kg and its centre of
mass is 15 mm from the shaft axis. The pulleys are arranged in a manner that they give
static balance. Determine *i)* the relative angular positions of the pulleys *ii)* the dynamic
forces developed on the bearings when the shaft rotates at 210 rpm.

14. a) Distinguish between uniform wear clutch and constant pressure clutch. [3]

b) The square-threaded screw jack is used to raise and lower the 100 kg block. Determine [7]
i) the torque required to begin for moving the block up, and *ii)* the torque required to
begin for moving the block down. Also determine if the block will remain stationary
when the torque is removed. The screw has lead = 10 mm, mean radius = 8 mm, and is
single-threaded. The coefficient of static friction between the screw and the supporting
threads of the base is 0.25.

15. a) Distinguish between flywheel and Governor. [3]

b) In a spring loaded governor of the Hartnell type, the mass of each ball is 5 kg and the [7]
lift of the sleeve is 50 mm. The speed at which the governor begins to float is 240 rpm.
and at this speed the radius of the ball path is 110 mm. The mean working speed of the
governor is 20 times the range of speed when friction is neglected. If the lengths of ball
and roller arm of the bell crank lever are 120 mm and 100 mm respectively. If the
distance between the centre of pivot of bell crank lever and axis of governor spindle is
140 mm, determine the initial compression of the spring taking into account the
obliquity of arms. If friction is equivalent to a force of 30 N at the sleeve, determine the
total alteration in speed before the sleeve begins to move from mid-position.

16. a) Formulate the dynamically equivalent system for I-section connecting rod of length: [5]
    1.5m and mass: 3kg. The cross section has dimensions: 40 mm width × 50 mm
    height × 10 mm thickness.

  b) Show the free body diagram of disc cam and roller follower (see Fig.3). Formulate [5]
    equations of motion for follower and cam. Mass and other dimensions are shown in the
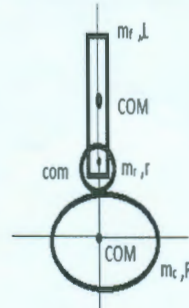   figure.

Fig-3

17. Answer any *two* of the following:

  a) Deduce an expression to calculate the shaking force in single cylinder in line engine [5]
    when it rotates with uniform speed.

  b) With line diagram, explain the working principle of rope brake dynamometer. [5]

  c) Torque-crank angle diagram during expansion stroke for C.I. engine is shown in Fig.4. [5]
    The power rating of engine: 5kW at mean speed 400 rpm. Estimate the mass of the
    flywheel required if fly wheel radius of gyration is 1m. Neglect torque delivered in
    other strokes.
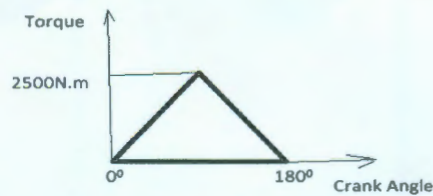

Fig-4

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