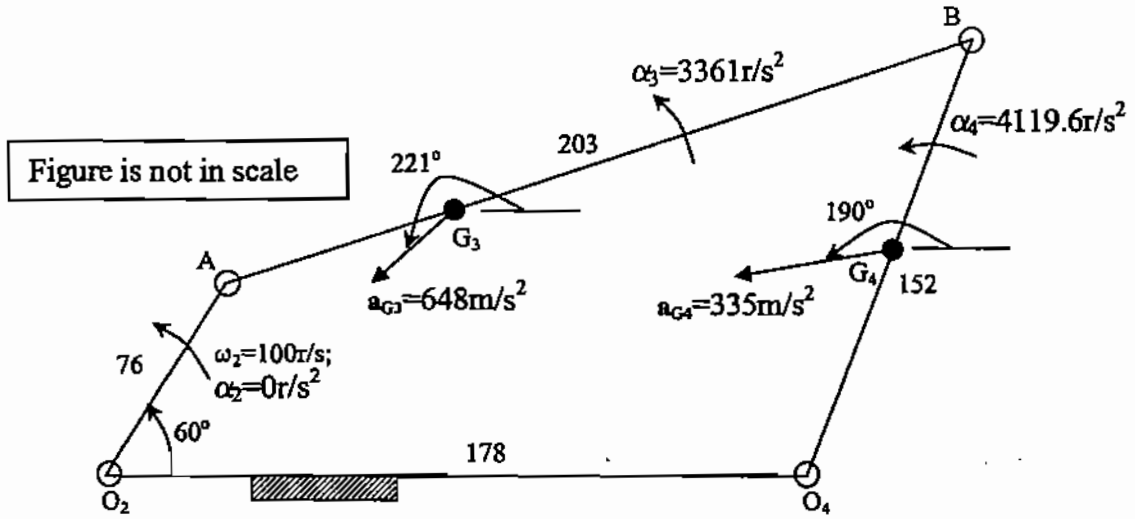
ME Dept., IIT Delhi
MEL211: Kinematics and Dynamics of Machines
Major Test (Dec. 01, 2006)

Duration: 2 hours **Total Marks: 35**

[Instruction: Write Part A and B in different answer books]

Part A (Marks: 17)

1. For the four-bar linkage shown below, find the torque required at joint O_2 to achieve the given motion using the method of superposition.



Link lengths: O_2O_4=178mm; O_2A=76mm; AB=203mm; O_4B=152; $AG_3=O_4G_4$=76mm
For link AB: Mass=1kg; Mass moment of inertia about G_3=0.002kg.m^2
For link O_4B: Mass=0.75kg; Mass moment of inertia about G_4=0.001kg.m^2

[10]

2. Using sketches illustrate a 3-position motion generation synthesis of a four-bar linkage with all revolute joints.

[3]

3. Define the following:
   a. Grashof's criterion
   b. Kinematic inversion
   c. Aronhold-Kennedy theorem
   d. Coriolis Acceleration

[4]

(P.T.O for Part B)

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Attempt all questions — Time: 2 hrs

Parts A and B to be answered in separate books — Total Marks: 35

PART - B (Marks 18)

Q1. (a) A pair of 4mm module spur gears of 14½ degree pressure angle are to be used for a speed reduction of 2:1. Determine the minimum possible center distance between the gears, if standard gears are to be used and there should be no interference.

(b) For the gear train shown in figure, determine the output speed and its direction. (1½ + 1½)

Q2(a) A radial cam with a flat face follower has a rise of 5cm over 180 degree cam rotation followed by a fall over the remaining 180 degree cam rotation. Assuming harmonic function for both the rise and the fall, determine the rotational speed of the cam at which the follower is likely to have a jump. Determine cam angle when jump occurs.

(b) Draw crank diagram of an inline 3 cylinder 4 stroke engine with firing order I-III-II. Assume clockwise rotation of cranks. Also check the balance condition of the rotor. (1½ + 1½)

Q3. A journal bearing operates with following data.
Length and diameter of the bearing = 8.0 cm; Rotational speed = 1500 RPM.
Load on the bearing = 30 kN ; Viscosity of oil = 15 cp ; Radial clearanee = 40 micron.
Determine the minimum film thickness. Assume full Sommerfeld condition. (3)

Q4. Determine absolute maximum load carrying capacity of a vertical thrust runner with 8 identical pivoted shoes having a 40 degree sector angle each. Maximum and minimum radii of the shoes are 40 cm and 20 cm respectively. Minimum permissible film thickness is 30 micron. Operating speed is 1500 RPM. Take viscosity of the oil as 25 cp.

Also determine the power loss and maximum oil film thickness under the above operating condition, when the bearing carries maximum load. (3)

Q5. For the unbalances shown on the rotor, determine the magnitude and angular location of the correction masses required on speeified left and right correction planes. Draw a diagram indicating the angular location of correction mass in each of the correction planes. You may take the horizontal line as a reference. (3)

Q6. (a) Consider a 90 degree V twin engine. Assume identical cylinders. Is it possible to achieve complete balance for primary forces?

(b) Figure shows a simplified T-θ diagram of a single cylinder 4 stroke engine operating at 1000 RPM. Determine the mass moment of inertia of the flywheel so that the maximum speed fluctuation is limited to with in 2 %. (1½ + 1½)

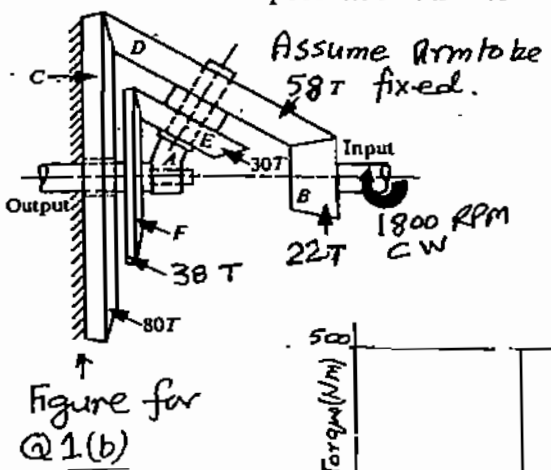

Figure for Q1(b)

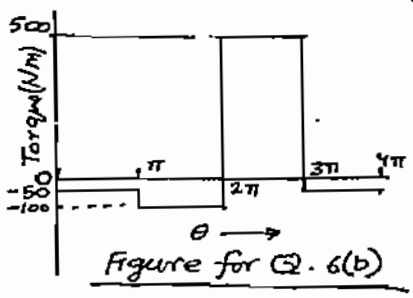

Figure for Q. 6(b)

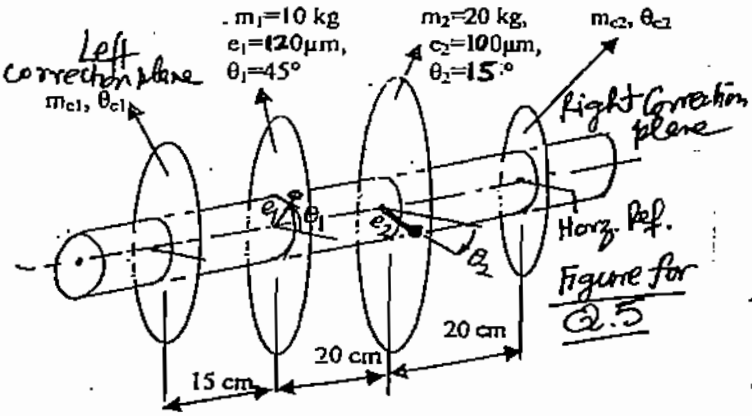

Figure for Q.5

PTO for PART-A