B.E. MECHANICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2025

KINEMATIC ANALYSIS AND SYNTHESIS

Time: 3 Hrs | Full Marks: 100

(Assume data if missing)

Q1. a) How are the kinematic pairs classified? Explain with examples.

b) Show that hand pump is an inversion of single slider crank mechanism.

c) What are Kutzback's and Grashoff's criteria.

d) Explain the types of constrained motion.

e) Find DOF of the following two linkages (Figure Q1).

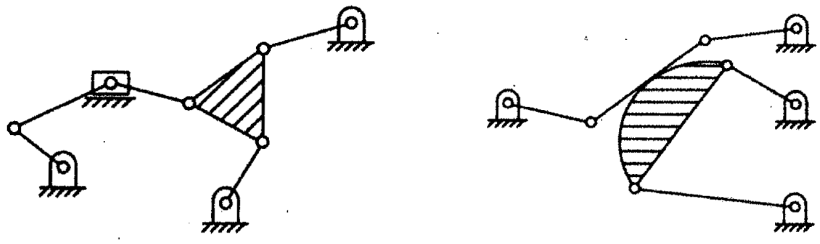

Figure 1

4+4+4+4+4=20

OR

Q1. Sketch and describe the following:

a) Scott-Russel mechanism

b) Paucellier mechanism

c) Davis or Akermann steering mechanism

d) Toggle mechanism

e) Transmission angle in context to four bar linkage

4+4+4+4+4=20

Q2. a) Determine the absolute velocities of linkage w.r.t velocity diagram of the crank- and slotted-lever mechanism from the line diagram with appropriate vector notation.

b) A link *AR* rotates about a fixed point *A* on it. *P* is a point on a slider on the link. Determine the acceleration of *P* parallel to *AR* and Acceleration of *P* perpendicular to AR. Where, ω and α are angular velocity and acceleration of the link. v and f are linear velocity and acceleration of the slider on the link. r is the redial distance of point *P* on the slide.

c) Locate all instantaneous centers of a typical slider crank mechanisms.

8+8+4=20

OR

Q2. The various dimensions of the mechanism, as shown in Figure Q2, are OA=120mm, AB=500mm, BC=120mm, CD=300mm and DE=150mm. the crank OA rotates at 150 rpm in CCW direction. The bell crank leaver is DE. Determine the absolute velocity of point E. Use graphical method.

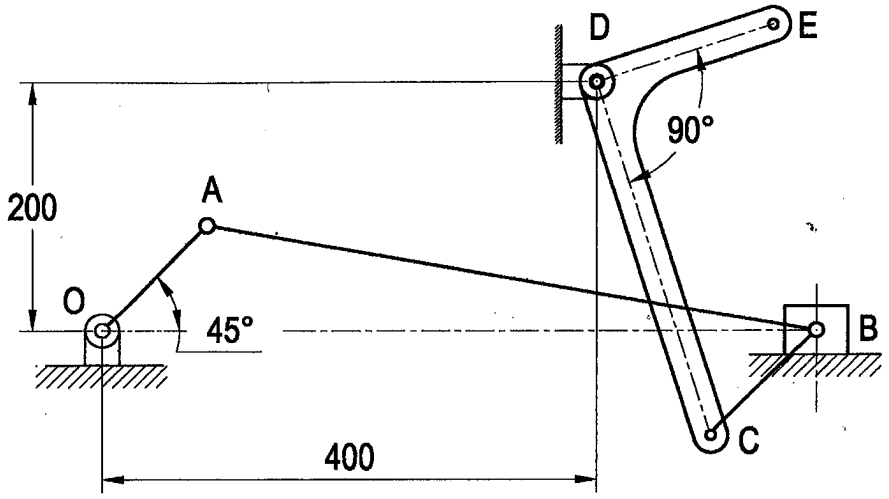

Figure 2

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Q3. a) State and drive the law of gearing.

b) Two involute gears in a mesh have a velocity ratio of 3. The arc of approach is not to be less than the circular pitch when the pinion is the driver. The pressure angle of the involute teeth is 20^0. Determine the least number of teeth on each gear. Also, find the addendum of the wheel in terms of module.

c) Find the minimum number of teeth on a pinion of standard addendum and 20^0 pressure angle to avoid interference between a rack and pinion.

5+5+10=20

OR

Q3. a) What is path of contact? Derive the relation for its magnitude.

b) Find relations to determine velocity ratio and centre distance of helical gear.

c) Two 20^0 gears have a module pitch of 4 mm. The number of teeth of gears 1 and 2 are 40 and 24 respectively. If the gear 2 rotates at 600 rpm, determine the velocity of sliding when the contact is at the tip of the tooth of gear 2. Take addendum equal to 1 module. Also find the maximum velocity of sliding.

5+5+10=20

Q4. a) In the figure 3, annulus A is rotating at 300 rpm about an axis of the fixed wheel S, which has 80 teeth. The three-armed spider is moving at 180 rpm. Determine the number of teeth required on the wheel P.

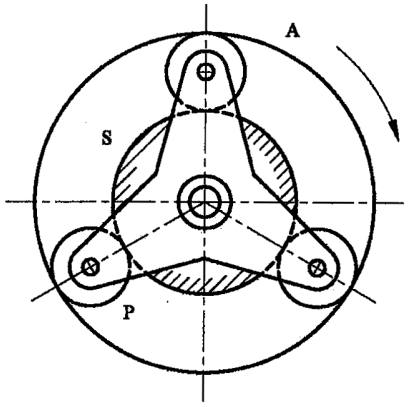

Figure 3

b) Design a four-link mechanism to coordinate three positions of the input and the output links as follows:

$$\theta_1 = 20^0;\ \phi_1 = 35^0$$
$$\theta_2 = 35^0;\ \phi_2 = 45^0$$
$$\theta_3 = 50^0;\ \phi_3 = 60^0$$

10+10=20

OR

Q4. a) The Figure 4, shows an Epicyclic gear train. Wheel E is fixed and wheels C and D are integrally cast and mounted on the same pin. If arm A makes one revolution per sec (Counter clockwise) determine the speed and direction of rotation of the wheels B and F.

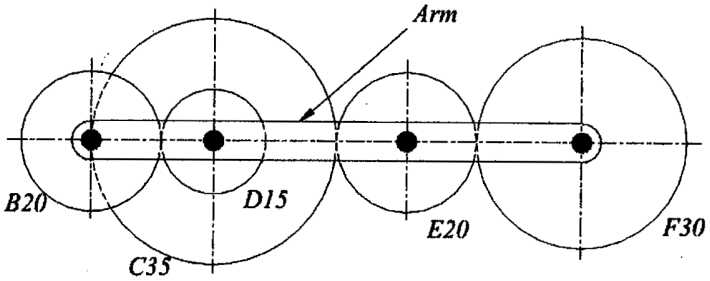

Figure 4

b) What is Freudenstein's equation? How is it helpful in designing a four-link mechanism when three positions of the input (θ_1, θ_2, θ_3) and the output link (ϕ_1, ϕ_2, ϕ_3) are known.

10+10=20

Q5. a) Describe different types of cams and followers.

b) Deduce expressions for the velocity and acceleration of the follower when it moves with SHM.

c) A follower is having a rise of 40 mm with cycloidal motion for 120° rotation of the cam. Determine and Plot the displacement, velocity, acceleration and jerk of the follower.

5+5+10=20

OR

Q5. Draw the profile of a cam operating a knife-edge follower having a lift of 30 mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60°. The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20 mm. What will be the maximum velocity and acceleration of the follower during the lift and the return?

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