B. E. MECHANICAL ENGINEERING (PART TIME) SECOND YEAR
SECOND SEMESTER EXAMINATION, 2017

KINEMATIC ANALYSIS & SYNTHESIS

Time: 3 hours   Full Marks: 100

(Answer any five)
(Assume data if required)

1. a) Determine the degrees of freedom of the following mechanisms shown in the figure 1.
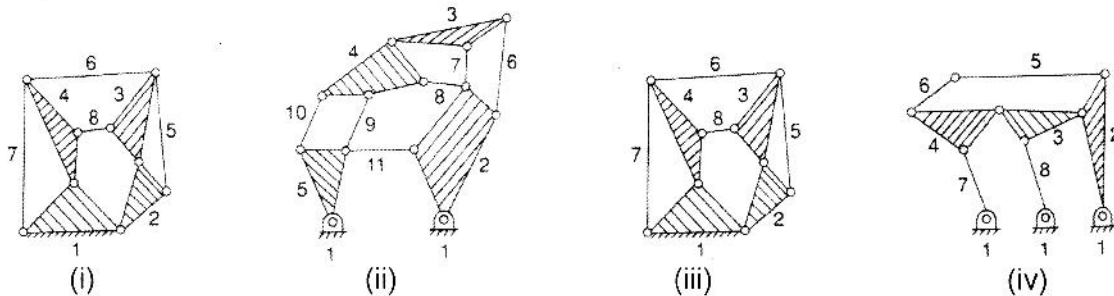

Figure 1

   b) Show that the slider crank mechanism is a modification of the basic four bar mechanism.
   c) Locate all instantaneous centers of a typical four bar chain.

                                                                    8+4+8=20

2. a) Explain Kutzback's criteria.
   b) Sketch and describe crank and slotted lever mechanism. Find the time-ratio of cutting stroke to return stroke and the stroke length. Why is it called quick return mechanism?
   c) Show that hand pump is an inversion of single slider crank mechanism.

                                                                    4+12+4=20

3. a) Indicate the type of each mechanism in the figure 2 (whether crank-rocker or double rocker or double crank). Dimensions are given in standard units of length.
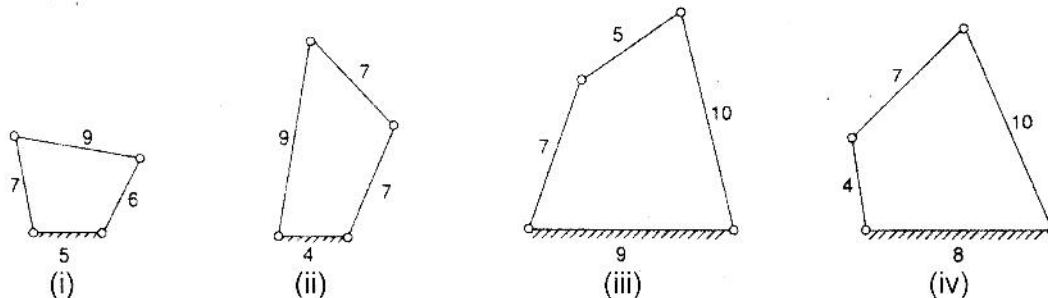

Figure 2

   b) Find the maximum and minimum transmission angles for the mechanisms shown in the figure 3. The values indicate the dimensions in standard units of length.

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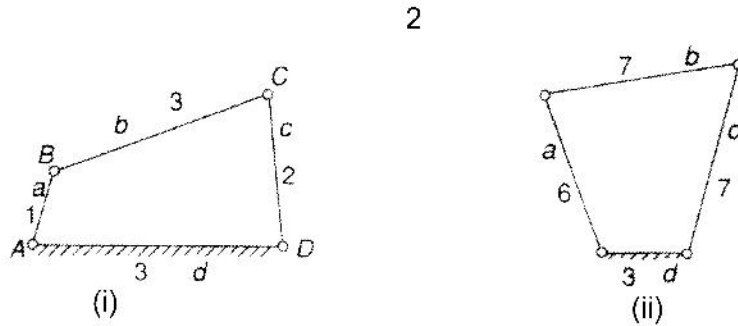
Figure 3

8+12=20

4. a) At the instant represented (figure 4) the disc with the radial slot is rotating about 'O' with CCW angular velocity of 4 rad/s, which is decreasing at a rate of 10 rad/s. The motion of the slider 'A' is separately controlled and at this instant $r = 150$ mm, $\dot{r} = 125$ mm/s, $\ddot{r} = 2025$ mm/s^2. Determine the absolute velocity and acceleration of 'A' for this instant. Draw velocity and acceleration polygon (not to the scale).

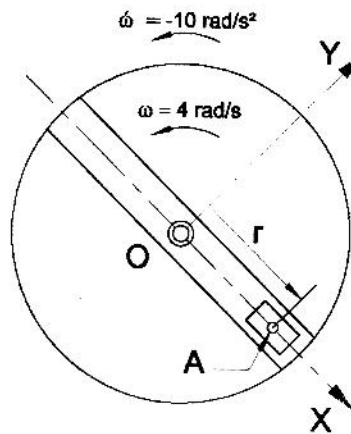Figure 4

b) In figure 5, Q_2B is 37.5 mm; Q_2Q_4 is 87.5 mm; Q_4C is 45 mm; BC is 50 mm. Angular speed of the crank Q_2B is 1 rad/sec CCW. Find velocities of C and P by resolution and composition method.
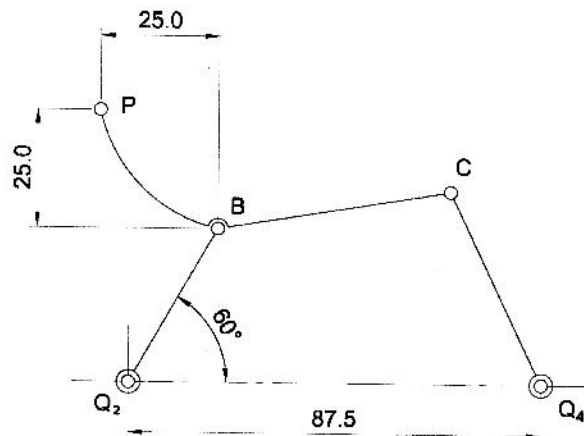

Figure 5

10+10=20

5. a) State and drive the laws of gearing.
   b) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20^0 pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and contact ratio.
   c) Derive the expression of minimum no. of teeth to avoid interference while two spur gears with involute profile in mesh.

6+7+7=20

6. a) The various dimensions of the mechanism, as shown in figure 6, 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.
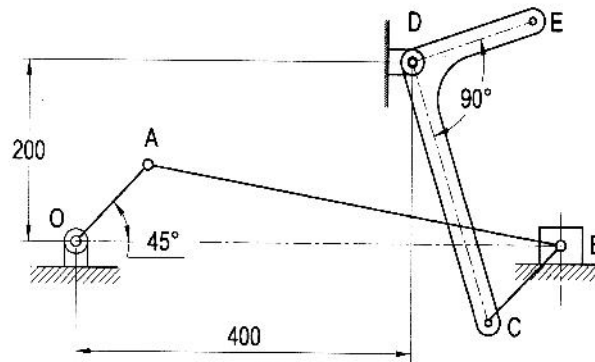

Figure 6

   b) Consider that the arm 4 of the following figure 5 rotates CCW at 50 rad /sec. Given: Teeth of gear 1 = 80, Teeth of gear 2 = 40, Teeth of gear 3 = 20. Determine angular **speed of gear 2 (figure 7).**
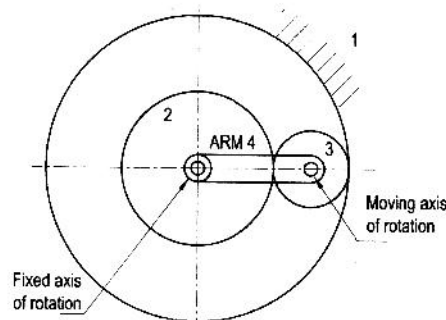

Figure 7

12+8=20

7. a) Discuss different types of dimensional synthesis.
   b) What is the pole of a coupler link of four link mechanism? Enumerate its properties.
   c) Design a four link mechanism to coordinate three positions of the input and the output links as follows:

$$\theta_1 = 20^0; \quad \varphi_1 = 35^0$$
$$\theta_2 = 35^0; \quad \varphi_2 = 45^0$$
$$\theta_3 = 50^0; \quad \varphi_3 = 60^0$$

6+7+7=20

[Turn over

8. Answer any four:
   a) Describe different types of plate cam.
   b) Derive expression for 3-4-5 polynomial curve.
   c) Define type, number and dimensional synthesis.
   d) What is structural error?
   f) Toggle mechanism / any straight line mechanism

$5+5+5+5=20$

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