B. E. MECHANICAL ENGINEERING (PART TIME) SECOND YEAR
SECOND SEMESTER EXAMINATION, 2018
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.

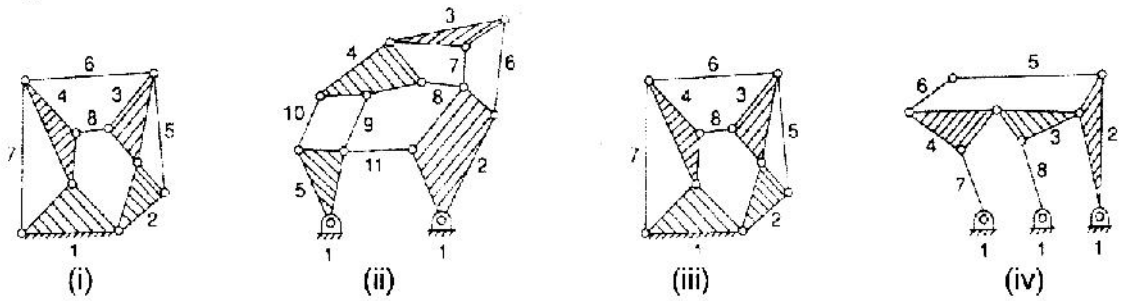

Figure 1

b) Derive the relation between input crank angle and transmission angle of a four bar linkage. Explain the significance of transmission angle.

10+10=20

2. a) Explain Kutzback's criteria.
   b) Show that the slider crank mechanism is a modification of the basic four bar mechanism.
   c) Show that hand pump is an inversion of single slider crank mechanism.

6+6+8=20

3. a) Locate all instantaneous centers of a typical four bar chain.
   b) At the instant represented (figure 2) 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).

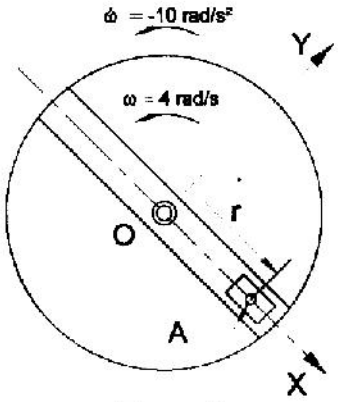

Figure 2

6+14=20

4. Given: Q_2B=75; BD=65; CE=115; and Q_4D=20. Link 5 (CE) is connected to link 3 (BD) at point C. Find the velocity of point C and E if the crank Q_2B is rotating in CCW direction with angular speed of 150 rpm.

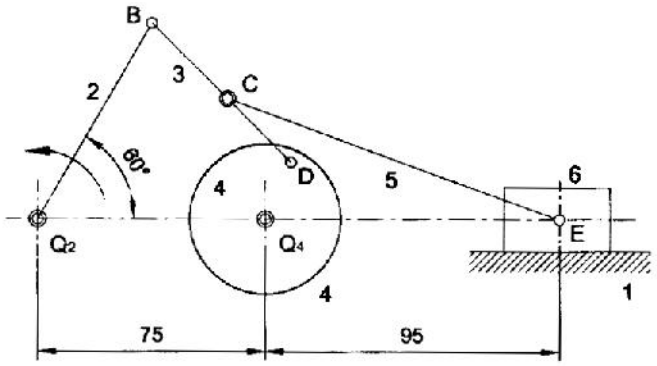

Figure 3

20

5. a) State and derive the laws of gearing.
   b) Derive the expression of minimum no. of teeth to avoid interference while two spur gears with involute profile in mesh.

10+10=20

6. a) The number of teeth on the gear and the pinion of two spur gears in mesh are 30 and 18 respectively. Both the gears have a module of 6 mm and a pressure angle of 20^0. If the pinion rotates at 400 rpm, what will be the sliding velocity at the moment, the tip of the tooth of pinion has contact with the gear flank? Take addendum equal to one module. Also, find the maximum velocity of sliding.

   b) Explain with sketches different types of gear trains.

10+10=20

7. a) Consider that the arm 4 of the following figure 4 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 4).

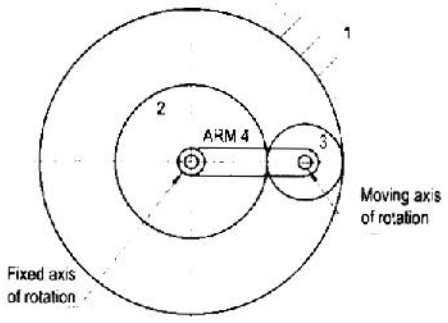

Figure 4

   b) For the gear train in the figure 5, shaft A rotates at 300 rpm and shaft B at 600 rpm in the directions shown. Determine the speed and the direction of rotation of shaft C.

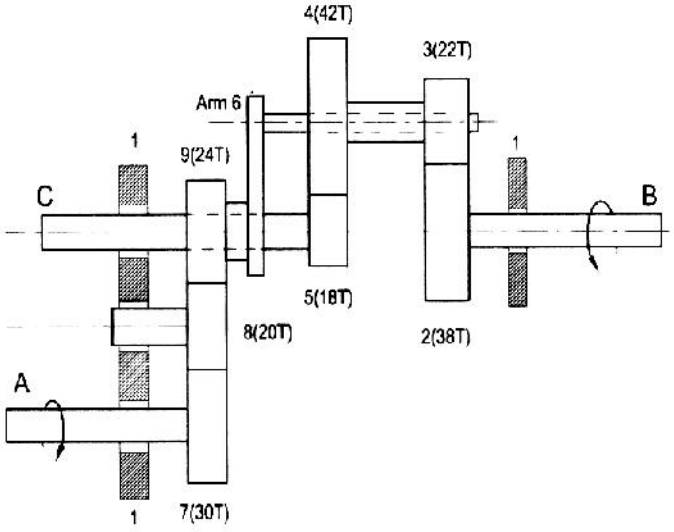

Figure 5

10+10=20

8. a) Discuss different types of dimensional synthesis.
   b) Design a four link mechanism to coordinate three positions of the input and the output links as follows:

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

6+14=20

9. 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