KINEMATICS & DYNAMICS OF MACHINES
(MEC2205)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) A mechanism has 7 links with all binary pairs except one which is a ternary pair. The number of instantaneous centres is
(a) 14 (b) 21 (c) 28 (d) 35

(ii) The Whitworth quick return motion mechanism formed in a single slider crank chain when the
(a) coupler link is fixed (b) longest link is fixed
(c) smallest link is fixed (d) slider is a fixed one.

(iii) When a slider moves on a fixed link having curved surface, their instantaneous centre lies
(a) on their point of contact (b) at the centre of curvature
(c) at the centre of slider (d) at the pin joint.

(iv) The velocity of any point on the link with respect to another point on the same link is always
(a) random to the line joining these points
(b) 45 degree to the line joining these points
(c) perpendicular to the line joining these points
(d) parallel to the line joining these points

(v) In a slider bar mechanism when does the connecting rod have zero angular velocity
(a) When crank angle = 0° (b) When crank angle = 90°
(c) When crank angle = 45° (d) never

(vi) A point on a rigid flywheel of radius 750 mm undergoes a uniform linear acceleration of 3 m/s2. The flywheel's angular acceleration is
(a) 0.25 rad/s2 (b) 2.5 rad/s2
(c) 4 rad/s2 (d) 250 rad/s2

(vii) The gyroscopic couple acting on a disc of moment of inertia I, rotating with speed ω and speed of precession ω_p, is given by
(a) $I\,\omega^2\,\omega_p$ (b) $I\,\omega\,\omega_p^2$ (c) $I\,\omega\,\omega_p$ (d) $I\,\omega^2\,\omega_p^2$

(viii) In a turning moment diagram, the variations of energy above and below the mean resisting torque line is called
(a) Fluctuation of energy (b) Maximum fluctuation of energy
(c) Coefficient of fluctuation of energy (d) None of these

(ix) The primary unbalanced force is maximum when the angle of inclination of the crank with the line of stroke is
(a) 0^0 and 90^0 (b) 0^0 and 180^0
(c) 90^0 and 180^0 (d) 180^0 and 360^0

(x) A disturbing mass m_1 attached to the rotating shaft may be balanced by a single mass m_2 attached in the same plane of rotation as that of m_1, such that (where r_1 and r_2 are the radii of rotation of m_1 and m_2 respectively)
(a) $m_1r_2 = m_2r_1$ (b) $m_1r_1 = m_2r_2$ (c) $m_1m_2 = r_2r_1$ (d) None of these

Fill in the blanks with the correct word

(xi) The pitching of a ship produces forces on the bearings which act _____ to the motion of the ship.

(xii) When the crank is at the inner dead centre, in a reciprocating steam engine, then the velocity of the piston will be _____.

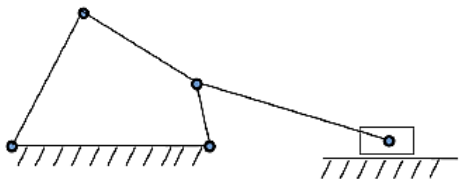
(xiii) In a simple gear train, if number of idlers is odd, then the direction of rotation of first and last gear shall be _____.

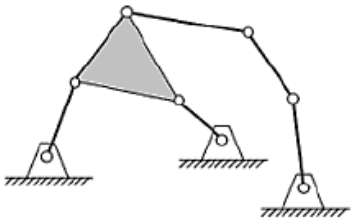
(xiv) A mechanism having 6 nos. of links have _____ nos. of instantaneous centre.

(xv) A type of exact straight line mechanism is _____.

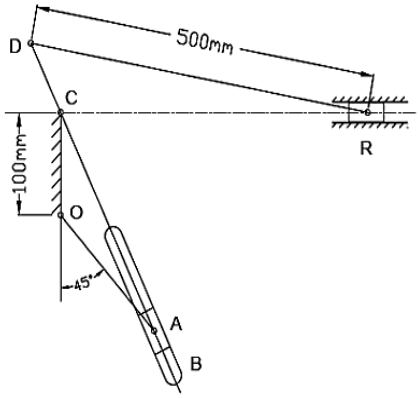
Group - B

2. (a) Find out the degree of freedom of following mechanisms. *[(CO1)(Apply/IOCQ)]*





(b) In a Whitworth quick return mechanism, as shown in following figure. The dimensions of various links are: OA = 150 mm; OC = 100 mm; CD = 125 mm; and DR = 500 mm. Determine the quick return ratio and stroke length.

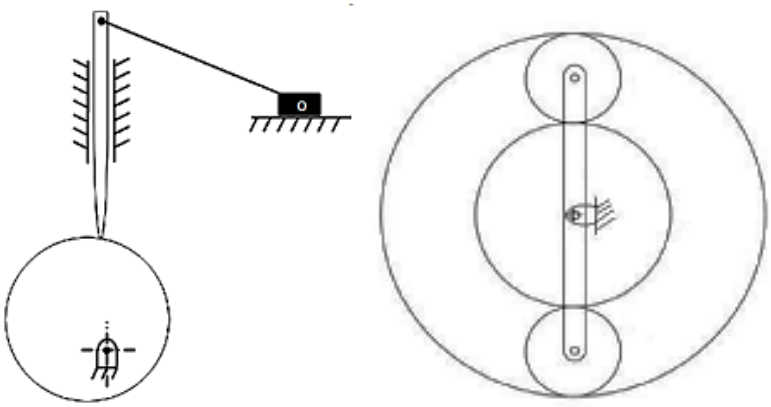


[(CO1,CO2)(Analyse/IOCQ)]

(3 + 3) + 6 = 12

3. (a) What is meant by inversions of mechanism? Describe various inversions of four bar mechanism when sum of shorter and longer link is equal to sum of other two links. *[(CO1)(Understand/LOCQ)]*

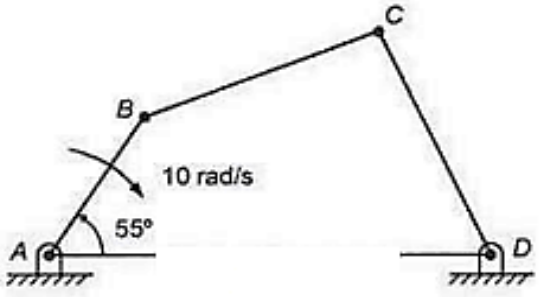
(b) Find out the degree of freedom of following mechanisms. *[(CO1)(Apply/IOCQ)]*



6 + (3 + 3) = 12

Group - C

4. In the four-bar mechanism shown in following figure, the lengths of the various links are: AB = 190 mm, BC = CD=280 mm, AD =500 mm, ∠BAD=55^0. The crank AB rotates with uniform angular velocity of 10 rad/s in the clockwise direction. (a) Draw velocity diagram (b) acceleration diagram and (c) the acceleration of the links B and C with respect to ground. *[(CO2)(Analyse/IOCQ)]*



12

5. Draw the profile of a cam operating a roller reciprocating follower and with the following data:
Minimum radius of cam = 30 mm
Lift = 40 mm
Roller diameter = 20 mm
The cam lifts the follower for 180° with SHM followed by a dwell period of 30°. Then the follower lowers down during 120° of the cam rotation with uniform acceleration and deceleration followed by a dwell period. If the cam rotates at a uniform speed of 140 rpm, calculate the maximum velocity and acceleration of the follower during the ascent and descent period. *[(CO2)(Apply/IOCQ)]*

12

Group - D

6. (a) The lengths of crank and connecting rod of a horizontal reciprocating engine are 200 mm and 1 m, respectively. The crank is rotating at 400 rpm. When the crank has turned 30 degree from the inner dead centre, the difference of pressure

between the cover end and piston end is 0.4 N/mm2. If the mass of the reciprocating parts is 100 kg and cylinder bore is 0.4 m, then calculate,
(i) Inertia force, (ii) Piston effort, (iii) Thrust in the connecting rods
(iv) Crank-effort and (v) Turning moment on the crank. *[(CO4)(Analyse/IOCQ)]*

(b) A flywheel with a mass of 5 KN has a radius of gyration of 1.8 m. Find the energy stored in the flywheel when its speed increases from 310 to 350 rpm. *[(CO3)(Analyse/IOCQ)]*

9 + 3 = 12

7. (a) The equation of the turning moment diagram for the three crank engine is given by:
$T = 25000 - 7500 \sin 3\theta$
where θ radians is the crank angle from the inner dead centre.
The moment of inertia of the flywheel is 400 kg.m2 and the mean engine speed is 300 rpm. Calculate the power of the engine and the total percentage fluctuation of speed of flywheel, if the resisting torque is $(25000 + 3600\sin\theta)$ N.m. *[(CO3)(Analyse/IOCQ)]*

(b) A constant torque 2.5 KW motor drives a riveting machine. The mass of the moving parts including the flywheel is 125 kg at 700 mm radius. One riveting operation absorbs 10 KJ of energy and takes 1 sec. speed of the flywheel is 240 rpm before riveting. Determine,
(i) Speed after riveting (ii) Number of rivets closed per hour. *[(CO3)(Analyse/IOCQ)]*

7 + 5 = 12

Group - E

8. (a) Three masses A, B and C having magnitudes 10 kg, 9 kg, and 16 kg revolves in same planes at radii 10 cm, 12.5 cm, and 5 cm respectively. The angular positions of masses B and C are 60° and 135°, respectively from the mass A. Determine the position and magnitude of the balancing mass which at a radius of 15 cm in the same plane. *[(CO5)(Analyse/IOCQ)]*

(b) Determine the magnitude of swaying couple for partial balancing of a reciprocating engine? *[(CO6)(Remember/LOCQ)]*

8 + 4 = 12

9. (a) A two cylinder V-engine has the cylinders set at an angle of 45^0, with both pistons connected to the single crank. The crank radius is 60 mm and the connecting rods are 300 mm long. The reciprocating mass per line is 1.5 kg and the total rotating mass is equivalent to 2 kg at the crank radius. Determine for an engine speed of 1800 rpm, the maximum value of the primary and secondary forces due to the inertia of reciprocating and rotating masses. *[(CO6)(Analyse/IOCQ)]*

(b) A four cylinder engine has the cranks arranged at angular intervals of 90°. The inner cranks are 1.2 m apart and are placed symmetrically between the outer cranks which are 3 m apart. Each crank is 45 cm long. The engine runs at 90 rpm and mass of reciprocating parts of each cylinder is 900 kg. Determine the magnitude of the unbalanced primary force and primary couple. *[(CO6)(Remember/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	10.42	89.58	0