iii. A ship propelled by a turbine rotor which has a mass of 5 tonnes at a **5** speed of 2100 rpm. The rotor has a radius of gyration of 0.5m and rotates clockwise when seen from stern. Find the gyroscopic effects in the following conditions:

(a) The ship sails at a speed of 30 km/hr. and steers to the left in a curve of 60m radius.

(b) The ship pitches 6° above and 6° below the horizontal position. The bow is descending with its maximum velocity. The motion during pitching is simple harmonic and periodic time is 20 sec.

(c) The ship rollsand at a certain instant has angular velocity of 0.03 rad./sec. clockwise when viewed from the stern.

Also determine the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.

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Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. The mechanism forms a structure when the DOF is equal to- **1**
(a) 1   (b) 0   (c) -1   (d) 2

ii. In a 4 bar linkage, if the lengths of shortest, longest and the other two **1** links are denoted by s, l, p and q, then what would result in Grashof's linkage provided-
(a) $l + p < s + q$ (b) $l + s < p + q$
(c) $l + p = s + q$ (d) $l + s \geq p + q$

iii. For any three links in a four-linkage mechanism, Kennedy's theorem **1** states that-
(a) All three instantaneous centre lie in same line.
(b) There exist 6 instantaneous centres for four links and they lie in a same line.
(c) All three instantaneous centre lie at same point.
(d) Only two out of three instantaneous centre lie in a same line.

iv. Corioli's component of acceleration is- **1**
(a) 2vw   (b) 3vw   (c) 4vw   (d) 2v/w

v. The cam follower generally used in automobile engines is- **1**
(a) Knife edge follower   (b) Flat faced follower
(c) Spherical faced follower   (d) Roller follower

vi. Pitch point in cam is the point at which- **1**
(a) Pressure angle has zero value
(b) Pressure angle has maximum value
(c) Pressure angle has minimum value
(d) None of these

P.T.O.

vii. The product of the diametral pitch and circular pitch is equal to- **1**
   (a) 1   (b) 1/π   (c) π   (d) 2π

viii. An imaginary circle which by pure rolling action, gives the same **1**
   motion as the actual gear, is called-
   (a) Addendum circle
   (b) Dedendum circle
   (c) Pitch circle
   (d) Clearance circle

ix. When viewed from stern side and rotor is in clockwise motion. The **1**
   effect of gyroscopic couple acting on it when the pitching of a ship is
   upward be-
   (a) To move the ship towards port side
   (b) To move the ship towards star-board
   (c) To raise the bow and lower the stern
   (d) To raise the stern and lower the bow

x. The rotor of a ship rotates in clockwise direction when viewed from **1**
   the stern and the ship takes a left turn. The effect of the gyroscopic
   couple acting on it will be-
   (a) To raise the bow and roll the ship CW
   (b) To lower the bow and roll the ship CW
   (c) To raise the bow and lower stern
   (d) To lower the bow and raise the stern

Q.2 i. Explain Ackermann and Davis's steering with the help of diagrams. **4**
   ii. Write the inversions of single slider crank chain and explain with the **6**
   help of neat sketch.
OR iii. Write the inversions of double slider crank chain and explain with the **6**
   help of neat sketch.

Q.3 i. Draw velocity polygon for single slider crank mechanism having crank **4**
   20 mm and connecting rod 70 mm long. When the crank has moved
   40 degree from its IDC position.
   ii. Draw a four-bar mechanism, and using Keneddy's theorem locate all **6**
   instantaneous centres.
OR iii. Explain the Klien's construction for velocity and acceleration diagram **6**
   in a single slider crank mechanism.

Q.4 i. Classify the followers used in radial cam. **4**

ii. A cam is to be designed for a knife edge follower with the following **6**
   data:
   (a) Cam lift = 40 mm during 90° of cam rotation.
   (b) Dwell for the next 30°.
   (c) Return stroke during the next 90° of cam rotation,
   (d) Dwell during the remaining of cam rotation.
   Draw the profile of the cam when the line of stroke is offset 20 mm
   from the axis of the cam shaft. The radius of the base circle of the cam
   is 40 mm. The follower moves with uniform velocity during both the
   outstroke and return strokes
OR iii. Explain the terms used in radial cam with the help of neat sketch. **6**

Q.5 i. State and prove law of gearing. **4**
   ii. In an epicyclic gear train, an arm carries two gears A and B having **6**
   36 and 45 teeth respectively. If the arm rotates at 150r.p.m. in the
   anticlockwise direction about the centre of the gear A which is fixed,
   determine the speed of gear B. If the gear A instead of being fixed,
   makes 300 r.p.m. in the clockwise direction, what will be the speed of
   gear B?
OR iii. Two gear wheels mesh externally and have gear ratio as 3:1. The teeth **6**
   are of involute type: module = 6mm; addendum = one module,
   Pressure angle = 20°. The pinion rotates at 90 rpm. Find the following:
   (a) The minimum no. of teeth on the pinion to avoid interference and
      corresponding teeth on the gear.
   (b) Length of path of contact
   (c) Length of arc of contact
   (d) Contact ratio.
   Also determine the ratio of the sliding velocity to the rolling velocity at
   the instant of engagement commences, engagement terminates and at
   the pitch point.

Q.6   Attempt any two:
   i. Explain rolling, pitching & yawing and its gyroscopic effect on a ship. **5**
   ii. An aeroplane makes a complete half circle of 50 metres radius, **5**
   towards left, when flying at 200 km per hr. The rotary engine and the
   propeller of the plane has a mass of 400 kg and a radius of gyration of
   0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from
   the rear. Find the gyroscopic couple on the aircraft and state its effect
   on it.

Marking Scheme
ME3CO28 Kinematics of Machines

Q.1   i   a) 0   1
      ii)   (b) l + s < p + q   1
      iii)   (a)ll three instantaneous centre lie in same line   1
      iv)   (a) 2vw   1
      v)   (c) spherical faced follower   1
      vi)   (b) pressure angle has maximum value   1
      vii)   (c) π 1
      viii)   (c) Pitch circle   1
      ix)   (b)To move the ship towards star-board   1

      x)   (c)To raise the bow and lower stern   1

Q.2   i.   2 marks for Ackermann and 2 marks for davis.   4
      ii.   0.5 marks each for diagram of any four inversions. 4 marks for   6
                 explaination
OR   iii.   0.5 marks each for diagram of any four inversions. 4 marks for   6
                 explaination

Q.3   i.   1 marks or slider crank diagram and 3 marks fro velocity diagram.   4
      ii.   1 mark each for instantaneous centres   6
OR   iii.   1 marks cranks mechanism, 2 marks velocity diagram and 3 marks   6
                 acceleration diagram

Q.4   i.   Classification any form 1 marks   1
      ii.   Displacement of diagram each 2 marks cam profile   6
OR   iii.   All 6 types, 1 mark each Neat skech 5 Marks   Any six definition   6
                 (0.5 marks each)

Q.5   i.   Diagram 1 marks Law of genuine derivation and statement 3   4
                 marks
      ii.   3 marks for systematic table. 2 marks for calculation and 2 marks   6
                 for correct answer

OR   iii.   2 marks for all correct formulae and 2 marks for calculation and 1   6
                 mark for correct answer

Q.6
      i.   3 marks for explanation and 2 marks for diagram   5
      ii.   1 mark for formulae, 2 marks for solution and 1 mark for diagram   5
                 and 1 mark for correct answer
      iii.   1 mark for formulae, 2 marks for solution and 1 mark for diagram   5
                 and 1 mark for correct answer

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