Indian Institute of Technology Delhi

Minor-1: First Semester: 2016-17

Course Title: Engineering Mechanics **Course No.: APL100**

Date: 28 August 2016 **Duration: 9.30 a.m.-10.40 a.m.** **Maximum Marks: 40**

Note: Question paper is in two parts: A and B. Answer Part A in the Minor Answer Book. Answer Part B in the question paper (Part B) itself. Marks are indicated against each question.

Part A

Q.1: In an amusement park ride (OA = 5 m, AB = 10 m), the passenger cockpit rotates relative to the arm AB as shown in Fig.Q.1. The arm AB swings relative to the arm AO at the rates shown. The arm AO rotates relative to the fixed vertical axis at the given rates. Point P is at the centre of the ear of a passenger strapped to a seat fixed in the cockpit. Find (i) the angular velocity and angular acceleration vectors of arm AB and cockpit, (ii) acceleration of point P at the given instant (write only the formulae of each step for case (ii)). **[10]**

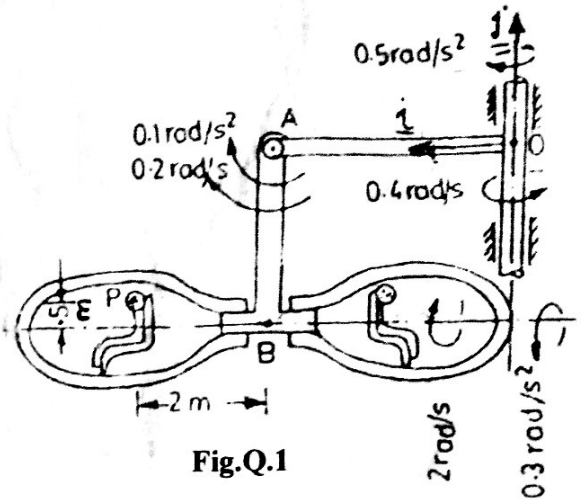

Fig.Q.1

Q.2: Members OA and DP of a planar mechanism (Fig.Q.2) rotate at constant rates of 2 rad/s and 3 rad/s. The pin at P attached to DP can slide in circular slot of radius 4 m in plate AC. In the given configuration when AP = 1 m. OA = DP = 2 m. Find: (i) acceleration of point A, (ii) acceleration of pin P, (iii) angular acceleration of the plate AC. **[10]**

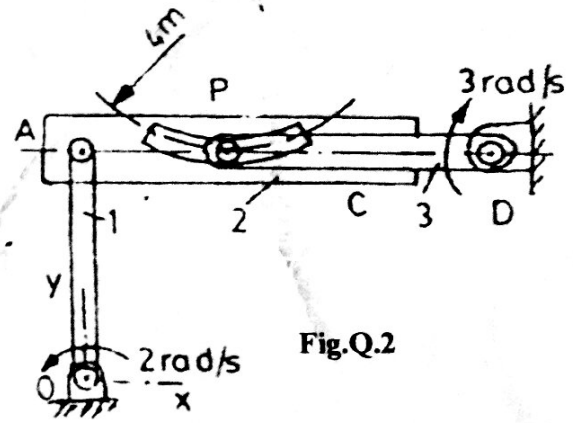

Fig.Q.2

Q.3: For the planar mechanism shown in Fig.Q.3, find the angular velocity and angular acceleration of rod 2. **[10]**

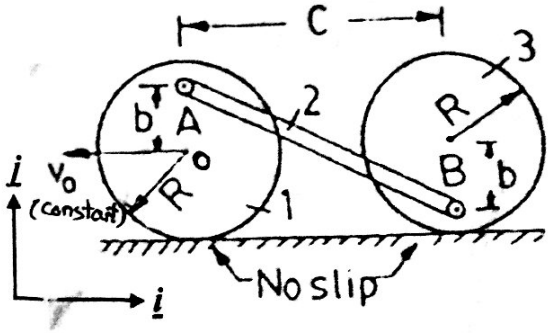

Fig.Q.3

Useful Formulae:

$$\underline{V}_P = \dot{r}\underline{e}_r + r\dot{\phi}\underline{e}_\phi + \dot{z}\underline{e}_z \; ; \quad \underline{a}_P = (\ddot{r} - r\dot{\phi}^2)\underline{e}_r + (2\dot{r}\dot{\phi} + r\ddot{\phi})\underline{e}_\phi + \ddot{z}\underline{e}_z$$

$$\underline{V}_P = \dot{s}\underline{e}_t \; ; \quad \underline{a}_P = \ddot{s}\underline{e}_t + \frac{\dot{s}^2}{\rho}\underline{e}_n,$$

$$\dot{\underline{A}}_{/F} = \dot{\underline{A}}_{/m} + \underline{\omega}_{m/F} \times \underline{A}$$

$$\underline{V}_{P/F} = \underline{V}_{A/F} + \underline{\omega}_{m/F} \times \underline{AP} + \underline{V}_{P/m}$$

$$\underline{a}_{P/F} = \underline{a}_{A/F} + \dot{\underline{\omega}}_{m/F} \times \underline{AP} + \underline{\omega}_{m/F} \times (\underline{\omega}_{m/F} \times \underline{AP}) + 2\underline{\omega}_{m/F} \times \underline{V}_{P/m} + \underline{a}_{P/m}$$