Exam No: _____

Ganpat University
M.Tech SEM-III Mechanical Engineering (CAD/CAM)
CBCS Regular Examination Nov-Dec 2015
3ME312 Dynamics of Mechanical System

Duration: 3hr

Total Marks: 60

Instructions:
1. **Write you answer precisely and to the point.**
2. **Assume Suitable engineering data.**

SECTION I

1. **Attempt following questions** [10]

(a) Derive the equations for derivation pertaining to spatial curve and their respective unit associate vector with respect to space coordinate.

(b) A radar station at the origin measures the azimuth angle θ, the elevation angle λ, and the radial distance r to a target as shown in Figure A. At the instant when a high-performance aircraft is at point B it has a velocity of 500 m/s directed from point B to point A and an acceleration of 8g directed upward. Determine the values of $\dot{r}$, $\ddot{r}$, $\dot{\lambda}$, $\ddot{\lambda}$, $\dot{\theta}$, and $\ddot{\theta}$ that are observed at this location.

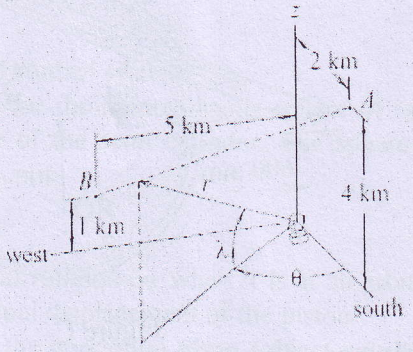

Figure A

OR

1. **Attempt following questions** [10]

(a) Derive the velocity and acceleration formulae for cylindrical coordinate system.

(b) Pin P, whose mass is 10 g, moves in the horizontal plane within a groove defined by $xy = 2$, where x and y are in meters as shown in figure B. The motion is actuated by arm ABC, which translates to the right at the constant speed of 30 m/s. (a) Determine the velocity and acceleration of the collar when $x = 2$ m. (b) Determine the forces exerted on the pin by the groove and arm ABC when $x = 2$ m.

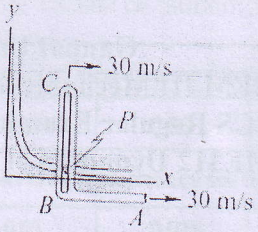

Figure B

2. **Attempt following questions**

(a) Write a short note on Rotation transformation in coordinate transformation. [10]

(b) What is the importance of mixed kinematical description? Elaborate by an example.

OR

2. **Attempt following questions**

(a) Explain the concept of Space fixed transformation system with diagram. [10]

(b) Pin P slides inside the 400- mm-radius groove at a constant rate of 8 m/s as shown in figure C. This motion is actuated by arm AB. Determine the rotation rate of this arm and the rate of change of that rate when (a) $\theta = 90$, (b) $\theta = 135$.

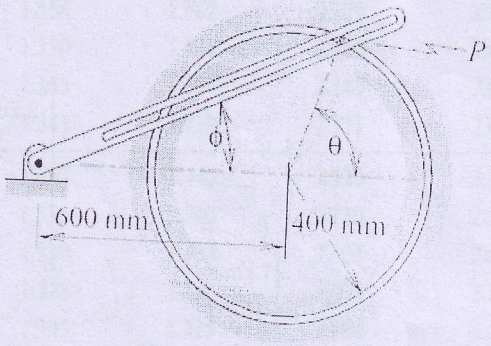

Figure C

3. **Attempt following questions.**

(a) Write a short note on Analytical angular velocity [10]

(b) A pellet of mass m moves through the smooth barrel as shown in figure D. At the instant before the pellet emerges, its speed relative to the barrel is u. At that instant, the magnitude of the propulsive force F, which acts parallel to the barrel, is a factor of 50 times greater than the weight of the pellet. The barrel rotates about the vertical axis at angular speed ω as the angle of elevation of the barrel is increased at the rate $\dot{\theta}$. Both rates are constant. Derive expressions for the acceleration term $\dot{u}$ and the force the pellet exerts on the walls of the barrel at this instant.

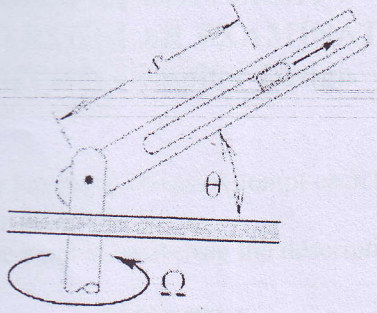

Figure D.

SECTION II

4. **Attempt following questions**

(a) The linkage, which lies in the vertical plane, is loaded by force F(t) that is always parallel to bar BC. The torsional spring, whose stiffness is k, is unreformed when $\theta = 60^0$. Determine the equation of motion for the system. [06]

(b) Define Control System. Differentiate between open loop system and close loop system [04]

OR

4. **Attempt following questions**

The disc spins about shaft AB at the constant rate ω_1, where the vertical shaft, to which shaft AB is pinned, rotates freely. The masses are m_1 for the disk and m_2 for shaft AB. Derive the equation of motion. [10]

5. **Attempt following questions**

(a) What are the requirements for good control system? [06]

(b) Determine the equation of motion for the homogeneous sphere of radius r that rolls without slipping along the interior of the semi cylinder. The sphere is constraint to remain in the vertical plane. [04]

OR

5. **Attempt following questions**

(a) The crankshaft AB is given a virtual rotation $\delta\varphi$ when it is at an arbitrary orientation φ. Determine the corresponding virtual displacement of the piston. [06]

(b) Two bars, pinned joint B, move in the horizontal plane subject only to the restriction that the velocity of end C must be directed toward end A. Determine the corresponding velocity constraint. Is this constraint holonomic? [04]

6. **Attempt following questions**

(a) The table rotate in a horizontal plane about bearing A due to a torque $\tau(t)$. The mass of table is M and its radius of gyration about its centre is k. The slider, whose mass is m, moves within groove BC under the restraint of a pair of springs which are unstretched in the position. Derive the equation of motion for this system. [08]

(b) Define

1. Scleronomic Constraint
2. Rhenomic Constraint [02]

ALL THE BEST