Department of Aerospace Engineering

AE21003 – Dynamics for Aerospace Engineers

Mid- Autumn Semester Examination, 2010-11

Time : 2hrs Marks: 50

(Answer all questions. All questions carry equal marks)

1. Instruments in an airplane which is in level flight indicate that the velocity relative to the air (airspeed) is 120 km/h and the direction of the relative velocity vector (heading) is 70° east of north. Instruments on the ground indicate that the velocity of the airplane (ground speed) is 110 km/h and the direction of flight (course) is 60° east of north. Determine the wind speed and direction.

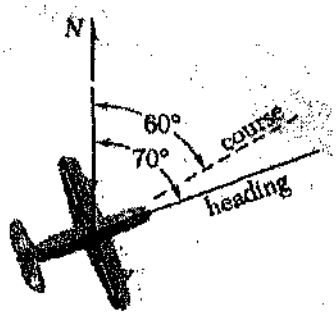

Fig: Q - 1

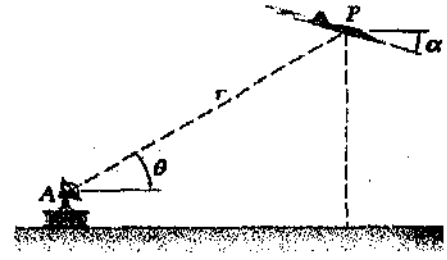

Fig: Q - 2

2. An airplane passes over a radar tracking station at A and continues to fly due east. When the airplane is at P, the distance and the angle of elevation of the plane are, respectively, r = 3840.48 m and θ = 31.2°. Two seconds later the radar station sights the plane at r = 4145.28 m and θ = 28.3°. Determine approximately the speed and the angle of dive α of the plane during the 2-s interval.

3. A 54.4 kg pilot flies a jet trainer in a half vertical loop of 1097 m radius so that the speed of the trainer decreases at a constant rate. Knowing that the pilot's apparent weights at point A and C are 1690 N and 356 N, respectively, determine the force exerted on the pilot by the seat of the trainer when the trainer is at point B.

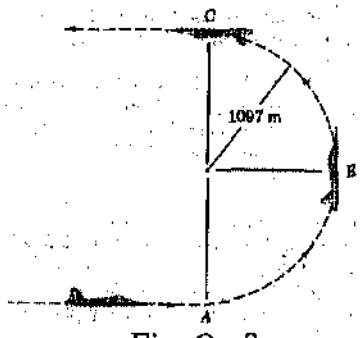

Fig: Q - 3

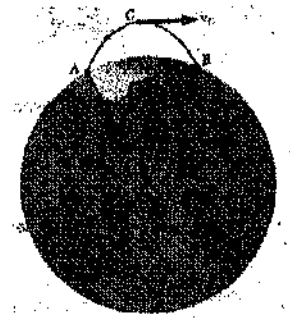

Fig: Q - 4

4. A long range ballistic trajectory between point A and B on the earth's surface consists of a portion of an ellipse with apogee at point C. Knowing that C is 1490 km above the surface of the earth and the range Rϕ of the trajectory is 5928.5 km, determine a) the velocity of the projectile at C, b) the eccentricity ε of the trajectory. (R=6345km).

5. A spacecraft approaching the planet Saturn reaches point A with a velocity v_A of magnitude 21 km/s. It is placed in an elliptic orbit about Saturn so that it will be able to periodically examine Tethys, one of Saturn's moons. Tethys is in a circular orbit of radius 295×10^3 km about the center of Saturn, traveling at a speed of 11.3 km/s. Determine a) the decrease in speed required by the spacecraft at A to achieve the desired orbit, b) the speed of the spacecraft when it reaches the orbit of Tethys at B.

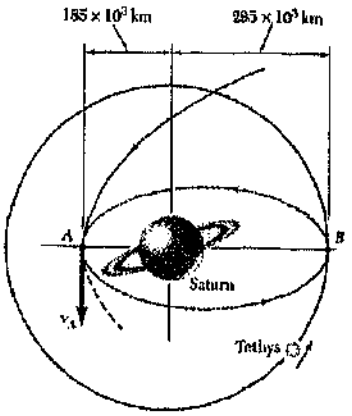

Fig: Q - 5

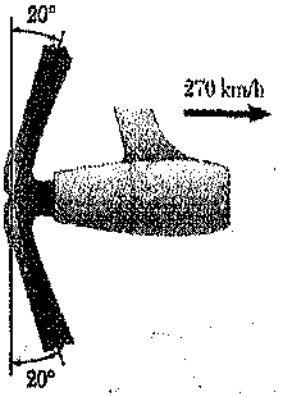

Fig: Q - 7

6. An airline employee tosses two suitcases, of weight 133.4 N and 178 N, respectively, onto a 22.68 kg baggage carrier in rapid succession. Knowing that the carrier is initially at rest and that the employee imparts a 2.74 m/s horizontal velocity to the 133.4 N suitcase and 1.83 m/s horizontal velocity to the 178 N suitcase, determine the final velocity of the baggage carrier in the first suitcase tossed onto the carrier is a) the 133.4 N suitcase, b) the 178 N suitcase.

7. In order to shorten the distance required for landing, a jet airplane is equipped with moveable vanes which partially reverse the direction of the air discharged by each of its engines. Each engine scoops in the air at a rate of 120 kg/s and discharges it with a velocity of 600 m/s relative to the engine. At an instant when the speed of the airplane is 270 km/h, determine the reverse thrust provided by each of the engines..