

# FIRST SEMESTER M.TECH. (AEROSPACE ENGG.) END SEMESTER DEGREE EXAMINATIONS, NOVEMBER - 2019

#### SUBJECT: NAVIGATION AND GUIDANCE OF AEROSPACE VEHICLES [ICE 5173]

### TIME: 3 HOURS

## MAX. MARKS: 50

### Instructions to candidates : Answer ALL questions and missing data may be suitably assumed.

- 1A. An aircraft was stationary at a latitude of  $0^{\circ}$  and longitude of  $100^{\circ}$  east. The aircraft takes off and flies east at a speed of 100 m/sec relative to earth frame for one hour on a level flight, what will be the horizontal position INS will show. Assume spherical earth with equatorial earth radius = 6378 km and neglect the travel altitude.
- 1B. Explain the principle of operation of inertial navigation systems. What are the components of inertial navigation system used in aircraft?
- 1C. An aircraft is flying on a straight-line leg of 73 Nautical miles between two points with a course of 215 degree as measured using a map. Local magnetic deviation is (-11<sup>0</sup>). Aircraft will fly at 12000 feet with a true air speed of 165 knots. Aircraft is flying in air that has wind from 350<sup>0</sup> at 25 knots. Calculate the time of flying.

(2+3+5)

- 2A. For a rate integrating gyro (RIG), output axis bearing friction torque value,  $T = 1 \times 10^{-8}$ kg m, angular momentum  $H = 1 \times 10^{-2}$  kg m<sup>2</sup>/s, gravitational acceleration, g = 9.8 m/s<sup>2</sup>. Compute the gyro drift, also comment on the physical significance of gyro drift value obtained on the performance of RIG.
- 2B. With diagram, briefly explain the working of Interferometric fibre optic accelerometer.
- 2C. Obtain the Euler angle based transformation matrix for transforming a vector from earth axis to body axis system.

(2+3+5)

- 3A. With the mathematical model block diagram of rate integrating gyro, show that the output,  $\theta_0$ , of RIG is proportional to the integral of the applied angular rate.
- 3B. Explain the law of gyroscopics, how this can be used to illustrate the working of single degree of freedom rate gyro.

3C. With diagram, explain in detail the working of pendulous accelerometer. List the drawbacks of pendulous accelerometer. Also, obtain the expression for output acceleration using pendulous accelerometer.

(2+3+5)

- 4A. Write about the basic operating principle of an optical gyro. Also, with diagram explain the working of a ring laser gyro.
- 4B. Briefly explain acceleration control system and attitude control system used in a missile.
- 4C. Write about roll stabilization system used in missiles.

(4+3+3)

- 5A. What are the different phases of flight for a multi-mode guided missile? List the major functions of GNC system in a missile.
- 5B. With diagram, explain conventional guidance topology and integrated guidance topology.
- 5C. Write about following intercept rules that are used in missile guidance:
  - a. Pure pursuit.
  - b. Deviated pursuit.
  - c. Lead collision.
  - d. Constant bearing.
  - e. Three point.

(2+3+5)

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