Reg. No. | | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (AEROSPACE ENGG.)

END SEMESTER DEGREE EXAMINATIONS, FEBRUARY - 2021

NAVIGATION AND GUIDANCE OF AEROSPACE VEHICLES (ICE5173)

TIME: 3 HOURS 26-02-2021 MAX. MARKS: 50

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

1A. An aircraft is flying from an airport in Delhi located at N28°35.75' E77°12.21' to an airport in Jaipur located at N26°49.93'E75°48.27'. The leg of flight path is shown in map (FIG: Q1A). Local magnetic deviation is 1° East. Aircraft will fly at 8000ft with an indicated speed of 95 knots. Air has wind from 207° at 14 knots. Calculate the time of flying. Also draw the actual flying leg.

Fig Q (1A)

1B. With diagram explain following reference frames:

a. Earth Centred Earth Frame (ECEF)
b. North – East – Down Frame (NED)
c. Body Frame

1C. *"In INS as well as in satellite based navigation system, precise knowledge of the shape of earth as well as the gravitational acceleration is necessary".* Comment on the correctness of the given statement.

(5+3+2)

2A. With schematic diagram, explain the strapdown navigation system implementing inertial frame. Write the equation governing the same. List the advantages and drawbacks of stable platform IMU.

2B. An aircraft is stationary at a latitude of 0° and longitude of 100° east and has an INS navigating in geographic frame. What will be the indicated velocity? If the aircraft takes off and flies east at 100 m/sec for one hour on a level flight, what is the horizontal position INS will show?

2C. "*In aided inertial navigation system, the sensor error behaviours are complementary in nature*". State whether the given statement is True/ False. Justify the answer.

(5+3+2)

3A. With a diagram explain operation of pendulous accelerometer. Show that the instrument scale factor of pendulous accelerometer is proportional to length of proof mass.

3B. Derive the expression for relative position ($\mathbf{r}_{rel}$), relative velocity ($\mathbf{v}_{rel}$), and relative acceleration ($\mathbf{a}_{rel}$) of an aircraft with respect to a moving frame. The absolute position of aircraft and moving frame are $\mathbf{r}$ and $\mathbf{r}_o$ respectively, with respect to an inertial frame.

(5+5)

4A. With a block diagram, explain missile autopilot configuration for lateral and longitudinal motion.

4B. Explain the operation of a missile seeker subsystem.

4C. What are the various requirements for the protective dome that the guidance designer must consider? Why a radome with L/D ratio = 3 is preferred for providing protective cover for seeker mechanism?

(4+3+3)

5A. Write different phases of guidance in a missile flight. List the major functions of GNC system in a missile.

5B. With necessary diagrams explain beam rider guidance and CLOS guidance.

5C. With a block diagram, explain decoupled and integrated GNC system architecture.

(4+3+3)

****