Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AVIONICS)

END SEMESTER EXAMINATIONS, APRIL/MAY 2024

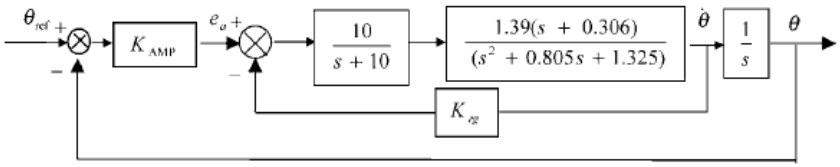
NAVIGATION, GUIDANCE AND CONTROL [AAE 5217]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 03 May 2024** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

Q.NO	Questions	Marks	CO	BTL
1A.	The following is a model of pitch displacement of missile autopilot with rate feedback:  Determine the closed loop transfer function $\frac{\theta}{\theta_{ref}}$. Note, you will have to determine the closed loop transfer function for the inner loop first. K_{AMP} and K_{rg} represent the gain of the amplifier and the rate gyro, respectively.	*(05)*	*CO5*	*L05*
1B.	A marine radar operating at 10 GHz has a maximum range of 50 km with an antenna gain of 4000. If the transmitter has a power of 250 kW and a minimum detectable signal of 10^{-11} W. Determine the cross-section of the target, the can sight.	*(03)*	*CO3*	*L05*
1C.	Explain why time-to-go t_{go} is an important trajectory parameter in missile guidance.	*(02)*	*CO3*	*L03*
2A.	The Boeing 747-8 is typical of a large classical transport aircraft is typical cruising flight at Mach 0.65 at an altitude of 20,000 ft. The characteristic equation of the aircraft is $$\Delta(s) = s^4 + 1.0999s^3 + 1.3175s^2 + 1.0594s + 0.01129 = 0$$ Identify all the modes, find the frequencies and damping ratio of all the modes and comment on stability.	*(05)*	*CO4*	*L03*

2B. Explain the terms: (1) Line of Sight rate and (2) Closing Velocity. ***(03) CO3 L03***

2C. Explain doppler shift? How do you mathematically define the total phase change in the two-way propagation path? ***(02) CO2 L03***

3A. Looking at the trajectories of the surface-to-air missile as shown in figure 1, explain their guidance systems in detail. ***(05) CO3 L04***

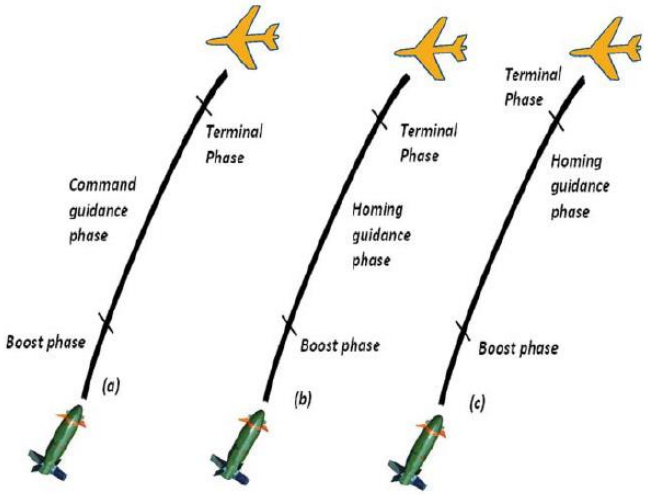


Figure 1

3B. Look at the figure below: ***(03) CO1 L03***

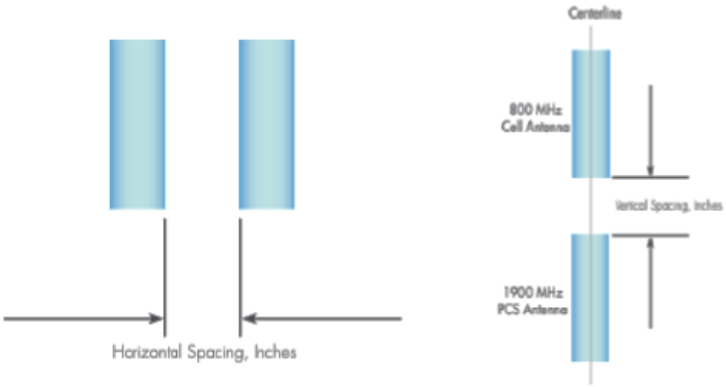


Figure 2

These are two antennas, physically separated by a given distance, and in the second there is an appropriate duplexer with a single-antenna system. Identify what will happen with these two implementations?

3C. Consider a system with transfer function: ***(02) CO3 L05***

$$T(s) = \frac{s+6}{ks^2+s+6}$$

Its damping ratio will be 0.5, determine the values of k.

4A. Explain all the three segments of Global Positioning System and explain trilateration by Satellite. ***(05) CO2 L04***

4B. Explain the function of seeker stabilization in the typical Guidance-section functional block diagram shown in figure 3 below: ***(03) CO3 L04***

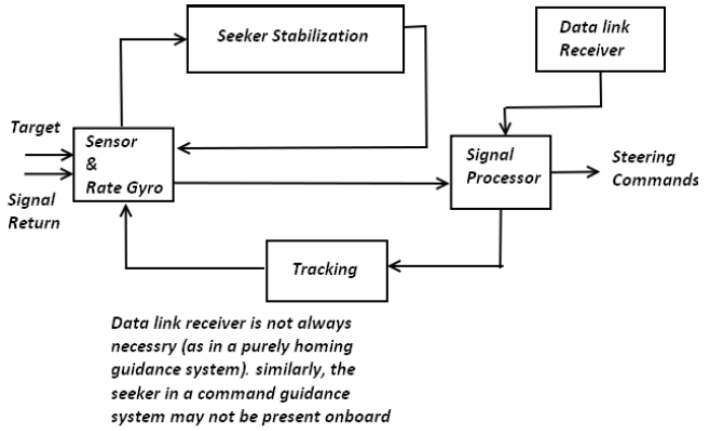


Figure 3

4C. Determine the output, if the feedback $H(s)$ is $+1$, and $G(s)$ is the transfer function of the system. ***(02) CO4 L05***

5A. Determine the Range and Doppler velocity of an approaching target using a triangular modulation FMCW Radar. Given: Beat frequency f_b(up) = 15KHz and f_b (down) = 25 kHz, modulating frequency: 1 MHz, Δf : 1 kHz and Operating frequency : 3Ghz ***(05) CO3 L05***

5B. Explain with diagrammatical representation, how a typical active RF proximity fuse is a small active CW radar system. ***(03) CO1 L03***

5C. Build the transfer function of the differentiator circuit shown in figure 4 ***(02) CO3 L03***

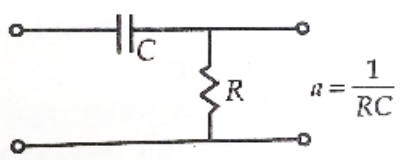


Figure 4