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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (CONTROL SYSTEMS)

END SEMESTER DEGREE EXAMINATIONS, NOVEMBER - 2019

SUBJECT: NAVIGATION GUIDANCE AND CONTROL [ICE 5153]

TIME: 3 HOURS MAX. MARKS: 50

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

1A. Explain the following terms with reference to lateral dynamics of an aircraft. (i) Spiral mode (ii) Roll subsidence

1B. With block diagrams explain a scheme for damping the dutch roll of an Aircraft.

1C. A jet transport and displacement autopilot with pitch rate feedback having following transfer function.

Elevator servo transfer function= $\frac{-10}{(s+10)}$. Gain of rate gyro is 1.2

Aircraft transfer function $\frac{\dot{\theta}}{\delta_e}(s) = \frac{-1.4(s+0.4)}{s^2+0.8s+2}$. Find the gain of the amplifier by root locus plot.

(2+3+5)

2A What is the function of a seeker stabilization loop in the guidance system.

2B Differentiate the terms (i) Active Homing (ii) Semi active Homing (iii) Passive Homing

2C Aircraft longitudinal dynamics simplified model is given by $\frac{Z_\alpha}{v} = -69$, $\frac{Z_E}{v} = -6.9$, $M_q = -0.5, M_\alpha = -5$, $M_E = -9$, $X_\alpha = -966$, $X_E = -69$. All other coefficients are negligible. Find the open loop poles (short period and phugoid modes) of the aircraft. Is the aircraft is in stable mode. Find the damping ratio and frequency of oscillations and comment on both.

(2+3+5)

3A If all targets are known to be within a distance of 74 Kms from a certain RADAR then what is the maximum pulse repetition frequency which will not cause ambiguities in range measurements? What is the maximum expected time difference between a transmitted signal and a receiving its echo?

3B A target is being tracked by 2 radars as shown in Fig. Q3(B). If the radar 1 registers Doppler shift of 100Hz and radar 2 registers Doppler shift of 60Hz. What is the velocity of the target.

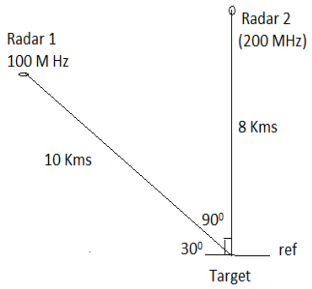

Fig. Q3(B)

3C Consider a missile target engagement geometry shown in Fig. Q3(C). Find the following (i) Closing velocity (ii) Rate of change of LOS length (iii) Estimated time to go. Where $\alpha = 60^0$ $\beta = 150^0$ $\theta = 15^0$, R=15 Km; V_T = 400 m/s; V_M= 500 m/s.

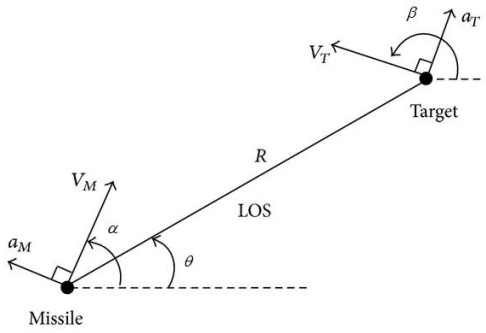

Fig. Q3(C)

(2+3+5)

4A Differentiate the terms terrestrial Navigation and Celestial Navigation.

4B Explain with block diagrams how the sign of the radial velocity of the target is determined in a C W Radar.

4C In a FM-CW radar transmitting at average frequency of 400 MHz the rate of triangular frequency modulation is 10Hz.and peak- peak variation is 100 KHz. Calculate the beat frequencies during the increasing and decreasing portions of the FM cycle. The radar target configuration is shown in Fig. Q4(C).

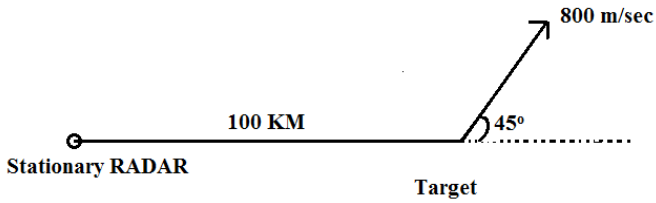

Fig. Q4(C)

(2+3+5)

5A List the applications of a RADAR

5B For a unity feedback system with

$G(s) = \dfrac{1}{s(s+1)(s+2)}$. Design a PI controller that yield 20% overshoot and settling time 1 sec for a step input.

5C Starting from fundamentals, derive an optimal control law for a Linear Quadratic Regulator. Also derive Riccati equation.

(2+3+5)

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