Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

V SEMESTER B.TECH (AERONAUTICAL ENGINEERING)
END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: PE-I: NAVIGATION GUIDANCE AND CONTROL [AAE 4009]

REVISED CREDIT SYSTEM

Time: 3 Hours | 29/11/2016 | MAX. MARKS: 50

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. What are the major sub-components of the guidance subsystem? Explain with a block diagram. **(03)**

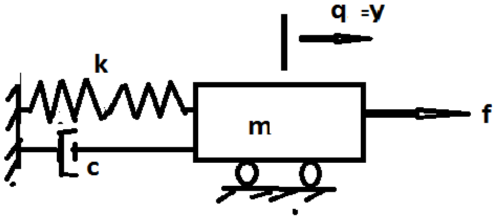
1B. Explain the VOR operation with diagrams. **(03)**

1C. Explain the engagement geometry of pure pursuit guidance laws and discuss the trajectory in (V_θ, V_R) –space. **(04)**

2A. Explain the basic principle of INS system to determine position and velocity estimate with neat diagram. **(02)**

2B. What is Doppler effect? **(02)**

2C. Derive the state feedback gain vector k(Bass-Gura) formula. Design a state feedback controller for mass-spring-damper system with desired closed loop characteristic equation with 10 % overshoot, 5 second peak time and 8 second settling time. Mass=10, other k=1, c=1, f=step input and q is position change (All are in SI unit. Assume if require any other parameter). **(06)**



3A. What is LOS guidance law? **(02)**

3B. What is GNSS-INS integration scheme? Sketch the three major integration **(03)**

scheme of GNSS-INS.

3C. For a given linear system $d\mathbf{x}/dt = A\mathbf{x} + B\mathbf{u}; \mathbf{x}(0) = \mathbf{x}_0$, Find the $\mathbf{u}$(t) (open loop optimal control solution); $0 \le t \le t_f$, such that the objective function, **(05)**

$$J = (1/2)\mathbf{x}^T(t_f)\mathbf{S}_f\mathbf{x}(t_f) + (1/2)\int[\mathbf{x}^T(t)\mathbf{Q}\mathbf{x}(t) + \mathbf{u}^T(t)\mathbf{R}\mathbf{u}(t)]dt$$ is minimized.

Solve the optimal control input to consider balancing a pointer model.

4A. Draw the missile-target engagement geometry for TPN guidance law. **(02)**

4B. Sketch the diagram and explain the neural network layer of a given equation: **(03)**

$y_k = \sum_{j=1}^{N_h}\left[w_{ik}.\sigma_j\left(\sum_{i=1}^{n} v_{ij}.x_i + \theta_{vi}\right) + \theta_{vk}\right], k = 1,2...,m.$ Briefly explain its application in neuro-adaptive control.

4C. Explain the block diagram of FM-CW radar and derive the beat frequency variation in it with neat diagram. **(05)**

In FM-CW Radar, transmitting at an average frequency of 300 MHz. The rate of triangular modulation is 60 Hz & peak to peak frequency is 50 kHz. Aircraft Velocity with FM-CW Radar is 400 m/s and Target velocity is 600 m/sec. Aircraft and target makes 40 degree and 60 degree angle respectively from LOS. Distance between initial LOS= 50 km. Calculate the beat frequency variation during FM cycle and sketch it.

5A. Define the following terms: Latax, Line-of-Sight (LOS), Miss-Distance, Time-to-Go, Fire-and-Forget, Glint Noise, Collision Triangle with equation and diagram. **(04)**

5B. What are the differences between PPN & TPN? **(02)**

5C. What is Kalman Filter? Derive the optimal estimator or observer $\hat{\mathbf{X}}_\mathbf{k} = [\boldsymbol{\varphi}_\mathbf{k} - \mathbf{K}_\mathbf{k}\mathbf{H}\boldsymbol{\varphi}_\mathbf{k}]\hat{\mathbf{X}}_\mathbf{k} + \mathbf{K}_\mathbf{k}\mathbf{Z}_\mathbf{k}$ for a given plant model: $\mathbf{X}_{\mathbf{k/k-1}} = \boldsymbol{\varphi}_{\mathbf{k-1}}\mathbf{X}_{\mathbf{k/k-1}} + \mathbf{w}_{\mathbf{k-1}}$ and measurement equation $\mathbf{Z}_\mathbf{k} = \mathbf{H}\mathbf{X}_\mathbf{k} + \mathbf{v}_\mathbf{k}$. Prove that above estimator is time varying. **(04)**