Roll No: ----------

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program Name: M. Tech ASE+UAV **Semester – III**
Course Name: UAV System Design **Max. Marks : 100**

Course Code : MAEG 801 **Duration : 3 Hrs**
No. of page/s: 03

Note: Internal choice is given for Question No 11 & 12.

Section – A (5x4=20)

1. Explain the UAV Autopilot MicroPilot's MP2x28 and HORIZON^{mp} ground control software
2. Write short notes on Adaptive MAC Protocol for UAV Communication
3. List out the Comparison of wing aspect ratios for Boeing 747 Vs Global Hawk Model A
4. Consider the system represented by

$$\dot{X} = \begin{vmatrix} 0 & 1 \\ -2 & -3 \end{vmatrix} X + \begin{vmatrix} 0 \\ 1 \end{vmatrix} u$$

$$y = |1 \quad 0| X$$

Using matrix [sI – A], Determine the function of the system from a state variable representation

5. Explain the types of *VTOL* Configurations
   a) Tandem Rotor
   b) Coaxial Rotor

Section – B (4 x 10 = 40 Marks)

6. Explain the Minneapolis-Honeywell self-adaptive Autopilot system for given condition

$$A = \begin{Bmatrix} A1 & If\ |\ddot{\varepsilon}| > B \\ A2 + (A1 - A2)e^{-t/2} & If\ |\ddot{\varepsilon}| < B \end{Bmatrix}$$

$A1 = 9.2$, $A2 = 2.3^0 / (\sec \zeta_{o)}$

B is a preselected constant; A is a limited value of relay.

7. From Fig (1) Radio LOS derivation where *H*1 and *H*2 represent the heights of the radio antenna and air vehicle respectively, Effective Earth Radius (**EER**) may be taken

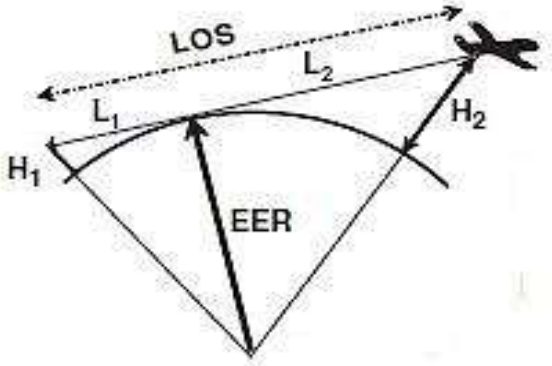

Fig (1)

as 8,500km for typical radio frequencies. Find the LOR Range

8. For the Given Fig (2) UAV glide slope controller S_c =10, k =27, $\dot{d} = \frac{U}{57.3}(\gamma + 2\frac{1}{2})^0$

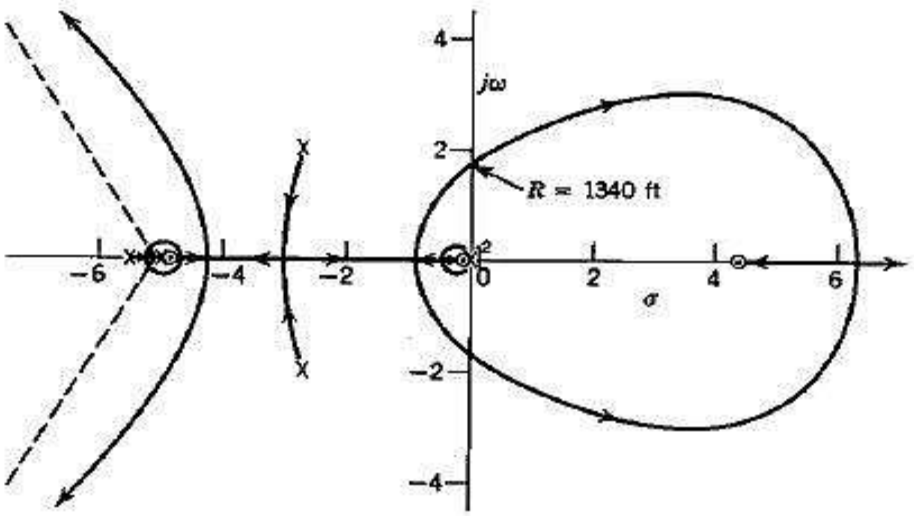

Fig (2)

Draw and explain the

a) Geometry of glide slope problem
b) Effect of beam narrowing

9. Explain the following DESERT HAWK III
   a) General Characteristics
   b) Performance
   c) Avionics: RADAR & Intelligence
   d) Communication and control station

Section – C (20 x 2 = 40 Marks)

10. Unmanned Aerial vehicle cameras with auto tracking can be used to follow moving objects Automatically, Assume the block diagram representation of a tracking system as shown in Fig (3) The tracking system monitors pixel changes and positions the camera to center the changes

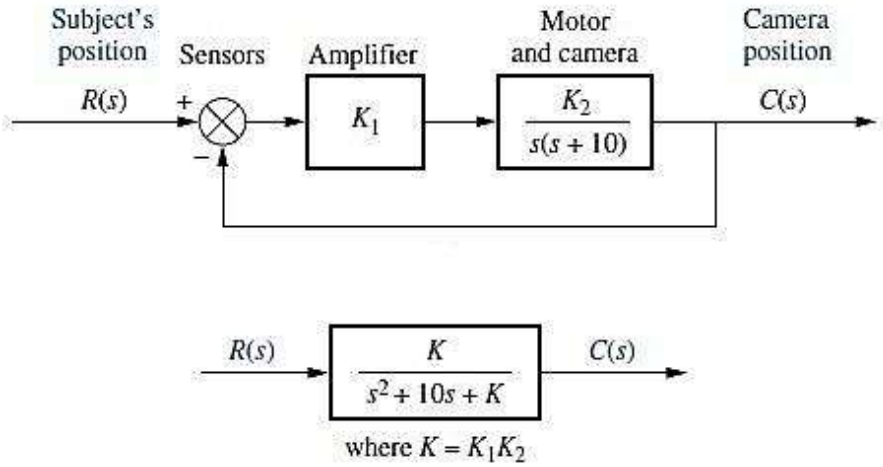

Fig (3)

Pole location as function of gain for the System of Figure (3)

K	Pole 1	Pole 2
0	−10	0
5	−9.47	−0.53
10	−8.87	−1.13
15	−8.16	−1.84
20	−7.24	−2.76
25	−5	−5
30	$-5+j2.24$	$-5-j2.24$
35	$-5+j3.16$	$-5-j3.16$
40	$-5+j3.87$	$-5-j3.87$
45	$-5+j4.47$	$-5-j4.47$
50	$-5+j5$	$-5-j5$

a) Plot the pole location in the S-Plane (Pole1 & Pole2)
b) Sketch the root locus and design the effect of loop gain upon the system's transient response and stability

11. Write a description of your overall UAV system concept suitable for use in a proposal. Proposal section that describes your starting baseline concept. The purpose of the write-up is to convince the customer that you have carefully thought the system design concept issues and that you are starting system concept is viable.

    a) Overall system requirements
    b) Overall system concept
    c) Alternate systems concepts
    d) Concept of operations
    e) Communication system requirements
    f) Control station requirements
    g) Payload requirements

    Note – there is no requirement that you stick with the system concept previously submitted as homework. If you have found some problems with your original concept or think there is a better starting design, feel free to make a change.

(Or)

12. a) Explain the application of AscTec *Falcon 8*r UAV Aerial Imaging – HD Film & Video

    b) Draw and explain the block diagram for the system using lateral acceleration to Obtain coordination with suitable equation and diagram. **(12+08)**

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Section – A (5x4=20)

1. Explain the types of *VTOL* Configurations
   c) Tandem Rotor
   d) Coaxial Rotor
2. Write short notes on Adaptive MAC Protocol for UAV Communication
3. Explain the application of AscTec *Falcon 8*r UAV Aerial Imaging
4. Draw and explain the Geometry of UAV Glide path
5. Explain the Lateral acceleration to obtain coordination with suitable diagram

Section – B (4 x 10 = 40 Marks)

6. From Fig (1) Radio LOS derivation where *H*1 and *H*2 represent the heights of the radio antenna and air vehicle respectively, Effective Earth Radius (**EER**) may be taken

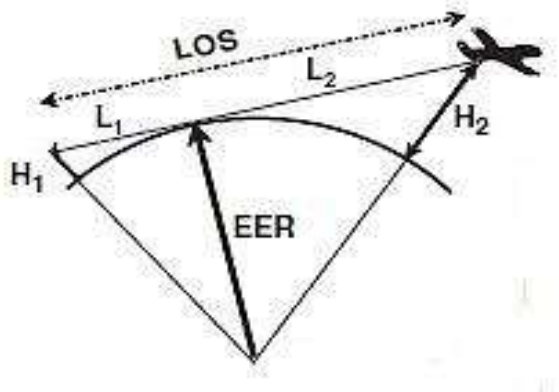


Fig (1)

7. Define the self-adaptive autopilot? Draw and explain the Block diagram of the *Minneapolis-Honeywell* self-adaptive control system. Gain changer operation: Input of the sinusoidal dither is given Fig (2) find the output across the relay

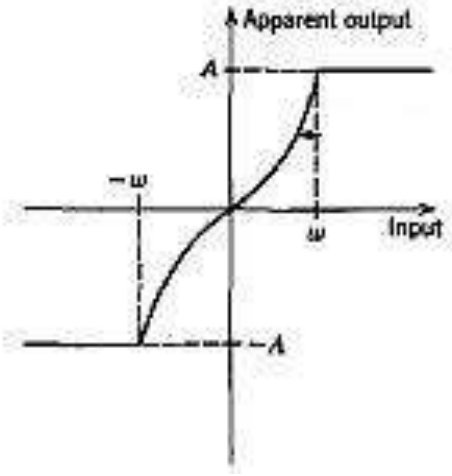
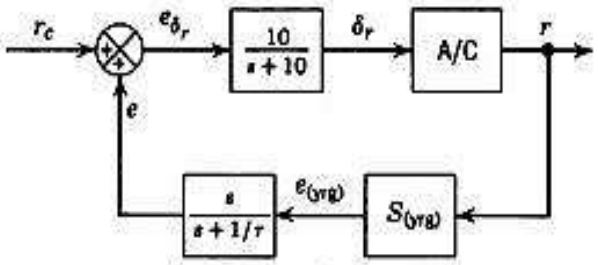


Fig (2)

8. Write the MATLAB programming for the below UAV Lateral Autopilot for yaw rate gyro sensitivity 1.04 time constant 3 sec



$$[TF] \qquad [\delta_r : r] = \frac{-1.38(s^2 + 0.05s + 0.066)}{(s - 0.004)(s^2 + 0.38s + 1.813)}$$

Sketch the root locus and design the effect of loop gain upon the system's transient response and stability

9. Explain the following MQ 9 Reaper
    a) Design Characteristics (V shaped tail & Active lift spoilers)
    b) Performance : Digital electronic engine control (DEEC)
    c) Avionics : RWR (Radar Warning Receiver) & ESM
    d) SATCOM satellite
    e) MIL-STD-1760 data bus management system

Section – C (20 x 2 = 40 Marks)

10. For the Given UAV Flare controller Fig (3) S_c = 3 deg /(ft/sec) , $\dot{h_r}$ = -0.6h

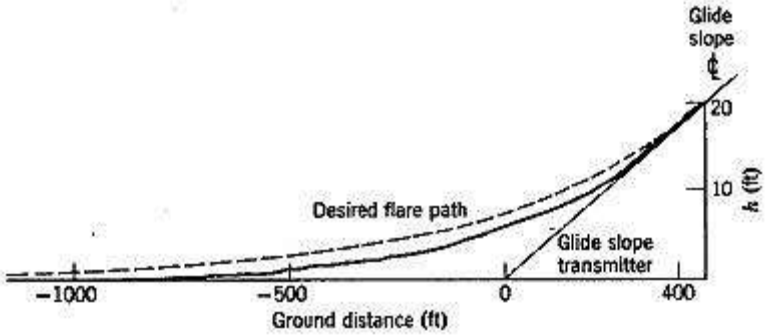


Fig (3)

Design the (a) Geometry of flare path (b) Automatic flare controller

11. a) Explain the UAV Autopilot MicroPilot's MP2x28 and HORIZON^{mp} ground control software **(14+06)**

b) Consider the system represented by

$$\dot{X} = \begin{vmatrix} 0 & 1 \\ -2 & -3 \end{vmatrix} X + \begin{vmatrix} 0 \\ 1 \end{vmatrix} u$$

$$y = \begin{vmatrix} 1 & 0 \end{vmatrix} X$$

Using matrix [sI – A], Determine the function of the system from a state variable representation

(Or)

12. Explain the following
    a) Aspect ratios for Boeing 747 Vs Global Hawk Model A
    b) Canard Configuration “Blue Horizon” UAV
    c) Flying Wing or “Tailless” Configurations
    d) Delta-wing Configuration
    e) Medium-range VTOL UAV systems