Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

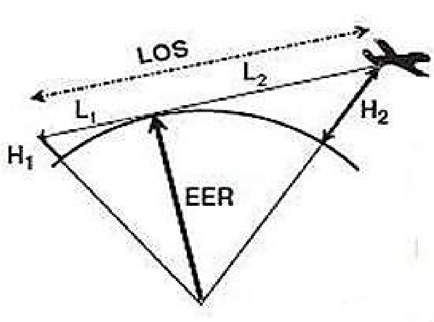
Programme Name: M. Tech ASE+UAV **Semester : III**
Course Name : UAV System Design **Time : 03 hrs**
Course Code : AVEG 8001 **Max. Marks : 100**
Nos. of page(s) : 05

Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected.
The Question paper has three sections: Section A, B and C, Section B and C having internal choices.

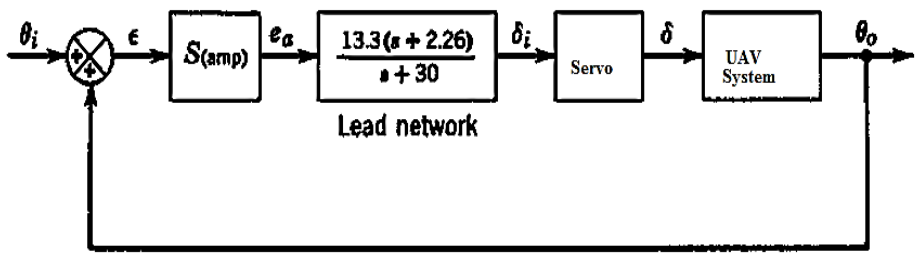
SECTION A

S. No.	Questions	Marks	CO
Q 1	Write short note on Long-endurance, long-range, HALE and MALE unmanned aerial vehicle	4	CO1
Q 2	Explain the UAV Autopilot MicroPilot's MP2x28 and HORIZON^{mp} ground control software	4	CO2
Q 3	List out the various UAV design requirements of MQ 9 Reaper	4	CO3
Q 4	Draw and explain the UAV Fly-by-wire flight control systems	4	CO4
Q 5	Define : RTCA DO 160	4	CO5

SECTION B

S. No.	Questions	Marks	CO
Q 6	The UAV Radio LOS derivation where *H*1 and *H*2 represent the heights shown in Figure (1) of the Radio antenna and Unmanned air vehicle respectively, Effective Earth Radius (**EER**) may be taken as 8,500km for typical radio frequencies. Find the Unmanned aerial vehicle LOR Range.  **Figure (1)**	10	CO2

<table>
<tr>
<td>Q7</td>
<td>
Write the MATLAB programming for UAV system as shown in Figure. 2



UAV Control System

Figure (2)

TF (servo) = $\frac{2750}{(S^2+84S+2750)}$; **TF (UAV)** = $\frac{-7.21}{(S+1.6)(s-1.48)}$

For the given UAV system, Attach the root locus analysis
</td>
<td>10</td>
<td>CO1</td>
</tr>
<tr>
<td>Q 8</td>
<td>
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 Figure (3) find the output across the relay

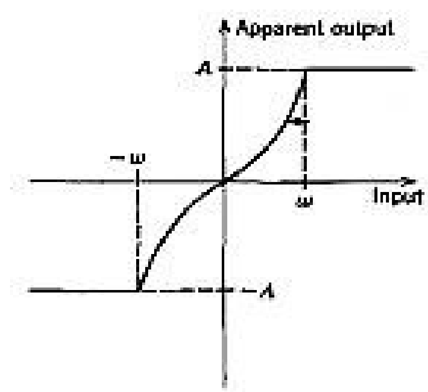


Figure (3)
</td>
<td>10</td>
<td>CO3</td>
</tr>
<tr>
<td></td>
<td>For the Given UAV Flare controller Figure (4) S_c = 3 deg /(ft/sec) , $\dot{h}_r$ = -0.6h</td>
<td>10</td>
<td>CO3</td>
</tr>
</table>

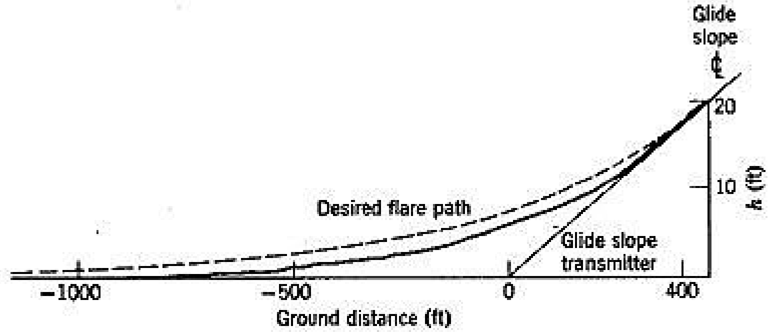
Q 9			

Figure (4)

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

(Or)

For the Given Fig (5) UAV glide slope controller S_c =10, k =27, $\dot{d} = \frac{U}{57.3}(\gamma + 2\frac{1}{2})^0$

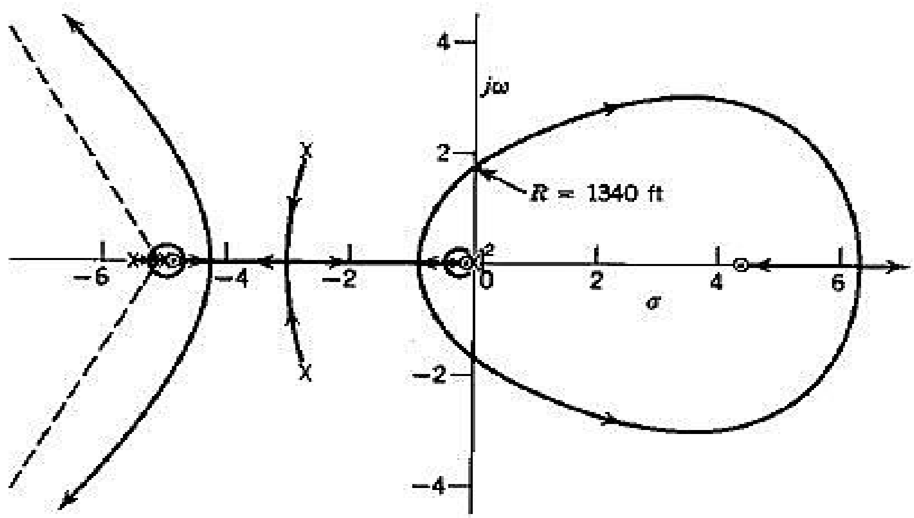


Figure (5)

Draw and explain the

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

SECTION-C

Q 10	Unmanned Aerial vehicle cameras with auto tracking can be used to follow moving	**20**	**CO4**

objects Automatically, Assume the block diagram representation of a tracking system as shown in Figure (6) The tracking system monitors pixel changes and positions the camera to center the changes

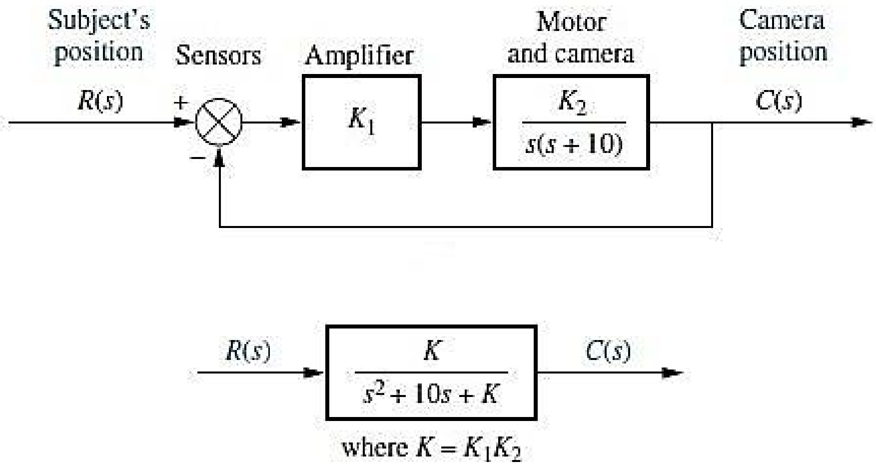


Figure (6)

Pole location as function of gain for the System of Figure (6)

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

Q 11	Write a description of your overall UAV system concept suitable for use in a proposal.	**20**	**CO5**

	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 (Or) Design of UAV Architecture with consideration to Systems performance, Power Consumption, Layout, a) Federated Architecture (F-16 A/B) b) Distributed Architecture (DAIS) c) Hierarchical Architecture (F-16 C/D, EAP) d) Pave Pillar Architecture (F-22)		

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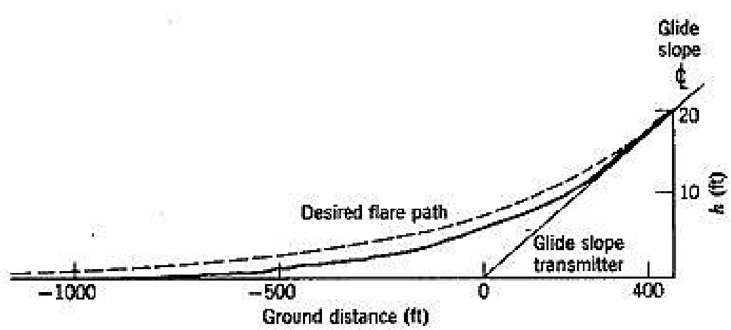
Course Code : AVEG 8001 **Max. Marks : 100**
Nos. of page(s) : 03

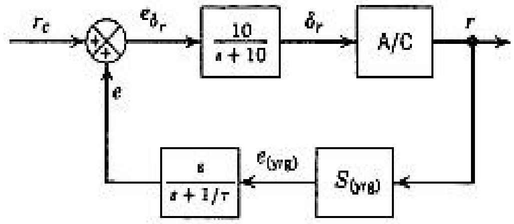
Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected.
The Question paper has three sections: Section A, B and C, Section B and C having internal choices.

SECTION A

S. No.	Questions	Marks	CO
Q 1	Explain the Adaptive MAC Protocol for UAV Communication	**4**	**CO1**
Q 2	List out the various UAV design requirements on MQ-8B Fire Scout	**4**	**CO2**
Q 3	Write some application of AscTec *Falcon 8*r UAV Aerial Imaging – HD Film & Video	**4**	**CO3**
Q 4	Draw and explain the UAV Fly-by-wire flight control systems	**4**	**CO4**
Q 5	Comparison of wing aspect ratios Boeing 747-200 vs. Global Hawk Model A	**4**	**CO5**

SECTION B

Q 6	For the Given UAV Flare controller Figure (1) $S_c = 3$ deg /(ft/sec) , $\dot{h}_r = -0.6h$  **Figure (1)** Design the (a) Geometry of flare path (b) Automatic flare controller	**10**	**CO3**
Q7	Write the MATLAB programming for the below UAV Lateral Autopilot shown in Figure (2) for yaw rate gyro sensitivity 1.04 time constant 3 sec	**10**	**CO1**

<table>
<tr><td></td><td>

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

For the given UAV system, Attach the root locus analysis</td><td></td><td></td></tr>
<tr><td>Q8</td><td>Draw the root locus plot for UAV Lateral Autopilot transfer function

$$\mathbf{G(s)} = \frac{K(s^2+6s+25)}{s(s+1)(s+2)}$$

a) Determine the value of K which gives continuous oscillation and the frequency of oscillation.
b) Determine the value of K corresponding to a dominant closed loop pole with damping ratio 0.7</td><td>10</td><td>CO4</td></tr>
<tr><td>Q 9</td><td>Consider the UAV 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 UAV system from a state variable representation

(Or)

Discuss the design requirements of following Fixed wing UAV

a) The Hunter RQ-5A UAV by IAI, Northrop Grumman, USA;
b) The Seeker II UAV by Denel Aerospace Systems, South Africa;
c) The Ranger UAV by RUAG Aerospace, Switzerland;
d) The Shadow 600 UAV by AAI Corp., USA.</td><td>10</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION-C</td></tr>
<tr><td>Q 10</td><td>Design the Minneapolis-Honeywell self-adaptive Autopilot system for given</td><td>20</td><td>CO3</td></tr>
</table>

	condition $$A = \begin{cases} A1 & If \lvert \ddot{\varepsilon} \rvert > B \\ A2 + (A1 - A2)e^{-t/2} & If \lvert \ddot{\varepsilon} \rvert < B \end{cases}$$ $A1 = 9.2,\ A2 = 2.3^{0} / (\sec \zeta_{o})$ B is a preselected constant; A is a limited value of relay.		
Q11	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 and concept b) Alternate systems concepts c) Concept of operations d) Communication system requirements e) Control station requirements f) Payload requirements (Or) Design the UAV Architecture with consideration to Systems performance, Power Consumption, Layout, a) Federated Architecture (F-16 A/B) b) Distributed Architecture (DAIS) c) Hierarchical Architecture (F-16 C/D, EAP) d) Pave Pillar Architecture (F-22)	**20**	**CO5**