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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – December, 2017

Program/course: B.Tech/ASE **Semester – VII**

Subject: Flight Dynamics & Control **Max. Marks : 100**
Code : ASEG-403 **Duration : 3 Hrs**
No. of page/s: 02

INSTRUCTIONS:

1. No students will be allowed to leave the examination hall before 1hr.
2. Assume any missing data with suitable explanation.

SECTION-A [05x04=20]

1. State the condition of equilibrium for the aircraft dynamics and deduce the relation corresponds to the aerodynamic properties **04**
2. Define phugoid motion of the aircraft dynamics. **04**
3. Explain body, stability and wind axis of an aircraft **04**
4. Explain the states and control inputs used to study the dynamical properties of an aircraft.

   04
5. Define the necessary conditions for Routh's-Hurwitz stability criterion. **04**

SECTION-B [10x04=40]

6. A unity feedback control system has an amplifier with gain K_A = 10 and gain ratio, G(s) = 1/s(s+2) in the feed forward path. A derivative feedback, *H(s)* = sK_0 is introduced as a minor loop around G(s). Determine the derivative feedback constant, k_0 so that the system damping factor is 0.6. **10**

7. The response of a servomechanism is, c (t) = 1+0.2 e^{-60t}− 1.2 e^{-10t} when subject to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. **10**

8. The characteristic polynomial of a system is **10**
   $S^7+5S^6+9S^5+9S^4+4S^3+20S^2+36S+36=0$

Determine the location of roots on the s-plane and hence the stability of the system using Routh's stability criterion.

9. Find the final value of functions having following Laplace transform. **10**

i) $$F(s)=\frac{(s+\alpha)}{(s+\alpha)^2+\omega^2}\ where\ \alpha>0$$

ii) $$F(s)=\frac{2(s+1)}{s(s^2+4s+5)}$$

SECTION-C [20x02=40]

10. a) For a control system open loop transfer function consist of: **20**

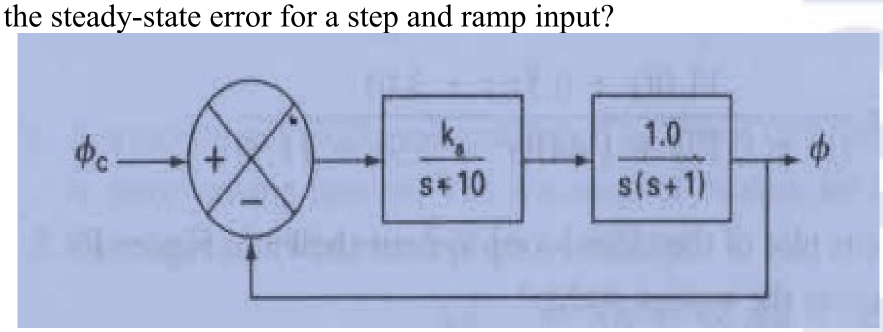
$$G(S)H(S)=\frac{K}{S^2(S+2)(S+3)}$$

Find the value of "K" to limit steady state error to 10, when input to system is $\{1+10t+20t^2\}$. Here't' is the time.

11. A roll control system is shown in figure below. Sketch the root locus diagram for this system. **20**

(a) Determine the value of the gain k, so that control system has a damping ratio of 0.707.

(b) What is the steady-state error for a step and ramp input?



OR

11. Explain the term "Control System". Describe its application in practical significant life with one example in brief. Also define the concept of positive and negative feedback system. Derive the relation between input and output for the both feedback systems for the following in positive and negative types of control systems. **20**

Forward path transfer function (G) and Feedback transfer function (H)

Forward path transfer function (G) and unity feedback.

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

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SECTION-A [05x04=20]

1. Explain all DOF for the aircraft in air with the schematic diagram. Also indicate the control surfaces. **04**

2. Explain longitudinal and lateral decoupling. State it with the equation statement **04**

3. List out the various dynamical models used in the study of flight dynamics. Tabulate the equation for each case. **04**

4. What do you understand by stability and control derivatives? Write down the force and moment expressions for each parameter along with the nomenclatures. **04**

5. Define aircraft state space vectors used for the flight dynamic studies. **04**

SECTION-B [10x04=40]

6. Derive the equation of motion for the aircraft free body in space. Also derive the force and moment equation for the aircraft in free space. Calculate the value of *L, M,and N*. **10**

7. A second order control system is represented by a transfer function given below **10**

$$\frac{\theta_0(s)}{T(s)} = \frac{1}{Js^2 + fs + K}$$

Where θ_0 the proportional output and "*T*" is the input torque. A step input and 10 N-m is applied to the system and test results are given below, $M_p = 6\%$ b) $t_p = 1\sec$ c) The steady state value of output is 0.5 radian. Determine the value of "J", "f" and "K".

8. Determine the stability of a system whose overall transfer function is given below **10**

$$\frac{C(s)}{R(s)} = \frac{2s+5}{s^5+1.5s^4+2s^3+4s^2+5s+10}$$

9. The open loop transfer function of a unity feedback system is given by, **10**

$$G(s) = \frac{K(s+1)}{s^3+as^2+2s+1}$$

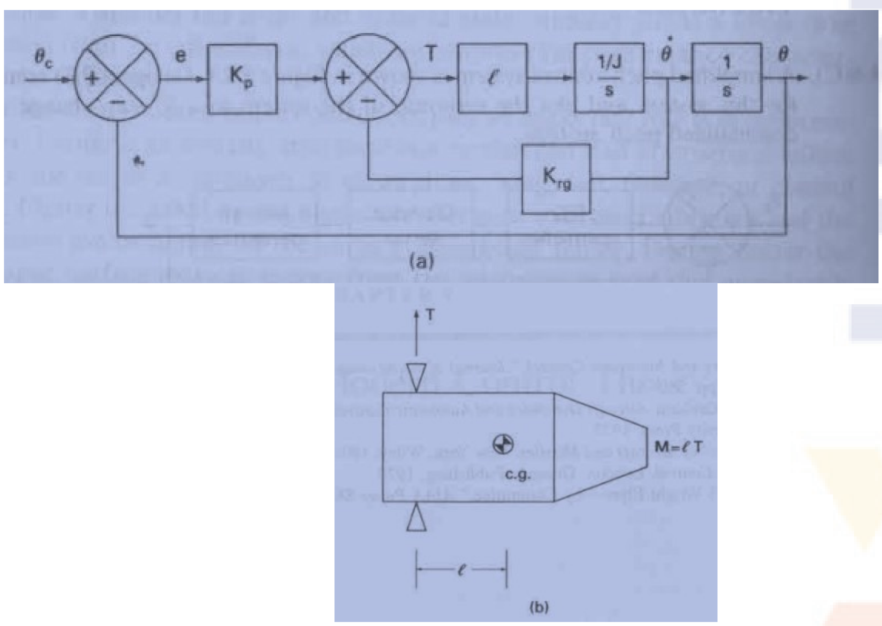
Determine the value of ***K*** and ***a*** so that the system oscillates at a frequency of 2 rad/sec.

SECTION-C [20X02=40]

10. Write short notes on following **4+4+4+4+4=20**

i) Settling time
ii) LT and ILT
iii) OLCS and FBCS
iv) Peak Overshoot
v) Roll and Yaw Dynamics

11. The block diagram for a pitch attitude control system for a spacecraft is shown in Figure (a). Control of the spacecraft is achieved through thrusters located on the side of spacecraft as shown in figure (b). Determine the rate gain k_{rg} and the outer loop gyro gain k_g so that the system has a damping ratio of 0.707 and settling time is 1.5s **20**



(a)
(b)

OR

11. Derive aircraft equation of motion specific to kinematic equations for translation and attitude for the rigid body kinetics. **20**