MINISTRY OF EDUCATION

MANDALAY TECHNOLOGICAL UNIVERSITY

Department of Mechatronic Engineering

2017-2018 Academic Year

Fourth Year **Second Semester Examination**

McE-42077 Control Engineering II

Date: 26.9.2018(WED) **Time: 1:00 to 4:00 pm**

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Attempt **ALL** Questions.

1. **(a.)** Consider the following unit-feedback system as shown in Figure-(1). System input is the unit-step function, When the amplifier gains are K_A=200, K_A=1500, K_A=13.5 respectively, calculate the time-domain specifications of the unit-step response? Investigate the effect of the amplifier gain K_A on the system response**.** **(10.Marks)**

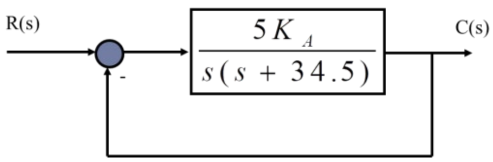

Figure-(1)

1. **(b.)** A motor control system for a computer disk drive must reduce the effect of disturbances and parameter variations, as well as reduce the steady-state error.

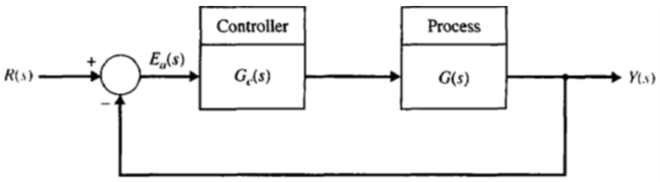

Figure-(2)

We want to have no steady-state error for the head-positioning control system, which is of the form shown in Figure-(2). (a) What type number is required? (How many integrations?) (b) If the input is a ramp signal, and we want to achieve a zero steady-stale error, what type number is required? **(5.Marks)**

1. (c.) A closed-loop control system transfer function *T(s)* has two dominant complex conjugate poles. Sketch the region in the left-hand s-plane where the complex poles should be located to meet the given specifications. **(5.Marks)**

i. $0.6 \le \zeta \le 0.8$, $\omega_n \le 10$,

ii. $\zeta \le 0.707$, $5 \le \omega_n \le 10$,

iii. $\zeta \ge 0.6$, $\omega_n \le 0.6$,

2. Electronic pacemakers for human hearts regulate the speed of the heart pump. A proposed closed-loop system that includes a pacemaker and the measurement of the heart rate is shown in Figure-(3). The transfer function of the heart pump and the pacemaker is found to be

$$G(s) = \frac{K}{s(\frac{1}{12}s+1)}$$

Design the amplifier gain to yield a system with a settling time to a step disturbance of less than 1 second. The overshoot to a step in desired heart rate should be less than 10%. (a) Find a suitable range of *K*. (b) If the nominal value of *K* is *K* = 10, find the sensitivity of the system to small changes in *K*. (c) Evaluate the sensitivity of part (b) at *DC* (set s = 0). (d) Evaluate the magnitude of the sensitivity at the normal heart rate of 60 beats/minute.

(20.Marks)

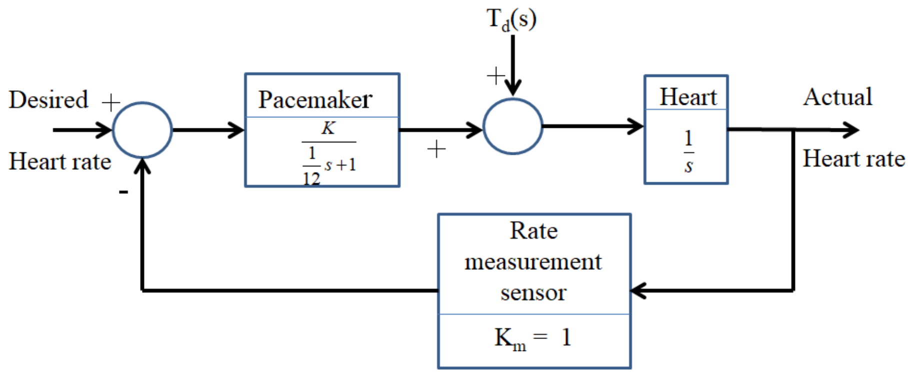

Figure-(3).

3. The goal of vertical takeoff and landing (VTOL) aircraft is to achieve operation from relatively small airports and yet operate as a normal aircraft in level flight. An aircraft taking off in a form similar to a missile (on end) is inherently unstable. A control system using adjustable jets can control the vehicle, as shown in Figure-(4). (a) Determine the range of gain for which the system is stable, (b) Determine the gain *K* for which the system is marginally stable and the roots of the characteristic equation for this value of *K*. **(20.Marks)**

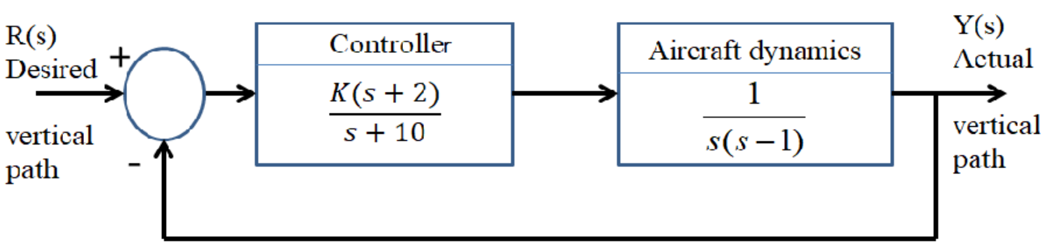

Figure-(4) Control of a jump-jet aircraft

4. A unity feedback system has the loop transfer function

$$L(s) = KG(s) = \frac{K(s+2)}{s(s+1)}$$

(a) Find the breakaway and entry points on the real axis.
(b) Find the gain and the roots when the real part of the complex roots is located at - 2 .
(c) Sketch the locus. **(20.Marks)**

5. **(a.)** A single-loop feedback control system has a characteristic equation as follows:

$$1 + GH(s) = 1 + \frac{K(s+1)}{s(s+2)(s+4)^2}$$

Sketch the root locus in order to determine the effect of the gain *K*. **(10.Marks)**

5. **(b.)** Designers have developed small, fast, vertical-takeoff fighter aircraft that are invisible to radar (stealth aircraft). This aircraft concept uses quickly turning jet nozzles to steer the airplane. The control system for the heading or direction control is shown in Figure-5. Determine the maximum gain of the system for stable operation. **(10.Marks)**

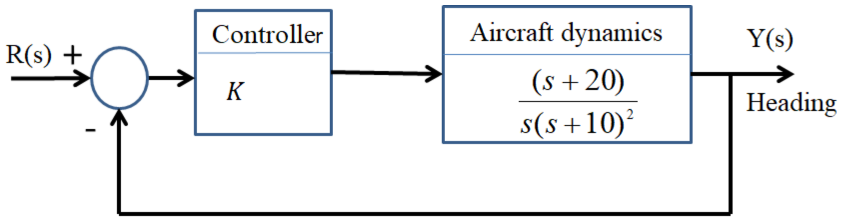

Figure-(5). Aircraft heading control

--**End of the Questions**--