EAST AFRICAN SCHOOL OF AVIATION

End Term II Exam

ENGINEERING SECTION

Electronics and Control Systems

STREAM: Mod II (Avionics + Air-frames) **Duration: 3 hrs**

DAY/DATE: 06/04/2017 **TIME: 0900 – 1200 HRS**

INSTRUCTION TO CANDIDATES

1. *This paper consists of SIX (6) pages*
2. *You should have the following for this examination:*
   Answer booklet;
   Electronic calculator
3. *Answer any **THREE** questions in **SECTION A and TWO** in **SECTION B** in this paper*

1. a) Explain why binary number system is employed in digital systems. **(2 marks)**

   b) Fill the conversion table below and show all the workings. **(12 marks)**

Decimal	**Binary**	**Octal**	**Hexadecimal**
		753.6	
			3EB
563.2			
	10111100111101		

c) The number CAB_{16} is a two byte. Determine its decimal value if it is in

I. Ones's complement

II. Two's complement **(6 marks)**

2 a) (i) Evaluate the following, showing all the working

I. $BEBC_{16} - 94EF_{16}$ **(4 marks)**

(ii) Use 8-bit 2's complement arithmetic to evaluate $(-37_{10}) - (69_{10})$ **(5 marks)**

(iii) For the one bye number, 10011101_2, determine its decimal value if it is in

I. One's complement

II. Two's complement

III. Unsigned **(6 marks)**

b) State three methods used to represent negative numbers **(6 marks)**

c) State two advantages of using hexadecimal over binary number systems **(2 marks)**

3 a) (i) Define a canonical term. Distinguish between a maxterm and a minterm **(4 marks)**

(ii) Obtain the standard sum of products (SSOP) form of the following Boolean function

F = AB + ACD' +B'D **(5 marks)**

b) For the following Boolean function

F (A,B,C,D) = Σ (0,1,2,3,7,8,9,12,14)

i Draw the truth table
ii Draw a K-map representation of the function
iii Simplify and state the output function as a sum of products
iv Implement the simplified circuit **(11 marks)**

4 a) A function F is defined such that it equals logic 1 when a 4 bit input code is equivalent to any of the decimal numbers 3,6,9,12 or 15. F is logic 0 input codes 0,2,8 and 10. F is indeterminate for other input values

i Use a truth table and Karnaugh map to determine the minimal expression for this function

ii Implement the minimal expression using
I. NAND gates
II. NOR gates **(14 marks)**

b) use the Boolean algebra postulates and theorems to minimize the following expressions

i XYZ + X'YZ' + X'YZ + XYZ' + X'Y'Z'
ii AB + CB' + CAB + ABD **(6 marks)**

5 a) State the difference between sequential logic circuit and combinational logic circuits giving an example of each. **(2 marks)**

b) Using suitable expressions and truth table implement a 1-bit digital comparator **(5 marks)**

c) With the aid of a truth table and logic expressions, implement a 4-to-line multiplexer (data selector) **(4 marks)**

d) Perform the following binary arithmetic
i. 1011011 + 1011110
ii. 1011 – 1101 using two's complement method
iii. 1100 – 10001 using one's complement **(9 marks)**

SECTION B: CONTROL SYSTEMS

6. a) Define the following terms as used in control systems:-
   i. Manipulated input. **(1 mark)**
   ii. Hybrid systems. **(1 mark)**
   iii. Actuator element. **(1 mark)**

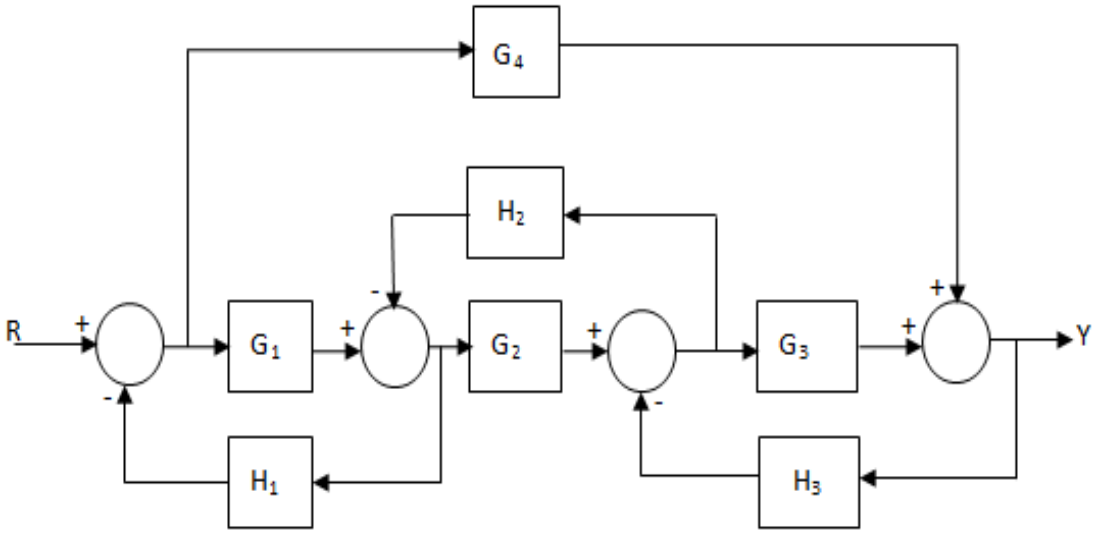
   b) State any four advantages of a closed loop control system **(4 marks)**

   c) From first principle, show that the overall transfer functions of closed loop system with positive feedback is given by:-

   $\frac{X_S}{Y_S} = \frac{G(S)}{1-G(S)H(S)}$ **(5 marks)**

   d) Draw a block diagram and state all the elements and signals of the basic structure of a feedback control system. **(8 marks)**

7. a) Reduce the following system into canonical form hence give the overall transfer function using:-
   i. Block reduction formula **(7 marks)**
   ii. The Mason's gain formula. **(9 marks)**



   b) State the following as used in control systems:-
   i. Superposition. **(1 mark)**
   ii. Node. **(1 mark)**
   iii. Branch. **(1 mark)**
   iv. Block. **(1 mark)**

8. Figure (a) below shows a block diagram of a control system whose objective is to control the position of mechanical load. The two potentiometers having sensitivity K_p converts the input and output positions into proportional electrical signals, which are in turn compared, and the error signals amplified by a factor K_A, is applied to the armature circuit of a DC motor whose field winding is excited with a constant voltage. The motor is coupled to a load through a gear train of ratio n. The block also shows a minor feedback loop which corresponds to a tacho - generator connected in the system to improve damping.

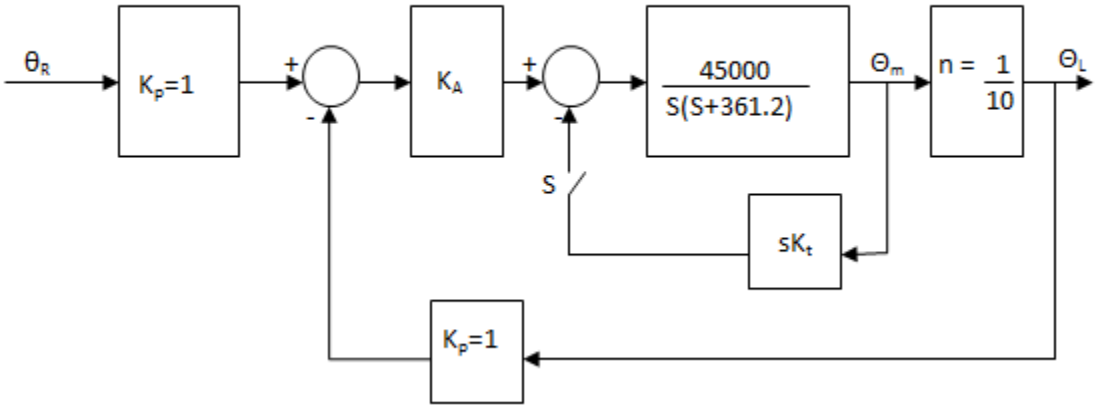


Figure (a)

With S open, find:-

a) The characteristic equation of the unity feedback system. **(2 marks)**
b) The damping ratio, ξ. **(2 marks)**
c) The closed loop poles. **(3 marks)**
d) The transfer function. **(3 marks)**
e) The steady state error of the system due to a ramp input $\theta_R(s) = 1/s^2$. **(3 marks)**

f) If the system has K_A=14.5, damping ratio ξ=0.707, the natural frequency ω_n=255.44 rads/sec, and the closed loop poles are located at -180±j180.6, calculate:-

i) Damped natural frequency, ω_d. **(2 marks)**

ii) Rise time t_r. **(2 marks)**

iii) Peak time t_p. **(1 mark)**

iv) Peak overshoot M_p. **(1 mark)**

v) Settling time t_s **(1 mark)**