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: 04/04/2017 Tuesday **TIME: 0900 – 1200 HRS**

INSTRUCTION TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Electronic calculator

*Answer any **THREE** questions in **SECTIONA and TWO** in **SECTION B** in this paper*

Maximum marks for each part of a question are as shown

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

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:-

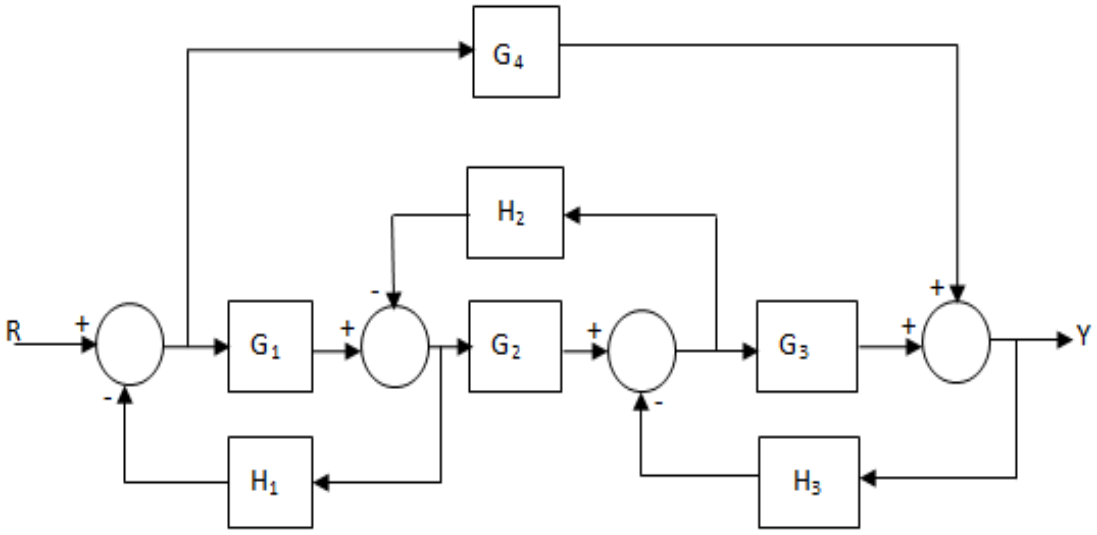
   $\frac{X_S}{Y_S} = \frac{G(S)}{1-G(S)H(S)}$ **(5 marks)**

   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.

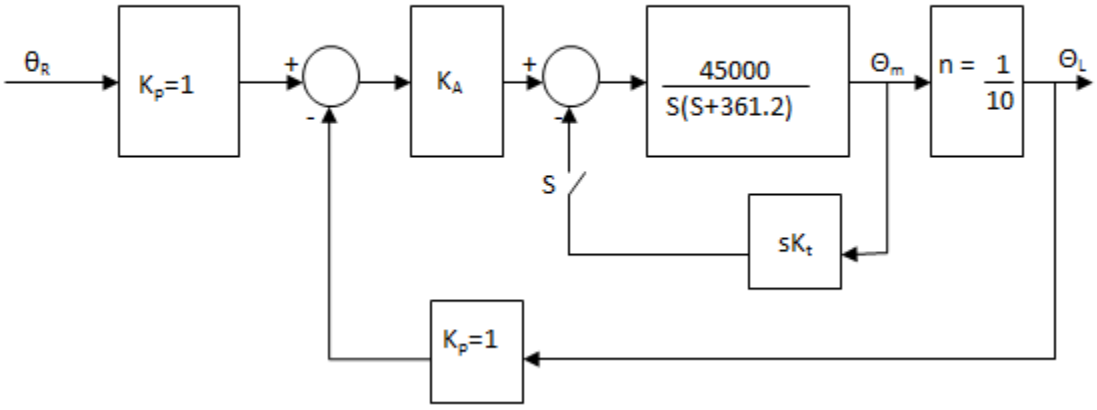


Figure (a)

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 $\xi=0.707$, the natural frequency $\omega_n=255.44$ rads/sec, and the closed loop poles are located at $-180\pm j180.6$, 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)**