EAST AFRICAN SCHOOL OF AVIATION EXAMINATION

END TERM II EXAMS

DIPLOMA IN AERONAUTICAL ENGINEERING AVIONICS

Electronics and Control Systems

STREAM: Module II (Avionics + Airframes & Engines) **Duration:**

DAY/DATE: **TIME:**

INSTRUCTION TO CANDIDATES

You should have the following for this examination:

i) Answer booklet
ii) Nichol's chart
iii) Log-linear graph paper
iv) Polar graph paper
v) Mathematical table/ scientific calculator

*Answer **ANY THREE QUESTIONS IN SECTION A** and **ANY TWO IN SECTION B** in this paper*

All questions carry equal marks.

Maximum marks for each part of a question are as shown

This paper consists of Seven (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.

SECTION A (Control Systems)

Answer any THEER questions from this Section

1. (a) (i) State the Nyquist stability criterion. **(2 marks)**

(ii) Define the following with respect to Nyquist stability of a system.

(I) Phase crossover point

(II) Phase crossover frequency

(III) Phase margin

(IV) Gain crossover frequency

(V) Gain crossover point **(5 marks)**

(b) Sketch the Nyquist plot for unity feedback system with an open loop transfer function:-

$$G(S) = \frac{6}{(s^2+2s+2)(s+2)}$$

Determine for the system the:-

(i) Phase crossover frequency

(ii) Gain margin

(iii) Gain crossover frequency

(iv) Phase margin **(13 marks)**

2. (a) State any FOUR advantages of bode plot in system stability. **(4 marks)**

(b) For a unit feedback control system with an open loop gain:-

$$G(S) = \frac{5}{S(1+0.6S)(1+0.1S)}$$

(i) Draw the Bode diagram using asymptotic approximations;

(ii) Determine the phase margin of the system;

(iii) Determine the gain margin of the system

(iv) State with reasons whether the system is stable or not. **(16 marks)**

3. (a) For the control system whose characteristic equation is given by:

$$5S^6 + 8S^5 + 12S^4 + 20S^3 + 100S^2 + 150S + 200 = 0$$

Determine the system stability using Routh array method **(15 marks)**

(b) (b) Determine and plot on an s-plane, the poles and zeros of:

$$F(S) = \frac{S^2 - 9}{S^2(S+2)(S-6)}$$

(5 marks)

4. Figure (1) 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.

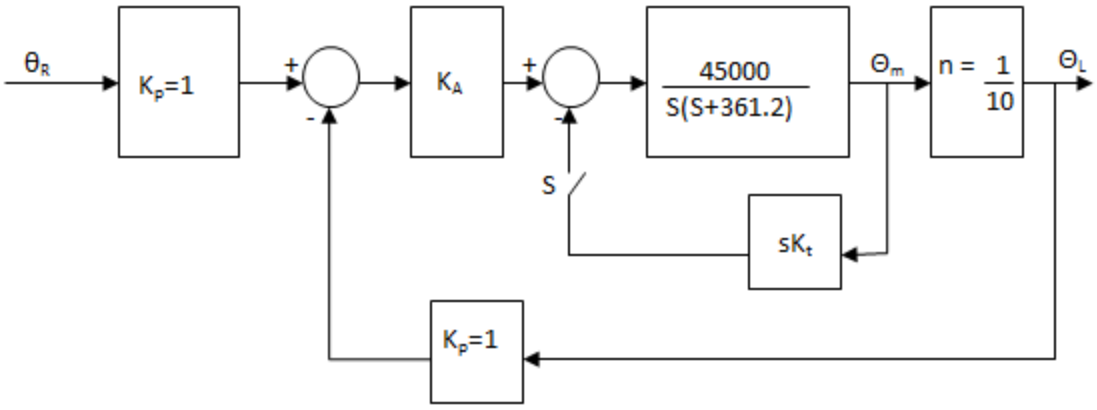

Figure (1)

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)**

5. Table below shows the results of an open-loop frequency response test on a unity feedback control system.

ω(rad/s)	1	2	4	6	8	10	20	30	40
Gain(dB)	26	20	14	9	7	4.5	-2	-10	-21
Phase (^{0})	-71	-84.5	-97	-103	-108	-115	-135	-160	-190

(a) Draw the Nichols chart. Hence determine the:

(i) Phase margin;

(ii) Gain margin;

(iii) Closed loop bandwidth;

(v) Resonance peak value;

(vi) Resonant frequency. **(13 marks)**

(b) A unity feedback system has an open loop frequency response given by the expression:-

$$G(S) = \frac{1}{S(S+1)(S+2)}$$

(i) Determine the closed loop response, $\frac{\mathbf{C(S)}}{\mathbf{R(S)}}$; **(5 marks)**

(ii) The characteristic equation of the closed loop system. **(2 marks)**

SECTION B (Electronics)

Answer any TWO questions from this Section.

6. (a) Perform the following arithmetic operation in the specified bases;

   i. $(A1D)_{16} + (99F)_{16}$

   ii. $9_{10} + 4_{10}$ in BCD Code

   iii. $29_{10} + 68_{10}$ in Excess-3 BCD Code **(6 marks)**

   (b) State five classes of logic family. **(5 marks)**

   (c) (i) State Demorgan's Theorems.

   (ii) With the aid of a truth table, prove the Demorgan's Theorems. **(9 marks)**

7. (a) Explain five characteristic of the logic family. **(5 marks)**

   (b) (i) Draw a truth table for binary to gray code encoder.

   (iii) Implement (b) (i) using Ex-OR gates only. **(7 marks)**

   (c) (i) Draw a logic diagram of R-S flip flop using NAND gates only.

   (ii) Draw the truth table of R-S flip flop. **(8 marks)**

8. (a) Perform the following code conversion;

   (i) Gray code 11100111 into binary

   (ii) 129_{10} to excess-3 number

   (iii) $(11001010)_2$ into gray code **(6 marks)**

(b) Define the following with respect to combinational logic;

(i) Decoder

(ii) Encoder

(iii) Multiplexer

(iv) Demultiplexer **(4 marks)**

(c) Figure (2) is a TTL NAND gate with totem pole output.

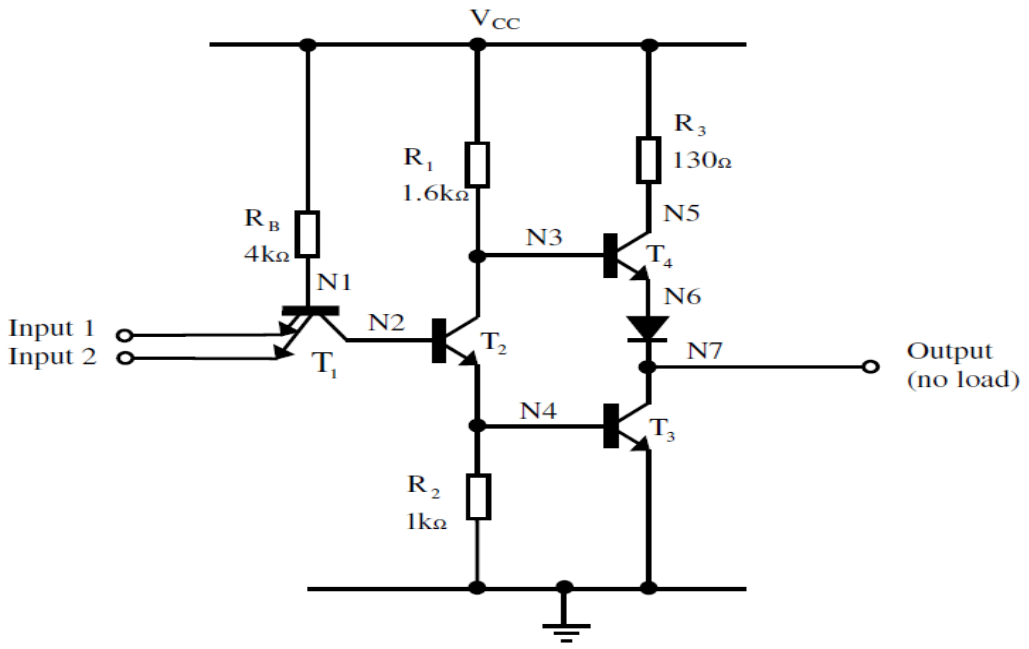

Figure 2

(i) Draw the truth table for input / output condition

(ii) Explain the gate operation. **(10 marks)**

****End****