THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

DEPARTMENT OF MEDICAL ENGINEERING

DIPLOMA IN MEDICAL ENGINEERING

DME 109

ELECTRONICS

END SEMESTER EXAMINATION

MAY 2010 SERIES

TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE.

You should have the following for this examination.
- Answer booklet
- Scientific calculator
- Drawing instruments

This paper consists FIVE questions.
Answer question ONE and any other TWO questions.
Question ONE carries 30 marks, all other questions carry 20 marks each.

Q1(a). (i). State any THREE properties of OP-amps. (3 marks) (ii). A non inverting amplifier is to be used to provide a variable voltage gain in the range 1 to 20, this is achieved by replacing the feedback resistor with a potentiometer. Draw a circuit diagram of the arrangement and suggest a suitable value for potentiometer R_f given that R_1=4.7KΩ.

(6 marks)

(iii). Define the following op-amp parameters

- (i). Common mode
- (ii). CMRR
- (iii). Slow rate

(4 ½ marks)

(iv). Draw a three input inverting amplifier and show that the output V_o is given by: $V_o = -R_f (V_1/R_1 + V_2/R_2 + V_3/R_3)$ (8 marks)

(b).(i). State the conditions for oscillations to occur. (3 marks)

(ii). A Hartley Oscillator is designed with L_1 = 2mH, L_2 = 20µH and variable capacitance. Determine the range of capacitance values, If the frequency of oscillation is varied between 950 KHz and 2050KHz. (5 marks)

Q2(a). (i). In the operational amplifier circuit of fig Q2. The Power supply voltage is ± 15V and the Input voltages are applied as shown. Calculate the value of V_o under these conditions. (4 marks)

Fig. Q2.

(ii). Two IC Op-ams are available to you. Their characteristics are listed below. Choose the one you think is more desirable.

Op-amp 1: $Z_{in} = 5M\Omega$, $Z_{out} = 100\Omega$, Aa = 50,000

Op-amp 2: $Z_{in} = 10M\Omega$, $Z_{out} = 75\Omega$, Aa = 150,000 (2 marks)

(b). The light operated switch in fig. Q2b uses an op-amp as a voltage comparator.

Fig Q2b.

(i). How must V_1 and V_2 compare if the op-amp output is to be negative in daylight. (2 marks).

(ii). In darkness what happens to

(a). the LDR

(b). V_2 compared with V_1

(c). The output of the Op-amp

(d). Transistor

(e). The relay ? (10 marks)

(iii). How would you alter the circuit to make the relay be off in the dark and switch on in daylight? (2 marks)

Q3.(a). What are the Boolean expressions for De Morgan's two theorems? State the rule used to apply them. (6 marks)

(b). Prove the following Boolean identities.

(i). A (A + B) = A

(ii). (A+B) (B+C) = A.C + B (6 marks)

(c). What are the Boolean expressions for each of the logic circuits in fig (i)-(ii).

For each circuit state the input combinations that give an output of Q=1. (4 marks)

(d). The electrical circuits in fig. can be regarded as logic gates. Which type is each one? (Treat A and B as inputs and F as the output) (4 marks) (i). (ii).

Q4(a). Differentiate between Transistor-transistor logic family and complementary Metal Oxide Semi conductor logic family in regard to:

(i). Power supply
(ii). Current requirements
(iii). Input impedance
(iv). Switching speed
(v). Fan-out
(vi). Un used inputs. (12 marks)

(b). Draw the diagram of pin connection s for the 7400 and 4011B quad two input Nand gates. (4 marks)

(c). Give FOUR areas of application where a Schmitt trigger circuit may be used. (4 marks).

Q5(a). Make the following code conversion.
(i). Decimal numbers 15,19,29 to binary numbers.
(ii). Binary numbers 1110, 10101,101101 to decimal numbers.
(iii). Hexadecimal numbers D,IE, IA5 to decimal.
(iv). Decimal numbers 75,197 to Octal. (10 marks)

(b). Add the following pairs of Binary numbers.

(i). 101 + 011
(ii). 1011 + 0111 (4 marks)

(c). Subject the following pair of numbers by the one's complement method.

(i). 1001 – 0101
(ii). 11001 – 00111
(iii). 0011 - 0110 (6 marks)

Q1(a). State the FOUR main characteristics of an ideal operational amplifier. (4 marks)

(b). Explain the term Negative feedback as used in operational amplifiers. (3 marks)

(c). Using the basic circuit for an inverting amplifier show that the closed loop gain A is given by. $A = \frac{Vo}{Vi} = \frac{-R_1}{Ri}$

State any assumptions made. (6 marks)

(d). A colpitts Oscillator is designed with C = 50 F, Cz = 100pF and a variable Inductance. Determine the range of Inductance values, if the frequency of oscillation is varied between. (5 marks)

(e). Give TWO areas of application where a schmitt trigger may be used. (2 marks)

(f)(i). Draw a diagram of a non-inverting amplifier with a gain of 50 designed using an operational amplifier. (10 marks)

2. (a)(i). Determine the common mode gain of an op-amp that has an open loop gain of 150,000 and a CMRR of 90 dB. (5 marks)

(ii). Calculate the open loop gain of an Op-amp that has a common mode gain of 6.0 and a CMRR of 80dB. (5 marks)

(b). The Op-amp shown in fig Q 2(b) has an input bias current of 100nA at 20º c. Calculate:-

(i). The voltage gain

(ii). The output offset voltage due to the input bias current.

(iii). How can the effect of input bias current be minimized. (6 marks)

(c). Design an Inverting amplifier to have a voltage gain of 40dB, a closed loop bandwidth of 5KHz and an Input resistance of 10KΩ. (4 marks)

Fig Q2(b).

Q3(a). For the summing Op-amp shown in figure 3a, determine the output voltage, Vo

(3 marks)

(b). Devise a light-operated alarm circuit using an op-amp, a LDR, a LED and a ± 15V supply. Explain briefly its operation. (12 marks)

(c). Voltages with waveforms in fig 3 c are applied one to each input of a two – input
(i). AND gate
(ii). NOR gate

Draw the output waveform for each. (5 marks)

4(a). Derive the Boolean expression and construct a truth table for the switching circuit shown in fig Q4(a). (7 marks)

(b). Construct a switching circuit to meet the requirements of the Boolean expression:
$Z = A.\ \underline{C} + \underline{A}.\ B + \underline{A}.B.\underline{C}$ (3 marks)

(c). Simplify the Boolean expression $(A.\underline{\underline{B} + C})\ .\ (A + \underline{A}.\underline{B.\underline{C}})$ by using de Morgan's laws and the rules of Boolean algebra. (5 marks)

(d). What are the Boolean expression for each of the logic circuits in fig Q4 (d) (i)-(iii).

Fig Q4d (i)-(iii) (5 marks)

Q5. (i). Convert 58.3125_{10} to a binary number. (5 marks)

(ii). Convert 5613.90625_{10} to a binary number via octal. (9 marks)

(iii). Convert 101.0101_2 to a decimal number. (3 marks)

(iv). Convert 110011110_2 into its hexadecimal equivalent. (3 marks)

