MACHAKOS UNIVERSITY

University Examinations for 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 403: ANALOGUE ELECTRONICS III

DATE: 12/6/2017 **TIME: 2 HOURS**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) With aid of a well labeled diagram derive the expression of output voltage of a current to voltage converter using OPAMP. (4 marks)

b) The differential amplifier shown in fig.1 has differential voltage gain of 2500 and CMRR of 30000. A single ended input signal of 500μV rms is applied. At the same time, 1 volt, 50Hz interference signal appears on both inputs and as a result radiated pick-up from the a.c. power system.

   i. Determine the common mode gain.
   ii. Express CMRR in dB.
   iii. Determine the rms output signal on output terminal.
   iv. Determine the rms interference voltage on the output. (8 marks)

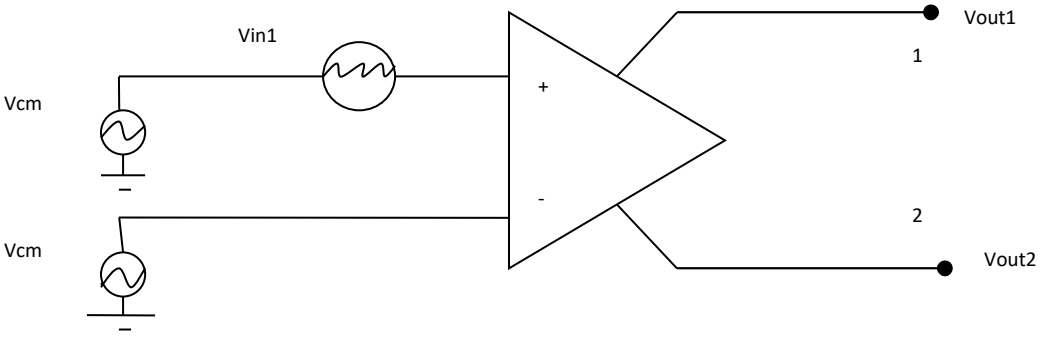

Fig.1

c) Derive the transfer function of a difference amplifier. (5 marks)

d) With aid of a diagram derive the output expression of diode based op amp antilog circuit. (3 marks)

e) Determine the maximum rate of change in volts per microsecond of the following signals:

(i) $v = 10sin4000t \ \ volts$

(ii) $v = 5sin2\pi 1000t \ volts$ (4 marks)

f) With aid of labeled diagrams, describe the working of voltage clampers and voltage clippers. (6 marks)

Question 2 (20 marks)

a) With aid of a well labeled diagram, derive the expression of load current of a voltage to current converter using OPAMP. (4 marks)

b) Briefly discuss the importance of common mode rejection ratio (CMRR). (3 marks)

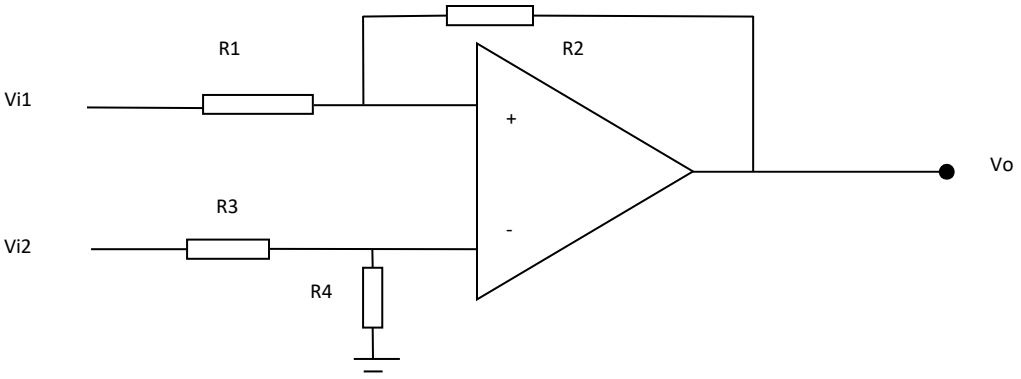

Fig.2

c) Calculate the common mode rejection ratio (CMRR) of the difference amplifier given in fig.2, given (R2/R1) =12 and (R4/R3) =15. (6 marks)

d) With aid of a labeled diagram, derive the expression of a log amplifier using OPAMP and a diode. (4 marks)

e) Derive the output expression of an ideal active integrator. (3 marks)

QUESTION THREE (20 MARKS)

a) Define slew rate. (2 marks)

b) Briefly discuss the advantages of instrument amplifiers in comparison with difference amplifiers. (3 marks)

c) Instrumentation amplifier in fig.3 is fabricated using ideal OPAMPs. R1=25KΩ, R2=120KΩ, R3=60KΩ and R4=240KΩ. The input voltages are $vi2 = 0.6 + 0.04\text{sinwt}$ and $\text{vi1} = 0.6 - 0.04\text{sinwt}$. Determine:

   i. Vo1
   ii. Vo2
   iii. Vo (9 marks)

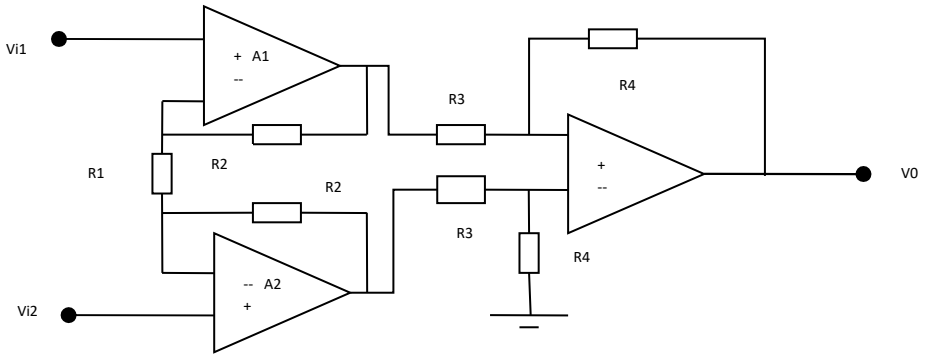

Fig3

d) The circuit in fig.4 is an active integrator. V_C=0 at t=0. A step input of Vi=-2 is applied at t=0. Determine the time constant such that the output reaches +20 volts at t=2mS. (6 marks)

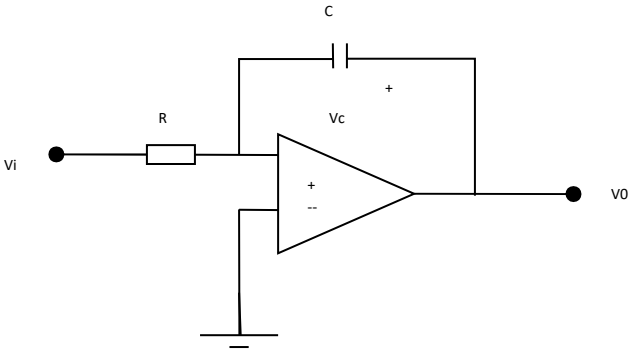

Fig4

QUESTION FOUR (20 MARKS)

a) Describe an operational transconductance amplifier (OTA). (2 marks)

b) The circuit in fig.5 is a voltage controlled voltage amplifier using an OTA. Given temperature dependent voltage VT=0.026 at room temperature and vc is 10 volts, determine the voltage gain Av=Vo/Vi. (8 marks)

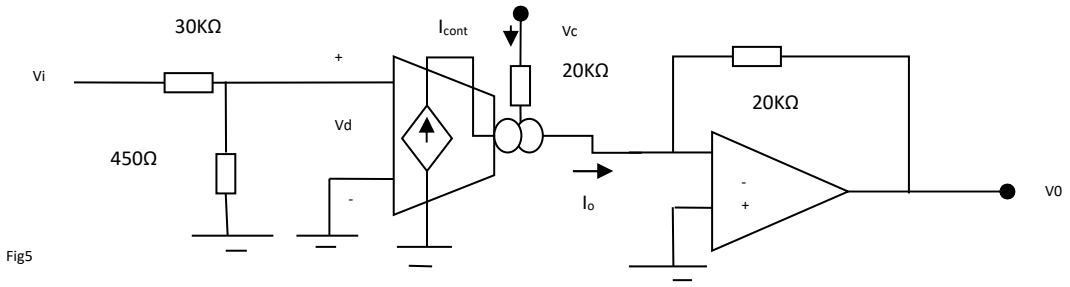

Fig5

c) State four characteristics of ideal Opamp. (4 marks)

d) With aid of diagram derive the expression Wien-bridge based opamp sine wave generator. (6 marks)

QUESTION FIVE (20 MARKS)

a) Sketch a typical opamp magnitude Bode plot. (2 marks)

b) With aid of diagrams show how logarithmic multiplier and logarithmic divider performs arithmetic multiplication and division. (8 marks)

c) Determine the values of I_{C1}, I_{C2}, V_{CE1} and V_{CE2} for the circuit in fig.6. (6 marks)

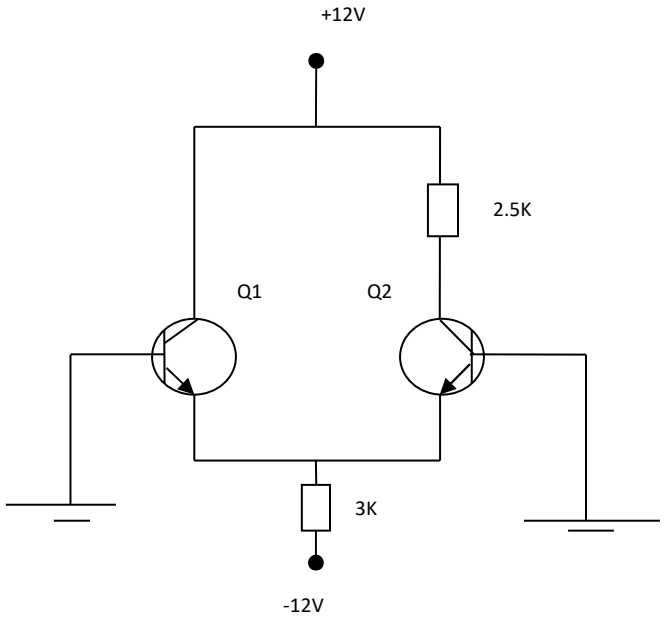

Fig.6

d) With aid of a diagram explain how a sample and hold opamp circuit works. (4 marks)