UNIVERSITY OF SWAZILAND

MAIN EXAMINATION, SECOND SEMESTER MAY 2010

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER: ANALOGUE ELECTRONICS II

COURSE CODE: E442

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. There are six questions in this paper. Answer any FIVE questions. Each question carries 20 marks.
2. If you think not enough data has been given in any question you may assume any reasonable values.
3. A sheet containing some useful equations is attached at the end of this examination paper.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

THIS PAPER CONTAINS FOUR (4) PAGES INCLUDING THIS PAGE

Q.1 a) What is the Barkhausen Criterion and why is it required? *(2 marks)*

b) For Hartley oscillator, determine the value of total inductance L_T and mutual inductance M, when it is operating at a frequency of 10 kHz with C = 10 nF, and $L_1 = L_2$ = 4 mH. *(7 marks)*

c) For the Wien bridge oscillator, determine the value of resistance R required for it to operate at a frequency of 1 kHz with C = 0.1 μF. What is the condition required to sustain oscillations? *(5 marks)*

d) What is the advantage of a Crystal oscillator? Explain its operation with suitable diagrams. *(6 marks)*

Q.2 a) What is the advantage and disadvantage of a Dual-Slope A/D converter? Explain its operation with neat diagrams. *(8 marks)*

b) Determine the number of counts for dual slope ADC, when V_{ref} = -1 V and V_{in} = 2 V and fixed counts = 1000. *(2 marks)*

c) With the aid of a relevant diagram, describe the principles of operation of the 4-bit binary R-2R ladder DAC. *(5 marks)*

d) Determine the out put voltage and resolution for an 8-bit DAC (R-2R network) when the input data is 10010101, and reference voltage is 10 V. *(5 marks)*

Q.3 a) For a series voltage regulator employing a series pass transistor

(i) Define voltage regulation, *(1 mark)*

(ii) With the aid of suitable diagrams, explain its working principle. *(6 marks)*

(iii) Determine the value of feed back resistance R_F required to obtain a constant output voltage 10V when the zener voltage is 5 V and R_1 =10 kΩ. Determine also the voltage gain? *(3 marks)*

b) In the circuit of Fig.Q.3b, which employs a fixed voltage 5V regulator LM340K-5, V_{in} varies from 15 to 20 V, I_Q = 4 mA, R_1 = 2 kΩ, and R_2 is a 1-kΩ variable resistance.

(i) Calculate V_{out} when R_2 = 1 kΩ. *(2 marks)*

(ii) Calculate V_{out} when R_2 = 500 Ω. *(2 marks)*

(iii) Find the maximum power that the regulator chip dissipates assuming the load draws up to 200 mA of current. *(3 marks)*

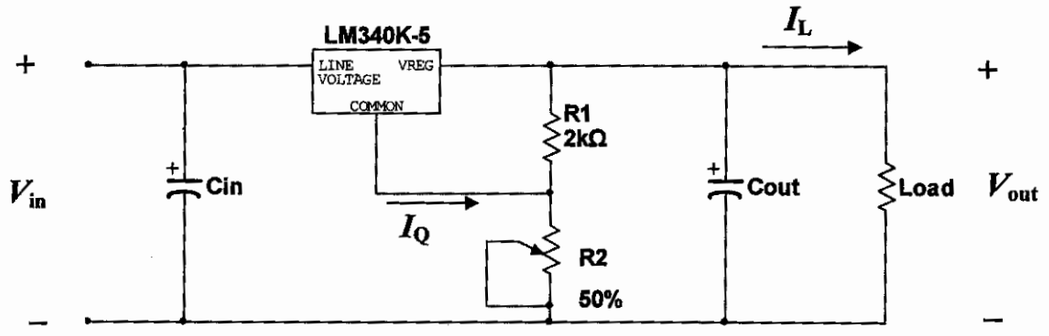

Fig. Q.3b

c) What is the advantage of SMPS over series voltage regulator and explain briefly *(3 marks)*

Q.4 a) Sketch and clearly label the output and transfer characteristics of an IGBT. *(5 marks)*

b) Describe the characteristics of an SCR and explain one of its applications. *(10 marks)*

c) Sketch and clearly label the output and transfer characteristics of an enhancement MOSFET. *(5 marks)*

Q.5 (a) Define the slew rate of an opamp. How does it limit the operation of an opamp used in linear applications and in non-linear applications? *(8 marks)*

(b) Design a simple opamp based function generator to generate a square wave and a triangular wave of 1 kHz. State any assumptions you make. *(12 marks)*

Q.6 Consider the circuit shown in Fig. Q.6 and answer the following questions.

(a) Derive expressions for the two threshold voltages for positive going signals and negative going signals. *(8 marks)*

(b) If $V_{ref} = 2\text{V}$, $R_1 = 10\ \text{k}\Omega$, $R_2 = 250\ \Omega$, and $V_{omax} = \pm V_{sat} = \pm 12\ \text{V}$, evaluate the threshold voltages. *(6 marks)*

(c) Sketch and clearly label the voltage transfer characteristic, v_o vs , v_{in} based on the values given in (b). *(3 marks)*

(d) If $v_{in} = 3\sin\left(2\pi \cdot 10^3 \cdot t\right)$ V and components values are as given in (b), sketch v_{in} and v_o versus t on the same time axis. *(3 marks)*

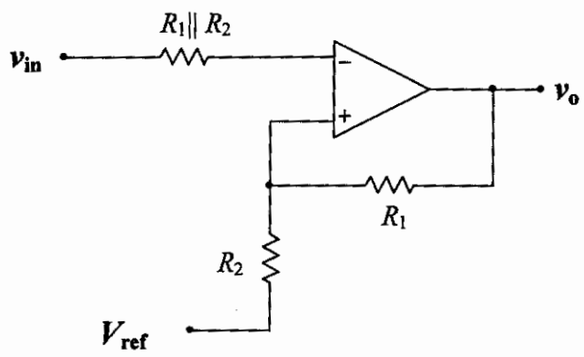

Fig. Q.6