UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: September 2014

Module Number: EE5228 **Module Name: Advanced Electronics**

[Three Hours]

[Answer **all questions**, each question carries 10 marks]

Q1. a) i) What are the different types of oscillators?.

ii) State the conditions required for a sustained state of oscillation.

[2.0 Marks]

b) Find the capacitor values in a Colpitts oscillator for an inductor value of 1 mH so that the output frequency is 2 MHz and the minimum voltage gain is 5.

[3.0 Marks]

c) Figure Q1 shows a circuit of a bi-stable multi-vibrator at its initial stable condition where Q1 is switches OFF (cut-off) and Q2 is switches ON (saturation). This circuit uses NPN silicon transistors having $h_{FEmin} = 50$, $V_{CE(sat)} = 0.3$ V, $V_{BE(sat)} = 0.7$ V, $V_{CC} = 12$ V, $V_{BB} = 12$ V, $R_C = 1$ kΩ, $R_1 = 10$ kΩ, $R_2 = 20$ kΩ.

i) Verify that the multi-vibrator is in its initial stable condition. Assume that the base current is 1.5 times of minimum base current, when the transistor is in its saturation state.

ii) Find the voltages of its initial stable state.

[5.0 Marks]

Q2. a) i) Explain the operation of the Schmitt trigger shown in Figure Q2(a) for a sinusoidal input.

[2.0 Marks]

ii) Determine the voltage levels in which Q1 conducts and Q1 is in cut-offstate when the input is a triangular wave. The circuit parameters are, R_{c1}=2.7 kΩ, R_{c2} = 1 kΩ, R_1 = 2.2 kΩ, R_2 = 3.9 kΩ, R_E = 3.3 kΩ and V_+ = 12 V. Assume transistors are ideal and $I_{B2} \simeq 0$.

[3.0 Marks]

b) A typical Zener regulator is shown in Figure Q2(b) .The tolerance of R is $\pm$ 5%. V_i = 10 V $\pm$6 % and V_o = 6 V $\pm$5 %. Suppose that you have given two Zener diodes which are, Z1 (6.5 V, 1.5 W) and Z2 = (6.5 V, 0.5 W).

i) Select a suitable Zener diode for a maximum load current of 100 mA while the minimum is kept at 0 mA.

ii) Find the valueof R from E12 series of 1W resistors.

[5.0 Marks]

Q3. a) i) States different of heat transfer methods used in semiconductor devices.

ii) Explain the need of transient heat flow models.

[2.0 Marks]

b) A thyristor with a steady power loss of 30 W has a junction-heat sink thermal resistance of 0.7 ^{0}C/W.The ambient temperature is 40 ^{0}C and the junction temperature is 125 ^{0}C.

i) Determine the thermal resistance of the heat sink.

ii) Determine the base temperature. [2.0 Marks]

c) i) State four advantages of the Printed Circuit Boards, PCB's.

ii) Draw a block diagram to illustrate the general steps of PCB designs.

iii) ExplainBriefly four etching techniques using the relevant sketches.

iv) ExplainBriefly two problems of etching using necessary sketches.

[6.0 Marks]

Q4. a) i) Draw the circuits for the N-Channel JFET and the P- Channel JFET in fixed bias with the usual notations, and derive their load lines.

ii) What is the equation of the Transfer Characteristics for a N-Channel JFET?

iii) Draw the circuits for the N-Channel JFET and the P- Channel JFET in self bias with a single DC supply.

iv) Explain how the N-Channel JFET in self bias is more stable than in fixed bias by considering the Transfer Characteristics and the load lines for two JFETs with slightly different saturation currents I_{DSS} and the pinch-off voltage V_P.

v) Explain how the simple self bias circuit in iii) could be made even more stable and give a practical circuit that can achieve this.

vi) Obtain an algebraic solution for the drain current I_D at the Q point for this practical circuit.

vii) In all these cases what condition must be satisfied to ensure that the JFET is operating in the pinch off region?

[8.0 Marks]

b) i) Explain how a JFET can be operated as a current source.

ii) Figure Q4 shows JFET operating as an Analog Switch where V_P denotes the pinch off voltage. If the JFET resistance when the switch is closed is 40 Ω and v_d is a sinusoid of 200 mV, what is V_L at

I. $V_{GS} = V_P$?

II. $V_{GS} = 0V$?

[2.0 Marks]

Q5 a) Sketch the Drain and Transfer Characteristics for depletion type N-Channel and P-Channel MOSFETS and indicate the regions for the two modes of operation.

[2.0 Marks]

b) For an enhancement N-Channel MOSFET explain the significance of the threshold voltage V_T and its effect on the channel width.

[1.5 Marks]

c) i Figure Q5 shows a N- Channel MOSFET amplifier circuit where $\beta = 0.5 \times 10^{-3}$ A/V^2, $V_T = 2V$ and $r_d = 75K$. The coefficients in the quadratic equation for I_D are $A = 2.5 \times 10^5$, $B = -7.74 \times 10^{-3}$ and $C = 13.98$.
The small-signal transconductance $g_m = \beta (V_{GS}-V_T)$. Determine the following parameters at the Q point.

I. I_D

II. V_{DS}

III. V_{GS}

All notations have their usual meaning.

ii Verify that the bias point is in the active region.

iii Find the input resistance

iv Sketch the small-signal equivalent circuit and find the overall voltage gain.

[4.0 Marks]

d) i Sketch the circuit for an N- Channel MOSFET as a non-linear resistor.

ii If the Drain Characteristic is given by

$$I_D = 0.5 \beta (V - V_T)^2, \quad V > V_T$$
$$= 0, \quad V \leq V_T$$

show that the small-signal resistance is $r = 1/(\sqrt{2} \beta I)$ and the DC resistance is $R = \sqrt{[2/ (\beta I)]} + V_T/I$ where I denotes the current. [2.5Marks]

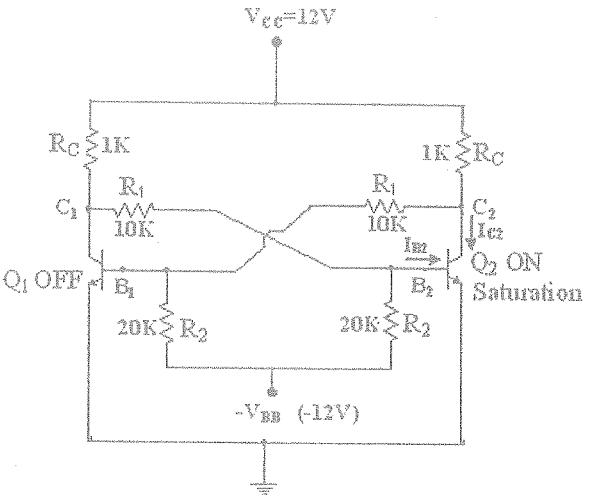

Figure Q1: Bistablemultivibrator

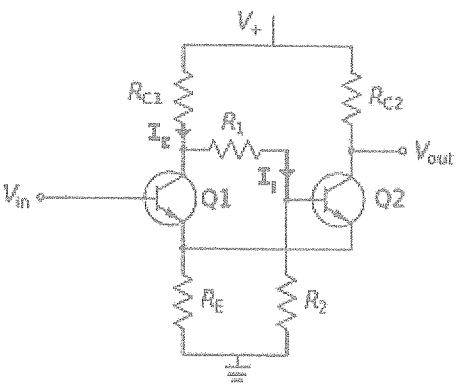

Figure Q2(a): Schmitt trigger

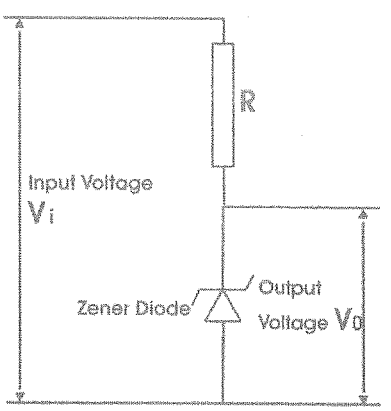

Figure Q2(b): Zener Regulator

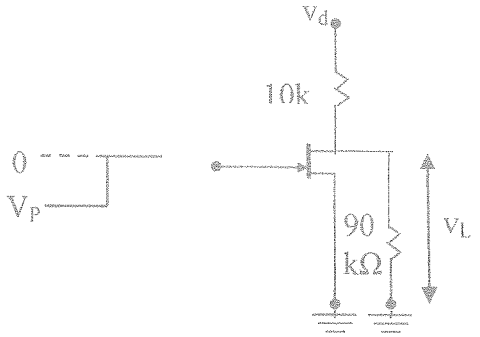

Figure Q4

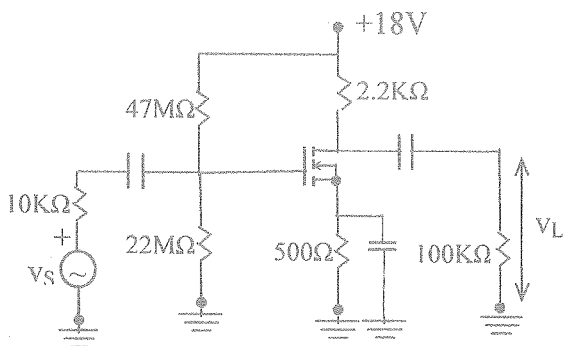

Figure Q5