The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Final Examination –2008
ECX 4230 – Fault Diagnosis in Electronic Circuits **(Closed Book)**

Time: 0930-1230 hrs. Date: 12.03.2009

Answer any five questions.

1. Consider the amplifier circuit shown in Figure-Q1.

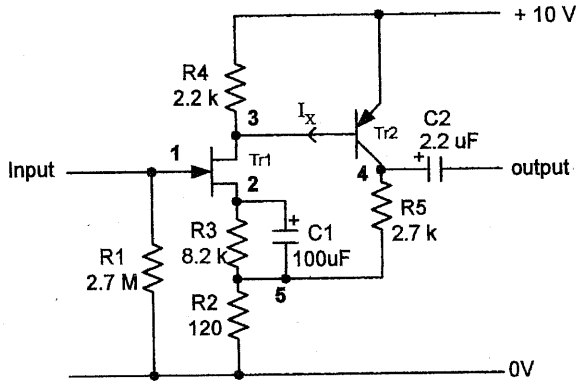

Figure - Q1

The drain current of the JFET is given by $I_D = 0.2(V_{GS} - V_P)^2$, where I_D is in mA, V_{GS} is in volts and V_P = -4V. You may assume usual notation. The current gain of the transistor Tr2 is 50.

(i) Calculate the current I_X and hence find out the voltages at the test points when there is no input signal.

(ii) If a signal having amplitude of 50mV and a frequency of 1KHz is given to the input, find the amplitude of the output signal.

(iii) Following table shows the test point voltages under fault conditions. Identify the faulty component/s and fault type with reasons.

case	1	2	3	4	5	other
A	0	2.758	9.400	9.000	0.241	output distorted
B	0	0.000	10.00	0.000	0.000	no output
C	0	5.880	8.440	0.084	0.084	no output
D	0	2.758	9.400	4.831	0.241	output amplitude low

2. The circuit shown in Figure-Q2 is a transistor Wien bridge oscillator.

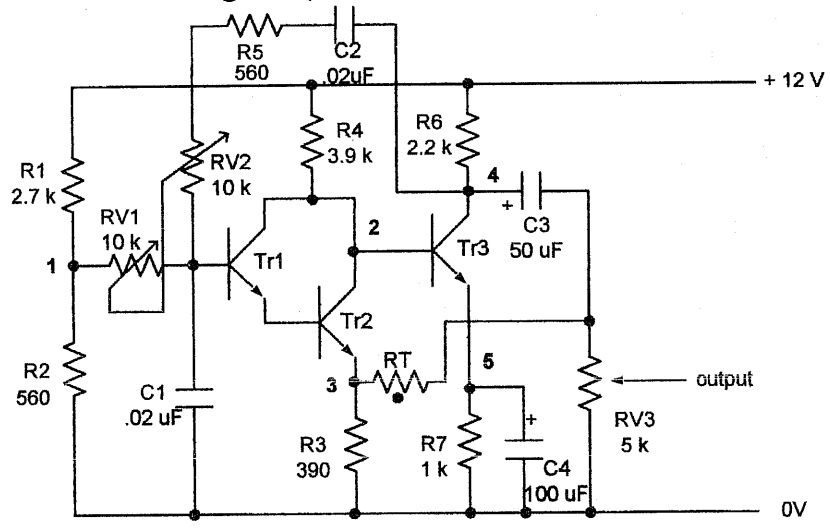

Figure - Q2

The transistors Tr1, Tr2 and Tr3 are of high gain type and RT is a thermistor.

(i) (a) Identify the components which determine the output frequency.

(b) What is the phase relationship of the signal at 4 with the signal at the base of Tr1?

(c) State the function of RT.

(ii) Estimate the maximum and minimum operating frequency of this circuit.

(iii) Calculate the dc voltages at the test points.

(iv) Following table shows the dc voltages at the test points under fault conditions. Identify the faulty component/s with fault type indicating reasons.

case	1	2	3	4	5	other
A	2.061	3.381	0.861	12.00	0.000	no output
B	2.061	3.381	0.861	5.880	2.781	waveform at 2; no output
C	2.061	3.381	0.861	5.880	2.781	output signal high & clipped
D	0.000	5.470	0.000	4.970	4.870	no output

3. A two-stage transistor amplifier is shown in Figure – Q3.

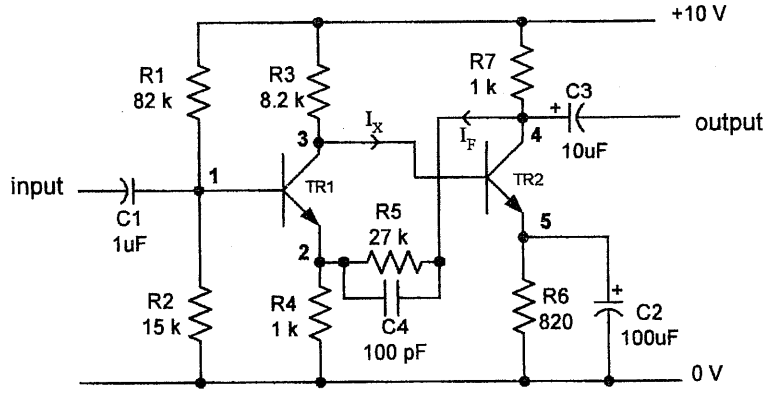

Figure - Q3

The transistor Tr1 is of high gain type and the transistor Tr2 is having a gain of 40.

(i) Calculate the currents I_X and I_F. Hence derive the voltages at the test points.

(ii) When a sine wave signal of the mid band range having an amplitude of 35mV is applied to the input, the output signal amplitude is 953mV. Estimate the open loop gain (when there is no feedback) of this amplifier.

(iii) The table given below shows the dc test point voltages at no signal under fault conditions. Find out the faulty component/s and fault type. The amplitude of the sine wave input signal used to observe the output is 35mV.

case	1	2	3	4	5	output
A	1.55	0.95	1.89	8.46	1.29	amplitude =10V, square wave
B	1.55	0.95	4.86	9.68	0.00	amplitude = 1.5mV, sine wave
C	1.55	0.95	3.26	6.63	2.66	amplitude = 34mV, sine wave
D	1.55	0.95	4.91	4.51	4.31	no output

4. Consider the multivibrator circuit shown in Figure-Q4. The transistors may be assumed as having high gain and $V_{CE(sat)} = 0$.

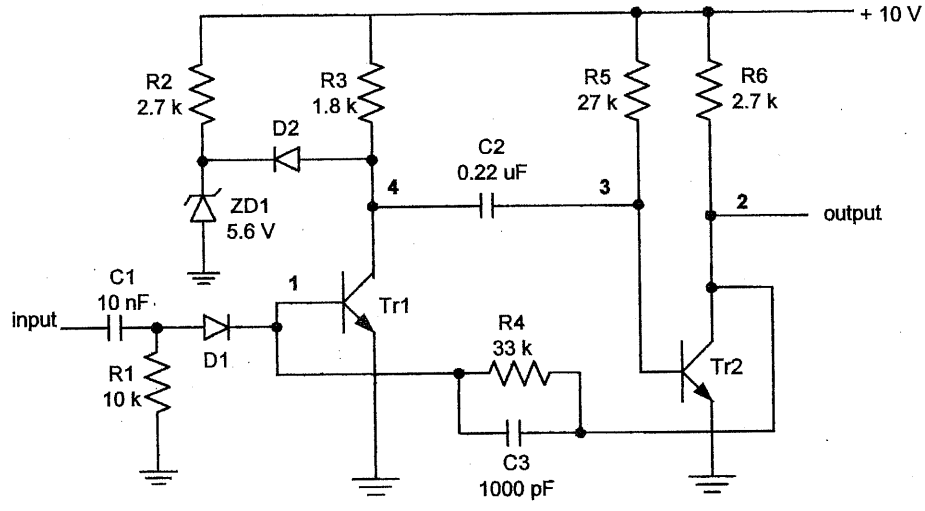

Figure - Q4

(i) Identify the type of this multivibrator. Calculate the test point voltages when there is no input signal and find the collector current in each transistor.

(ii) A pulse of short duration having an amplitude of 8V is applied to the input. Draw the resulting waveforms at each test point on a common time scale. Calculate and mark important voltage and time values on your sketch.

(iii) Under fault conditions, all test point voltages are observed before applying any input. Then the test points are observed by an oscilloscope after applying a narrow test pulse of 8V. Some of the results observed are listed below. Find the faulty component/s indicating the fault type with reasons.

case	1	2	3	4	other
A	0.0	0.0	0.6	0.6	no output
B	0.0	0.0	0.6	6.2	no output pulse; -ve pulse at 3
C	0.0	0.0	0.6	6.2	output pulse width > normal
D	0.0	0.0	0.6	6.2	output pulse height< normal

5. A section of a pulse generator circuit is shown in Figure-Q5.

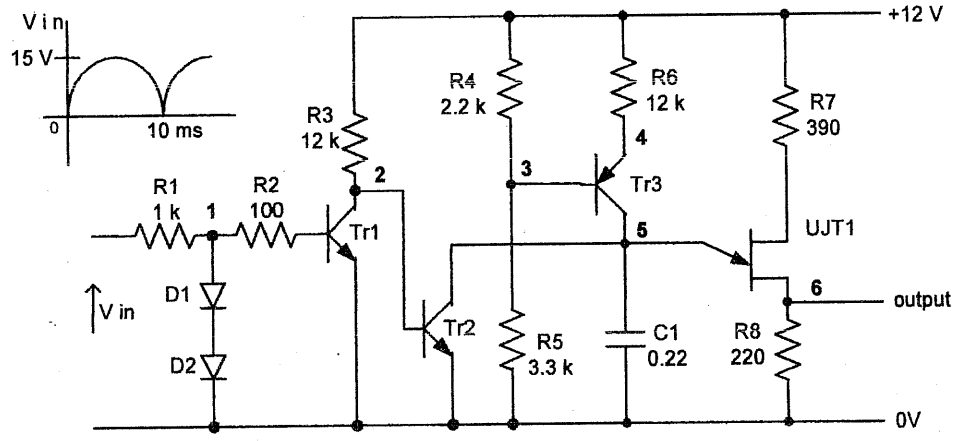

Figure - Q5

The transistors Tr1, Tr2 and Tr3 are of high gain type and the constant η for UJT1 is 0.4. The waveform shown in the figure is applied to the input Vin.

(i) (a) State the role of D1 and D2.

(b) Indicate the function of Tr1, Tr2 and Tr3.

(ii) Sketch the waveforms at each test point on a common time scale with the input signal marking the values of voltage and time parameters. Show the calculations you used to derive these values.

(iii) Consider the following fault cases and find the faulty component/s giving the fault type with reasons. The dc values at the test points are given and if the voltage is varying, it is denoted by 'V'.

case	1	2	3	4	5	output
A	V	V	7.200	7.800	V	pulse interval > normal
B	V	V	7.616	8.216	8.016	no output
C	V	V	7.200	12.00	0.000	no output
D	V	V	7.616	8.216	0.000	no output

6. A Schmitt trigger circuit is shown in Figure-Q6. Assume the transistors have high gain and $V_{CE(sat)} = 0$.

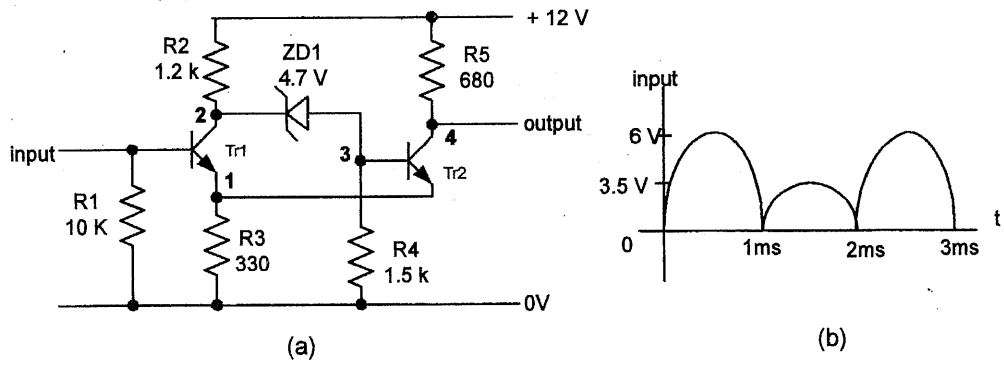

Figure-Q6

(i) Calculate the input threshold voltages and hysteresis of this circuit.

(ii) Find the possible values that the output can have and derive the test point voltages for these cases.

(iii) Sketch the waveform of the output when the signal shown in Figure-Q6(b) is applied to the input. Your sketch must show the input and the output on a common time scale and the time and voltage values must be marked clearly.

(iv) Under fault conditions, two dc voltages are given to the input and the resulting test point voltages are listed below. State the faulty component/s giving fault type with reasons.

case	input	1	2	3	4
A	0.00	0.00	12.0	0.00	12.0
B	0.00	0.00	8.16	4.06	12.0
C	6.00	5.40	8.16	4.06	12.0
D	6.00	5.40	5.60	0.90	0.00

7. A switching power supply circuit is shown in Figure-Q7.

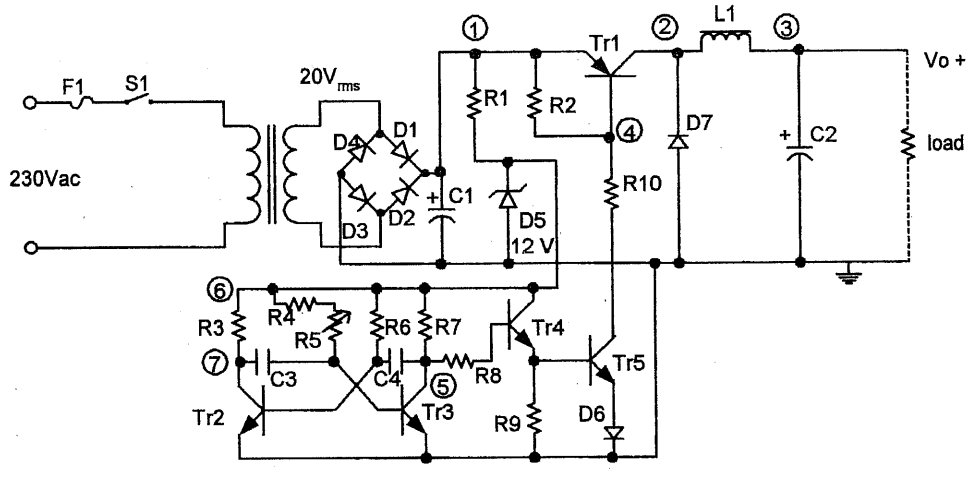

Figure -Q7

(i) (a) State the current path flowing through the load for the two cases when V_4 is high and low.

(b) What is the function of L1 and D7?

(c) State the effect on Vo when R6 is increased and decreased.

(d) State the difference between D7 and D1.

(ii) Draw the waveforms at the test points 5, 7, 4 with V_{12}, on a common time scale. Mark the voltage levels clearly on the diagram. Derive expressions for each important time parameters related to your sketch.

(iii) Consider the following fault cases and determine the faulty component/s with fault type giving reasons. Any pulse activity observed at a test point is indicated by 'P'.

case	1	2	3	4	5	6	7
A	25.0	24.6	24.3	12.0	12.0	12.0	0.2
B	25.0	0.0	0.0	25.0	0.2	12.0	0.2
C	25.0	0.0	0.0	25.0	0.0	0.0	0.0
D	25.0	0.0	0.0	P	P	12.0	P

8. (a) Explain how you are going to calibrate a P^H meter after a repair.

(b) A circuit of a P^H meter is shown in Figure-Q8.

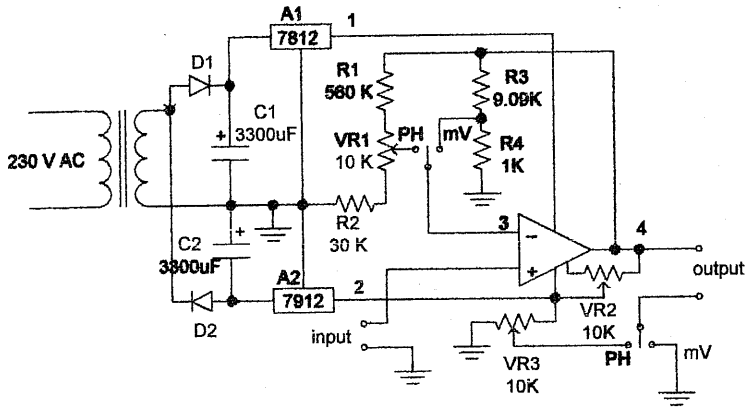

Figure-Q8

(i) State the function of A1 and A2. Identify the use of VR1, VR2 and VR3 in this circuit.

(ii) When measuring P^H of a solution, it is observed that the reading is drifting. When the input is connected to the ground, the output is 0mV and stable. Identify the fault in the instrument.

(iii) Following is a list of test point voltages obtained under fault conditions. Identify the faulty component/s and the fault type giving reasons. The instrument is set to P^H.

case	input	1	2	3	4	other
A	0	12.0	-12.0	0.8	12.0	when set to mV, V_3 = 1.2V
B	0	12.0	-12.0	0	12.0	when set to mV, V_4 = 0V
C	0	12.0	0	0	12.0	when set to mV, V_4 = 12V