UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: December 2015

Module Number: ME 4311 **Module Name: Analog and Digital Electronics**

[Three Hours]

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

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

Q1. a) An Oscilloscope is a type of electronic test instrument that allows observation of constantly varying signal voltages, usually as a two-dimensional plot of one or more signals as a function of time.

i) State and describe two different types of Oscilloscopes.

ii) Identify the components numbered 1 to 8 of the Oscilloscope shown in Figure Q1 (a).

[4.0 Marks]

b) Measurement instruments are used in variety of engineering applications. Write short descriptions about the following topics related to Engineering Measurements.

i) Tolerance,

ii) Linearity,

iii) True value,

iv) Sensitivity,

v) Resolution.

[4.0 Marks]

c) When a Voltmeter is used for reading a standard value of 24 volts, the following readings are obtained: 24V, 23V, 22V, 25V, 21V. Calculate the,

i) Absolute accuracy,

ii) Relative accuracy,

iii) Bias of the readings.

[4.0 Marks]

Q2. a) An Analog-to-Digital Converter (abbreviated ADC, A/D or A to D) is an electronic circuit that converts continuous signals to discrete digital numbers. State the different types of "ADCs" and briefly explain three of them.

[4.0 Marks]

b) i) Explain Quantization Error of ADCs with necessary diagrams/ figures.

ii) Explain "Over sampling" and state its possible disadvantages.

[4.0 Marks]

Q2. is continued to Page 2.

c) ADCs are used virtually everywhere when an analog signal has to be processed, stored, or transported in digital form.

i) Briefly explain the impact of "Commercial ADCs" on our daily activities.

ii) Full scale measurement range of a device is rated as 0 to 10 volts. ADC is 24 bits. Determine the resolution of the ADC.

[4.0 Marks]

Q3. a) Operational Amplifiers (Op-Amps) are general purpose voltage amplifiers employed in a variety of circuits. Figure Q3(a) shows a configuration of such voltage amplifier.

i) What are the typical characteristics of a good voltage amplifier?

ii) Identify the amplifier configuration shown in the Figure Q3(a).

iii) Draw the circuit model for the Op-Amp with standard notations/parameters.

iv) Derive the voltage transfer function of the model.

v) Show that the voltage transfer function of the circuit is independent of the Op-Amp gain.

[5.0 Marks]

b) Figure Q3(b) presents three circuit configurations (A, B and C) of different applications of Op-Amps. Identify each of them.

[2.0 Marks]

c) Consider the amplifier circuit shown in the Figure Q3(c). The input voltage is $V_i = 0.5\cos(\omega t)$. Assume a unity-gain bandwidth of 10^6 Hz, short circuit current $I_{SC} = 100$ mA, Slew Rate $S_0 = 1$ V/µs and the Op-Amp is powered by a ±15 V power supply.

i) What is the amplifier gain in dB?

ii) For what range of frequencies, does this amplifier behave as a linear amplifier?

[5.0 Marks]

Q4. a) Hand-held devices, cell phones, navigation receivers, personal computers, digital cameras, personal media players, and virtually all electronic consumer products have the ability to send, receive, store, retrieve, and process information represented in a binary format.

i) Briefly explain the difference between sequential circuits and combinational circuits by considering the electronic properties of the above devices.

ii) What are the types of storage elements (Latches) commonly employed in the above applications?

iii) Distinguish Flip-Flops from Latches.

iv) Draw the circuit configurations for the commonly used Flip-Flops and provide the respective characteristic table for each.

[6.0 Marks]

Q4. is continued to Page 3.

b) Figure Q4(b) presents an example of a sequential circuit which is employed in a typical electronic device.

   i) Describe the sequential circuit algebraically by means of state equations.

   ii) List the state table for the sequential circuit.

   iii) Draw the corresponding state diagram.

   iv) D flip-flops are widely used in industrial applications compared to the other types of flip flops. Briefly explain the reason.

[6.0 Marks]

Q5. The reduction in the number of flip-flops in a sequential circuit is referred to as the state-reduction. State-reduction algorithms are concerned with procedures for reducing the number of states in a state table, while keeping the external input-output requirements unchanged.

a) What are the benefits of having reduced number of states in a sequential circuit?

[1.0 Mark]

b) Table 5(b) presents a state table which is to be implemented using D flip-flops.

   i) Draw the corresponding state diagram.

   ii) Tabulate the reduced state table.

   iii) Draw the state diagram corresponding to the reduced state table.

   iv) Starting from state a, and input sequence 01110010011, determine the output sequence for the state Table 5(b).

   v) Show that the same output sequence can be obtained for the same input sequence in part iv) and reduced state table in part ii).

[4.0 Marks]

c) A sequential circuit has three flip-flops A, B, C; one input *x_in*; and one output *y_out*. The state diagram is shown in Figure Q5 (c). The circuit is to be designed by treating the unused states as don't-care conditions.

   i) Identify the unused states from the state diagram.

   ii) Obtain the state table for the present states A, B, C, input *x_in* and output *y_out*.

   iii) By using D flip-flops, obtain the state equations and output equations.

   iv) Draw the logic diagram of the circuit.

   v) Analyze the circuit obtained from the design to determine the effect of the unused states.

   vi) Repeat parts iii), iv) and v) using JK flip-flops for the design.

[7.0 Marks]

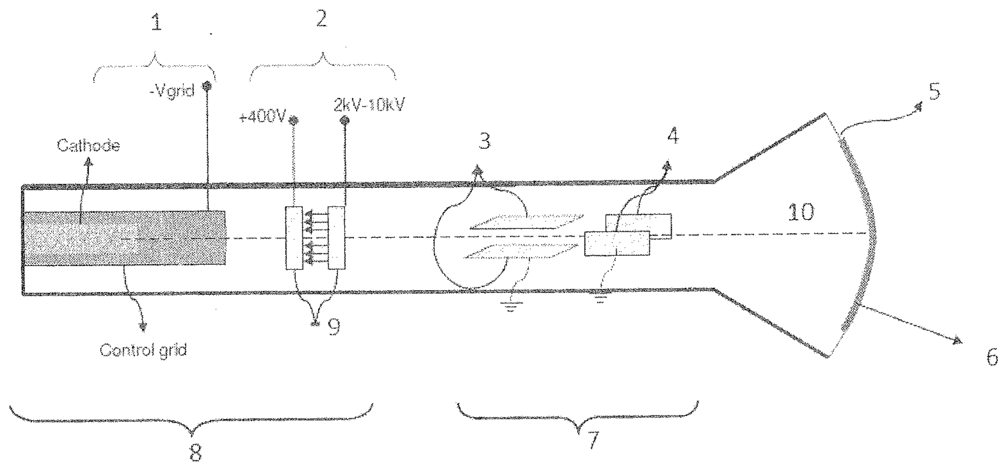


Figure Q1 (a): Oscilloscope

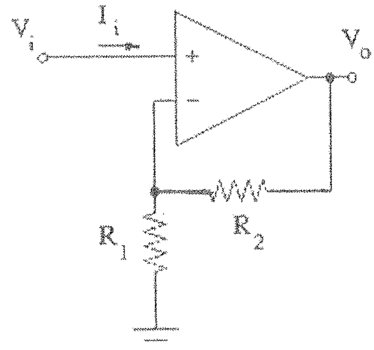
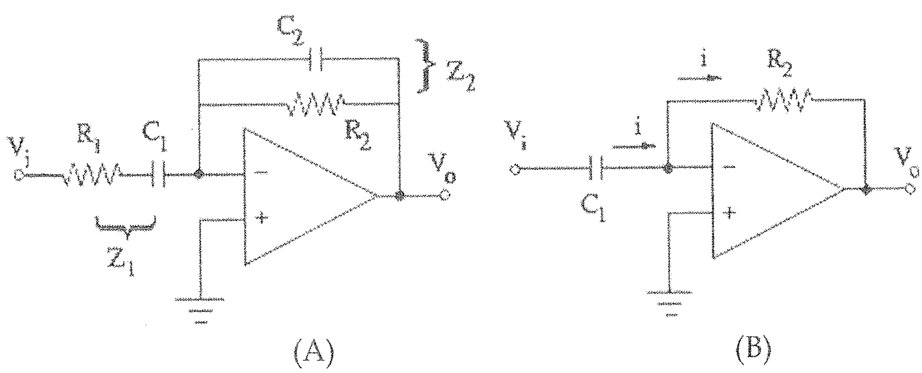


Figure Q3 (a): The Voltage Amplifier



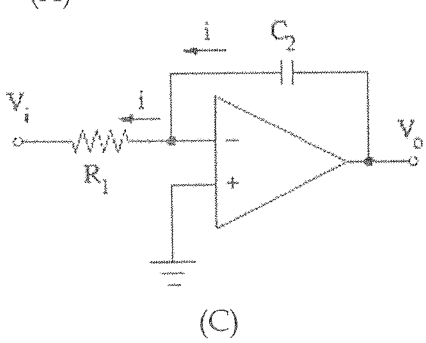


Figure Q3 (b): The Circuit Configurations for Three Applications of Op-Amps

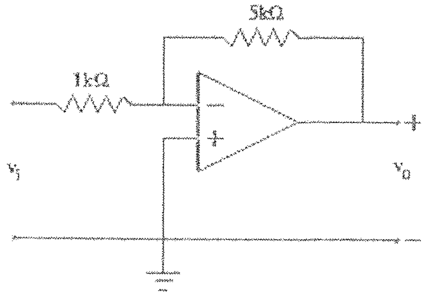


Figure Q3 (c): The Amplifier Circuit

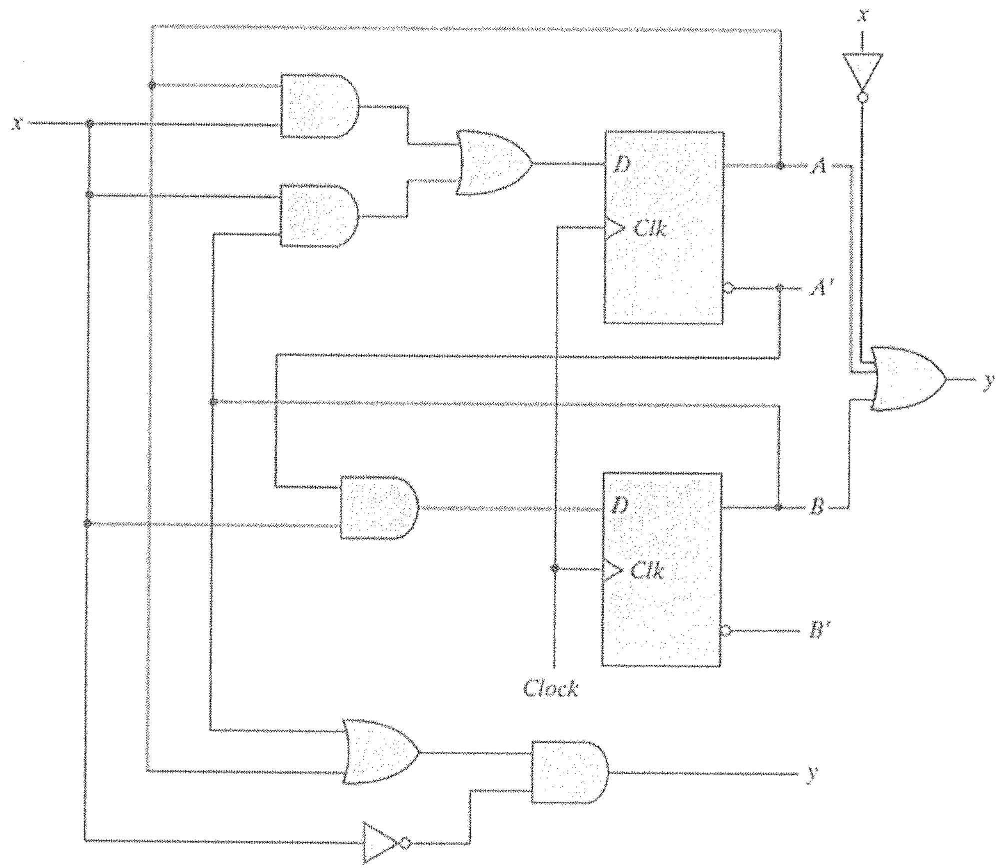


Figure Q4 (b): The Example of a Sequential Circuit

Table 5(b): The State Table

	Next State		Output	
Present State	$x = 0$	$x = 1$	$x = 0$	$x = 1$
a	f	b	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

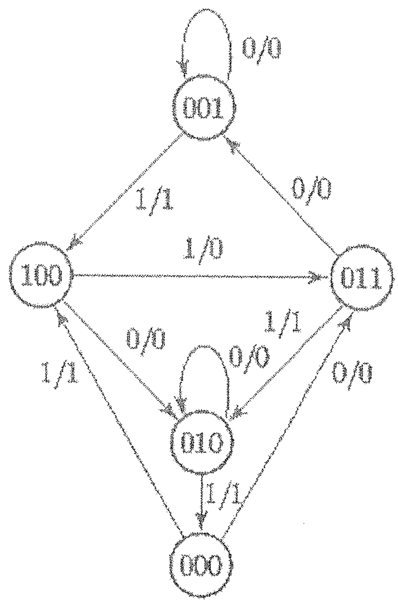


Figure Q5(c): The State Diagram