00177

The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology – Level 3

ECX 3231 – Electrical Circuits & Measurements
Final Examination 2012/2013

Duration 3 hours

Date: 31.07.2013 Time: 13.30 – 16.30

This question paper consists of two sections A and B over six pages. Answer **six** questions selecting **three** from section A and **three** from section B. All questions carry equal marks.

SECTION - A

Q1 Consider the circuits shown in Figure Q1.1, Component values are $R_1 = 10\ k\Omega$, $R_2 = 1\ k\Omega$, $C_1 = 10\ nF$, $L_1 = 20\ mH$, $L_2 = 30\ mH$ and $Is = 5Sin1000t\ mA$.

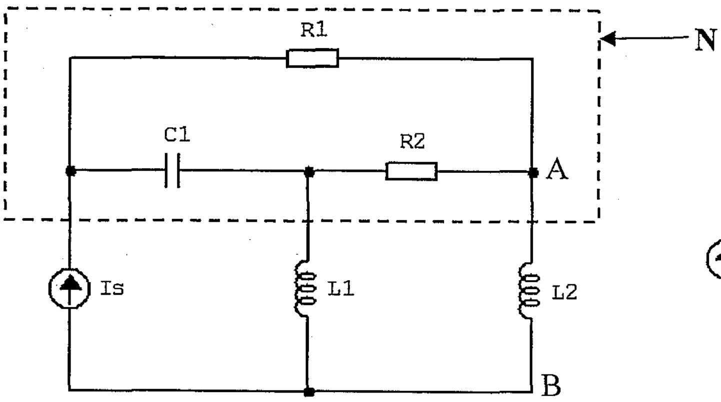

Figure Q1.1

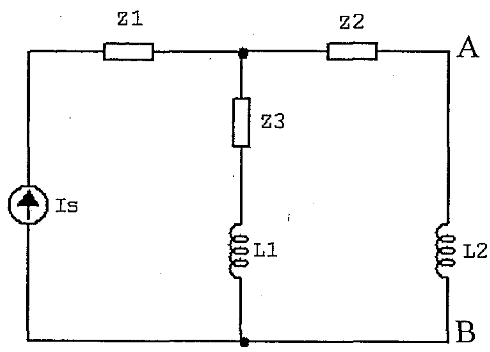

Figure Q1.2

a. Determine Z_1, Z_2 and Z_3 if the circuit has been converted to an equivalent circuit shown in Figure Q1.2. *[Marks 40]*

b. Obtain the Thevenin's equivalent circuit between the points A-B of the Figure Q1.2 *[Marks 40]*

c. What should be the impedance to be connected across terminals AB to get maximum power and determine that maximum power? *[Marks 20]*

Q2 Consider the passive two-port network shown in the Figure Q2. Suppose that $Z_{L1} = j20\ \Omega$, $Z_{L2} = j25\ \Omega$ and $R_1 = 20\ \Omega$.

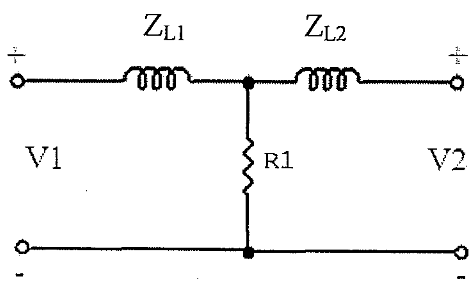

Figure Q2

a. Derive equations for open circuit impedance and short circuit admittance parameters of a two port network. *[Marks 20]*

b. Determine the z and y parameters of the network shown in Figure Q2. Is it reciprocal network? *[Marks 40]*

c. What are the transmission parameters? Deduce the relation $A^2 - BC = 1$, for a symmetrical two port network. *[Marks 40]*

Q3 Consider the circuit shown in Figure Q3. This circuit shows a large signal AC equivalent model of an AM radio IF amplifier. The circuit is at steady state. The operating frequency is 455×10^3 rad/s.

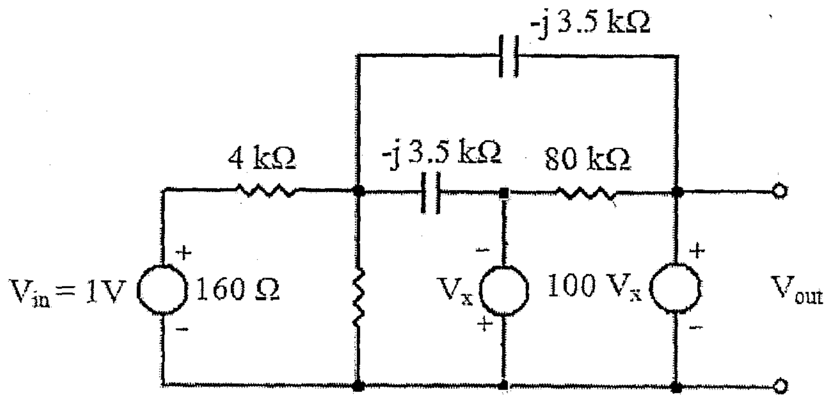

Figure Q3

a. Obtain nodal admittance equations in the matrix form. *[Marks 30]*

b. Solve equations and obtain voltages at nodes. *[Marks 30]*

c. Explain four MATLAB functions that help to solve this circuit. *[Marks $5\times4 = 20$]*

d. Briefly explain four types of PSPICE analysis that can be used for electrical circuits. *[Marks $5\times4 = 20$]*

Q4

a. List five characteristics of an ideal operational amplifier. *[Marks $5\times4 = 20$]*

b. Consider the circuit shown in Figure Q4. Assume that the operational amplifier is ideal, cut-off frequency $f_0 = 1$ kHz and $K = 1.586$.

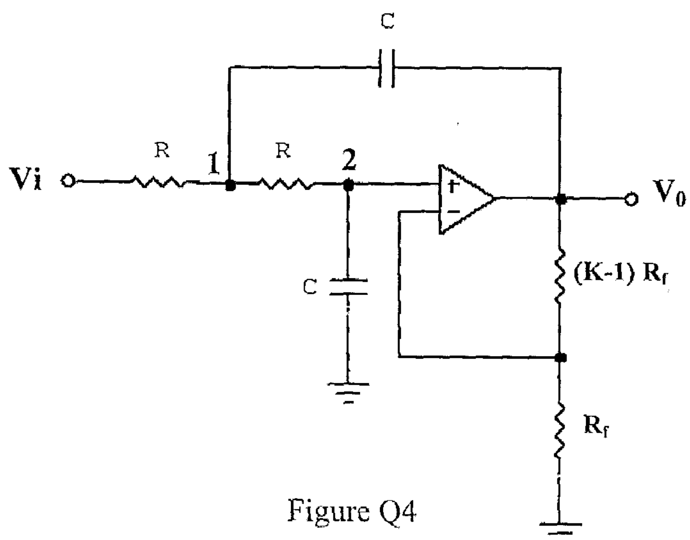

Figure Q4

i. Derive the transfer function V_0/V_i for the circuit in Figure Q4. *[Marks 40]*

ii. State the type of the filter by comparing the transfer function with the standard system function. *[Marks 20]*

iii. Find component values using the result of part (ii). *[Marks 20]*

Q5

a. Explain the reason why cathode ray oscilloscope cannot be directly used to observe the transient response of a circuit. *[Marks 10]*

b. The switch of the circuit shown in Figure Q5 was opened for a long time and closed at t = 0. Perform a transient analysis for the circuit with the help of steps given below.

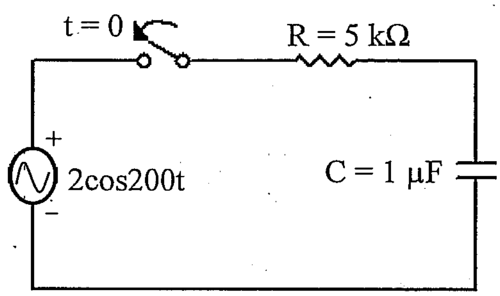

Figure Q5

i. Derive an expression for current i(t) at t > 0. *[Marks 50]*

ii. Calculate the current through the circuit at 2 ms. *[Marks 20]*

iii. Sketch the neutral response, forced response and complete response of current through the circuit on the same graph. *[Marks 20]*

SECTION – B

Q6 During a practical session a student followed certain steps to measure an waveform. He connected the oscilloscope leads directly to the output of the signal generator. The signal generator frequency was approximately 500 Hz and sinusoidal signal was selected.

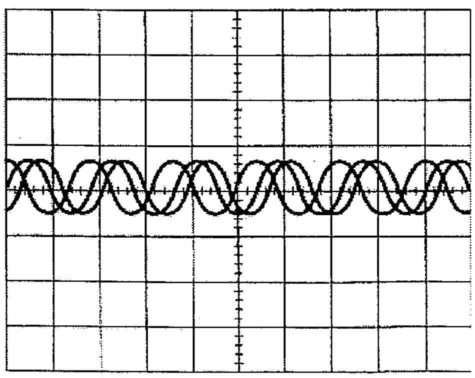

Figure Q6.1

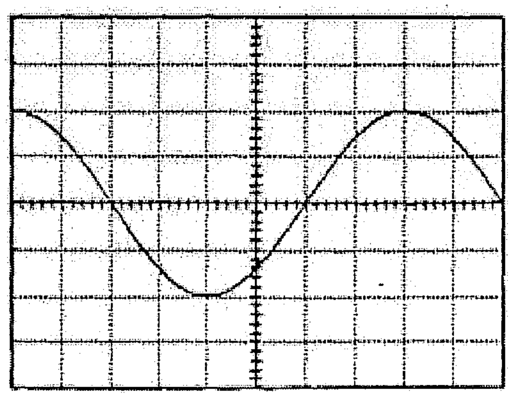

Figure Q6.2

a. If he got a waveform as shown in Figure Q6.1 explain the reason to get such a waveform and how do you correct this issue. [Marks 60]

b. After successfully overcome above problem he got a decent sine curve on the screen as shown in Figure Q6.2. What observation can be made if following changes ware done,

 i. Change the Time/div knob of the oscilloscope.
 ii. Increase the frequency knob of the signal generator.
 iii. Change the amplitude of the signal on the signal generator.
 iv. Change the oscilloscope probe switch to the ×10 position. *[Marks 5×4=20]*

c. If he adjusted Time/div and Volts/div knobs as shown in figure Q6.3,

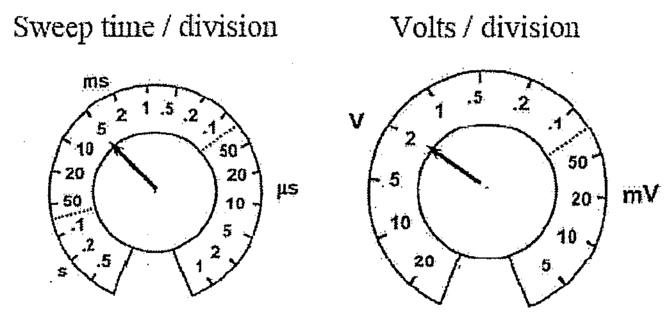

Figure Q6.3

 i. What would be the period, frequency and peak-to-peak amplitude of the waveform shown in Figure Q6.2?
 ii. Obtain the maximum value of the waveform.
 iii. What is the RMS value of the waveform? *[Marks 20]*

Q7

a. Explain two different methods used in high resistance measurement? *[Marks 5×2=10]*

b. Draw the schematic block diagram of Digital Volt Meter (DVM). *[Marks 20]*

c. Calculate the rms voltage of the waveform shown in Figure Q7. *[Marks 30]*

d. The waveform shown in Figure Q7 is measured using an average responding AC voltmeter that is calibrated to measure sinusoidal voltages. Determine the meter reading. *[Marks 40]*

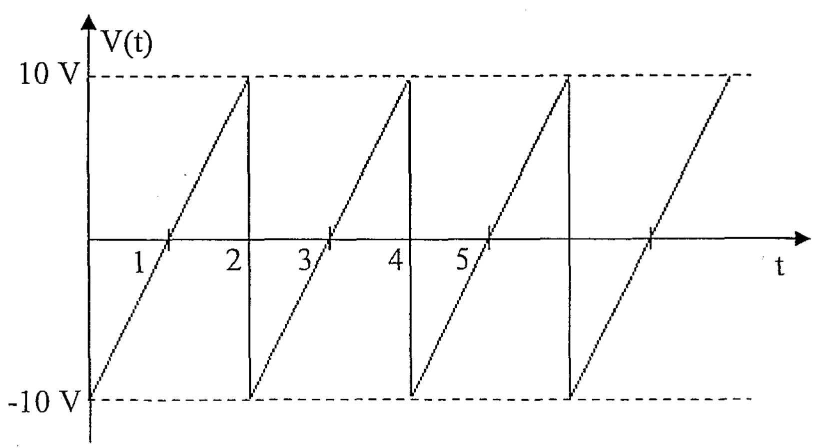

Figure Q7

Q8

a. Explain in detail four different types of errors in measuring instruments. *[Marks 4×5=20]*

b. Define the terms "precision" and "sensitivity". *[Marks 5×2=10]*

c. What is the significance of calibration? *[Marks 30]*

d. Show the block diagram indicating functional elements of measurement system. *[Marks 20]*

e. Explain on the static and dynamic characteristics of a measurement system. *[Marks 20]*

Q9

a. List three differences between DC and AC bridges. *[Marks 5×3=15]*

b. What are the two conditions that must be satisfied to make an AC bridge balance? *[Marks 5×2=10]*

c. Describe and draw the setup that gives the best accuracy to measure the following variables using your knowledge about bridges.

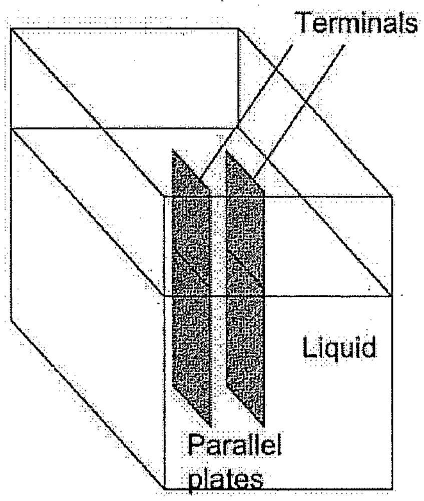

Figure Q9.1

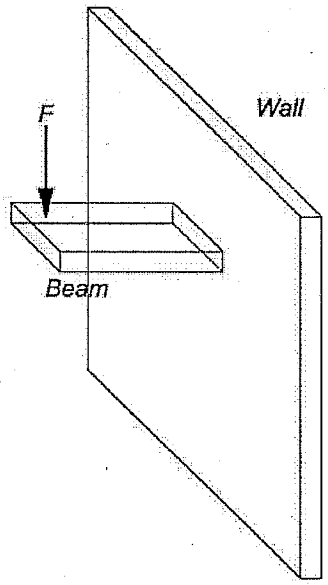

Figure Q9.2

i. The level of a non-conducting liquid using two parallel plates as shown in Figure Q9.1. The liquid level is expected to change every 1 second. *[Marks 25]*

ii. The force on a cantilevered beam as shown in Figure Q9.2. The force is a sinusoidal function of frequency 20 Hz. *[Marks 25]*

iii. The exact value of a coil that has an approximate inductance and resistance of 1mH and 10 mΩ respectively frequency is 50 Hz. *[Marks 25]*

Q10 A Lessajous pattern produced by the dual trace oscilloscope is a one of technique for phase shift measurement. Consider following two sinusoidal waveforms given by equations 1 and 2. Note that φ is the phase shift to be determined and V_1 and V_2 are not equal to each other.

$$Vx = V1 \sin \omega t \quad \ldots\ldots\ldots\ldots\ldots (1)$$
$$Vy = V2 \sin(\omega t + \varphi) \ldots\ldots\ldots\ldots (2)$$

a. Use equations (1) and (2) to derive the following expression,

$$\cos \omega t = \frac{Vy - \frac{V2\ Vx\cos\varphi}{V1}}{V2 \sin \varphi}$$

[Marks 20]

b. Using the result in part (a), derive the equation of the ellipse,

$$\sin^2\varphi = \frac{Vy^2}{V2^2} + \frac{Vx^2}{V1^2} - \frac{2VxVy\cos\varphi}{V1V2}$$

[Marks 40]

c. Obtain a relationship for the phase shift φ when the V_x or $V_y = 0$, in terms of V_1, V_2, V_x and V_y.

[Marks 20]

d. Figure Q10 shows a Lissajous pattern shown on the oscilloscope screen. Measure the phase shift between two waveforms.

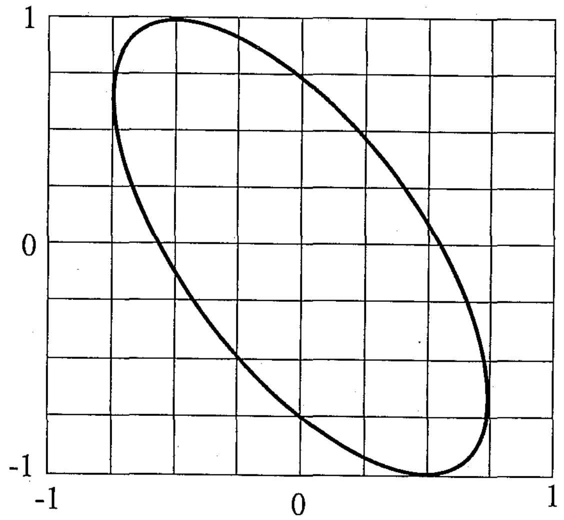

Figure Q10

[Marks 20]

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