UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2005/2006

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: ELECTRIC CIRCUITS

COURSE CODE: E310

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. There are two Sections to this paper. SECTION A has questions 1 to 4 and SECTION B has Questions 5 to 6. Answer FOUR questions including AT LEAST ONE from SECTION B.
2. Questions carry equal marks.
3. Graph paper is provided.

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THIS PAPER CONTAINS SEVEN (7) PAGES INCLUDING THIS PAGE

SECTION A

QUESTION 1 - D.C. CIRCUITS *(25 marks)*

(a) (i) Suppose that Swaziland Electricity Board supplies a home with a 220-V, 35-A service, find the maximum power available to the home. Do you think the home can safely operate the following loads at the same time: a 5-hp motor, 3000-W dish washer, a 2400-W electric drill and a 1000-W steam iron? Explain. **(Note: 1 hp = 746 W).** *(5 marks)*

(ii) What is the efficiency of a dryer motor that delivers 1 hp when the input current and voltage are 4 A and 220 V, respectively? *(3 marks)*

(b) What is the total cost of using the following when a power company charges E0.34 per kilowatt-hour: a 110-W stereo set for 4 h, a 860-W air conditioner for 24 h, a 1800-W cloth dryer for 30 min, a 400-W washing machine for 1 h and a 1200-W dishwasher for 45 min? *(5 marks)*

(c) Find V_{ab} with polarity for the circuit of Fig 1.1. Each box can contain a load or a power supply, or a combination of both. *(4 marks)*

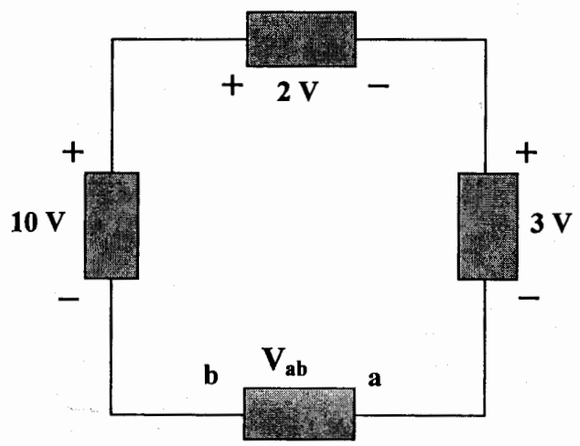

Fig. 1.1

(d) (i) Find the internal resistance of a battery that has a no load output of 60 V and supplies a current of 2 A to a load of 28 Ω. *(4 marks)*

(ii) Determine the voltage regulation for the battery of problem (ii) above. *(4 marks)*

QUESTION TWO – DC CIRCUITS *(25 marks)*

(a) For the network in Fig 2.1

(i) Write the equations to solve for the branch currents. *(7 marks)*

(ii) By substitution of Kirchhoff's current law, reduce the set of equations in (i) to three equations. *(5 marks)*

(iii) Rewrite the equations in a format that could be solved using third-order determinants. *(2 marks)*

(iv) Solve for the branch current I_3 through the resistor R_3 *(4 marks)*

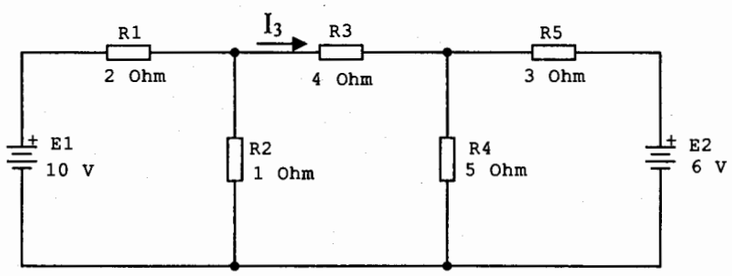

Fig. 2.1

(b) (i) Convert the voltage sources of Fig 2.2 to current sources. *(3 marks)*

(ii) Find the voltage V_{ab} and the polarity of the points *a* and *b*. *(3 marks)*

(iii) Find the magnitude and direction of the current I through resistor R_3. *(1 mark)*

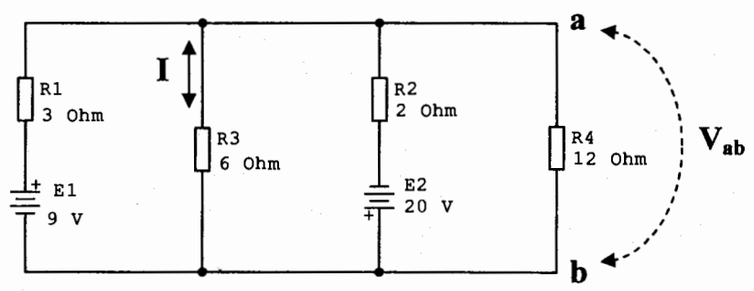

Fig. 2.2

QUESTION THREE - D.C. CIRCUITS ***(25 marks)***

(a) (i) In Fig 3.1, replace the Π-configuration that is composed of the 4 kΩ, 5 kΩ and 3 kΩ resistors with a T-configuration. *(7 marks)*

(ii) Solve for the source current, I_S. *(3 marks)*

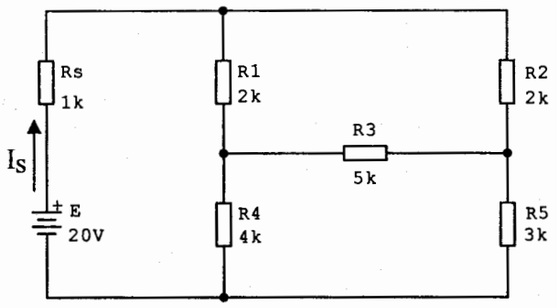

Fig. 3.1

(b) For the bridge network of Fig 3.2,

(i) Using the format approach, write the mesh equations. *(6 marks)*

(ii) Determine the current through R_3. *(6 marks)*

(iii) Find out if the bridge (R_1, R_2, R_3 and R_4) is balanced or not. *(3 marks)*

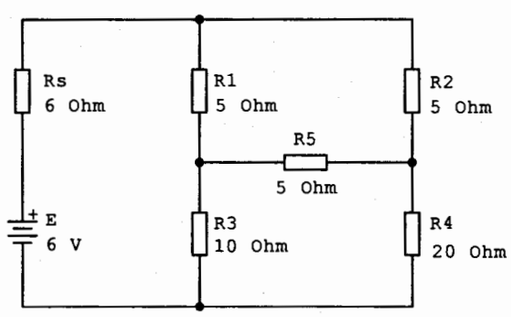

Fig. 3.2

QUESTION FOUR - TRANSIENTS *(25 marks)*

(a) Refer to the circuit shown in Fig 4.1.

(i) Write the mathematical expression for $i(t)$ and $v_c(t)$ when the switch is placed in position 1. *(2 marks)*

(ii) Write down the mathematical expression for $i(t)$ and $v_c(t)$ when the switch is then placed in position 2, after having been in position 1 for 1 s. *(5 marks)*

(iii) Sketch $i(t)$ in parts (i) and (ii) using a single time axis. In your sketch mark horizontal and vertical axis values at all points of interest. *(3 marks)*

(iv) Repeat (iii) for $v_c(t)$. *(3 marks)*

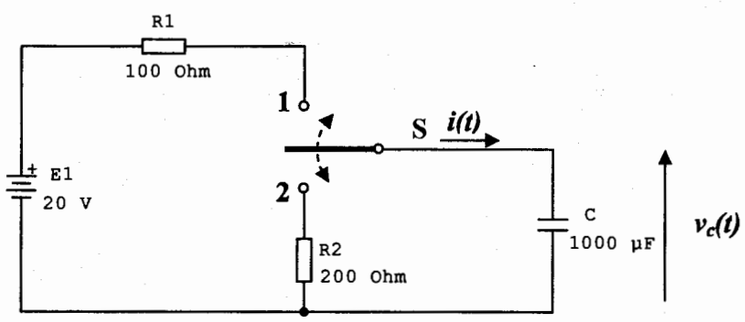

Fig 4.1

(b) Consider the circuit diagram shown in Fig 4.2. Switch S is closed at t = 0. Assume that all capacitors are initially uncharged.

(i) Find the initial current through the voltage source and the initial voltage across R_1, R_2 and R_3 in the circuit. *(6 marks)*

(ii) Find the steady-state current through the source and the steady-state voltages across R_1, R_2 and R_3. *(6 marks)*

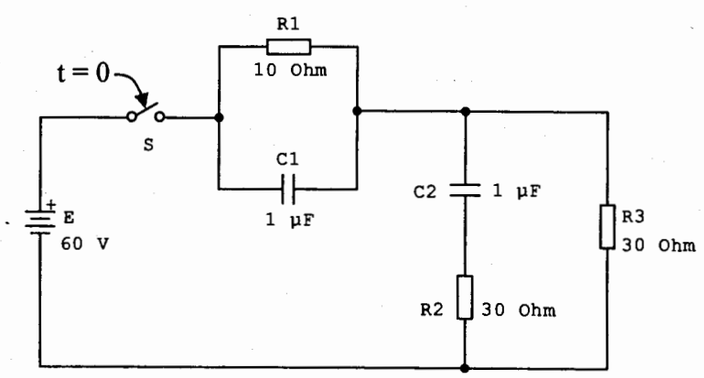

Fig. 4.2

SECTION B

QUESTION FIVE - AC CIRCUITS ***(25 marks)***

For the circuit of Fig 5.1, the source voltage is $e(t) = 20\sqrt{2}\sin(377t + 40^{\circ})$ volts.

Do the following:

(a) Determine **I**, $\mathbf{V_R}$ and $\mathbf{V_C}$ in phasor form. *(14 marks)*

(b) Calculate the total power factor and indicate whether it is leading or lagging. *(3 marks)*

(c) Calculate the average power delivered to the circuit. *(2 marks)*

(d) Sketch the impedance diagram. *(3 marks)*

(e) Sketch the phasor diagram of the voltages **E**, $\mathbf{V_R}$ and $\mathbf{V_C}$, and the current **I**. *(3 marks)*

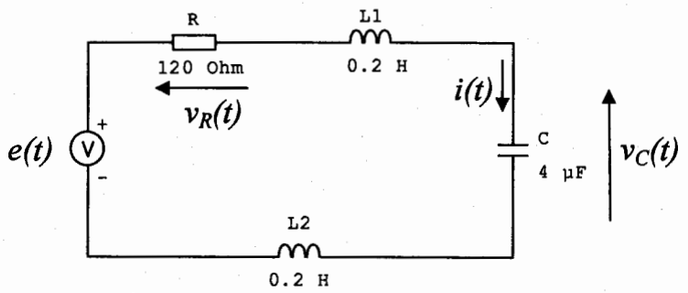

Fig. 5.1

QUESTION SIX - AC CIRCUITS ***(25 marks)***

(a) Using the general approach to mesh analysis, find the current I_1 in the network shown in Fig, 6.1. *(10 marks)*

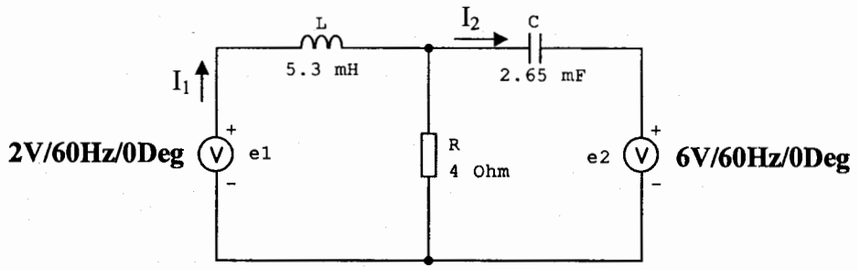

Fig. 6.1

(b) Determine the nodal voltages for the circuit shown in Fig. 6.2 *(15 marks)*

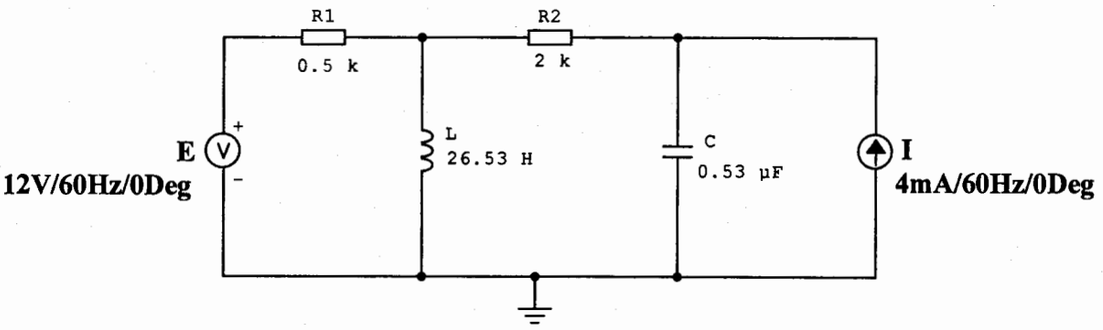

Fig. 6.2

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