Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2017					

ENG174 – Electrical Engineering	DURATION	
	Reading Time:	10 minutes
	Writing Time:	120 minutes

INSTRUCTIONS TO CANDIDATES

1.1 The exam consists of Five (5) questions.
1.2 Note that questions ARE NOT of equal value.
1.3 Read ALL questions carefully.
1.4 Show all diagrams, units and workings necessary to justify your answers. Insufficient working will result in a loss of marks.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

One A4 sheet of handwritten double-sided notes permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book 2 x Scrap Paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1 (9 Marks)

A series-connected circuit has a 120V rms AC voltage source, a 15Ω resistance, a 10Ω resistor and a resistor, R_x with unknown resistance. The voltage across the 10Ω resistor is 30V rms.

a) Draw a diagram of the circuit, clearly labelling all components. **(1 Mark)**

b) Determine the current flowing through each component **(2 Marks)**

c) Calculate the required value for Rx. **(3 Marks)**

d) If a second 10Ω resistor is connected in parallel with the original 10Ω resistor. How much power would the voltage source now supply? **(3 Marks)**

All values used in any calculations must be clearly included on your diagram.

Question 2 (10 Marks)

The circuit for a low voltage lighting system is shown in Figure 1 below. The bulbs (B1, B2 and B3) have a resistance of 22.5Ω each and are each rated for an average power of 10W. Assume the transformer is ideal.

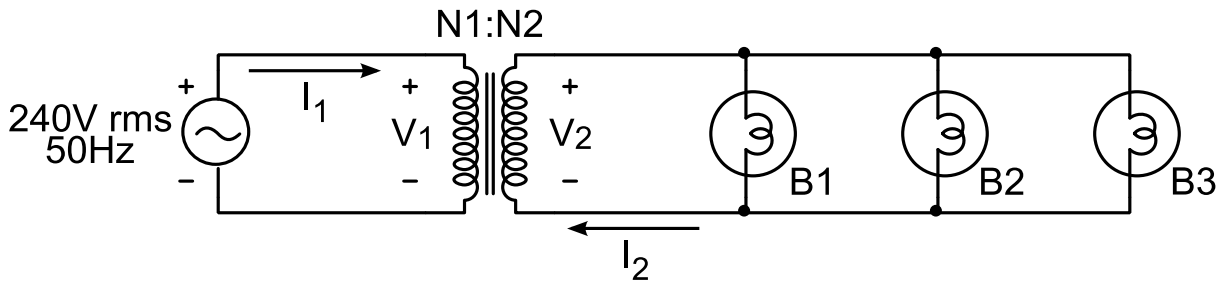

Figure 1.

a) If the bulbs are operated at their rated power, what should the RMS secondary voltage V_2 be? **(1 Mark)**

b) What type of transformer will be required and why? **(1 Mark)**

c) If the transformer has 400 turns on the primary winding (N1), how many turns are required on the secondary winding (N2)? **(1 mark)**

d) What is the value of the RMS current that will flow in the secondary winding (I_2)? **(2 marks)**

e) What is the peak value of the primary current (I_1)? **(2 Marks)**

f) Sketch the input voltage (V_1) and the voltage across the bulbs (V_2) on the same graph. Include all important values. Assume the shape of V_1 is a sine wave. **(3 Marks)**

Question 3 (8 Marks)

A simplified circuit for a camera flash is shown below in Figure 2. It consists of a high voltage DC power supply which produces 350V. This charges a capacitor when switch S1 is closed via a 100Ω resistor. When the capacitor is fully charged switch S1 is opened. Closing switch S2 then connects the flash bulb to the capacitor quickly discharging it and producing a flash.

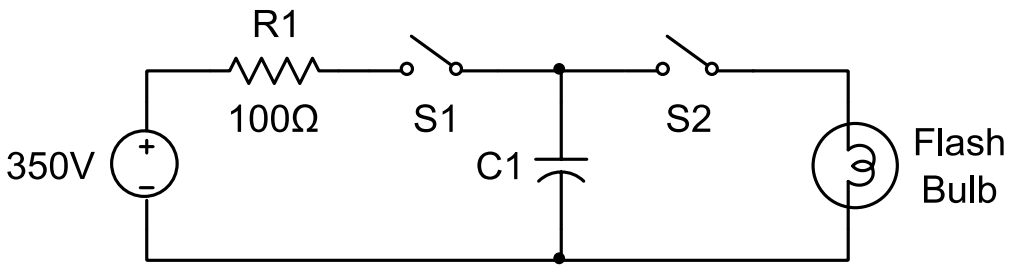

Figure 2.

a) If the flash bulb requires 150J of energy to generate one flash what is the minimum required capacitance of C1? **(1 Mark)**

b) After calculating a value for C1, you can't find one with the exact value and instead choose to use a 3300µF capacitor in your circuit. Approximately how long will it take for the capacitor to fully charge if it is initially fully discharged (V_{C1} = 0V)? **(2 Marks)**

c) Sketch the capacitor voltage verses time for the period between when switch S1 is closed until C1 is fully charged. Assume that there is no energy stored in C1 before switch S1 is closed. Show all relevant information on this sketch. **(3 Marks)**

d) What current will flow through resistor R1 at the instant when switch S1 is closed? Again, assume that there is no energy stored in C1 before switch S1 is closed. **(2 Marks)**

Question 4 (13Marks)

The circuit shown below in Figure 3 is used to control the current supplied to the motor such that the motor draws currents 0.5A, 0.3A, and 0.1A when the switch is at the high, medium and low positions respectively.

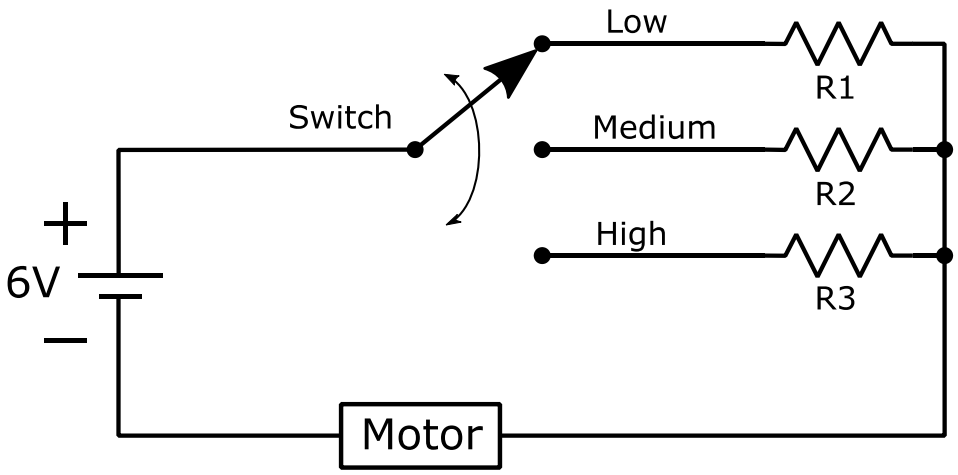

Figure 3

The internal resistance of the motor is determined to be 500mΩ and the motor constant k is 0.25 volt radians per second (or newton meters per amp).

a) Calculate the torque generated by the motor for each of the three settings. (3 Marks)

b) For the case when the switch is placed in the high position and the value of resistor R3 is given to be 1.5Ω, what speed, in radians per second, would you expect at the output of the motor? (3 Marks)

c) When the switch is in the medium position, the back-EMF generated by the motor is calculated to be 4 V, what must the value of resistor R2 be in ohms? (3 Marks)

d) What is the total power absorbed or produced by all components in the circuit when the switch is in the medium position? (4 Marks)

Question 5 (10 Marks)

a) Three AC voltages of the same frequency, V1 = 5cos(ωt + 85°), V2 = -3cos(ωt - 85°) and V3 = 4sin(ωt) are added together. Write the sum in the form $V_m\cos(\omega t + \theta)$ **(2 Marks)**

b) For the circuit shown below in Figure 4, calculate the complex impedance in polar form, between nodes a and b for ω = 200 radians per second, and again for ω = 2000 radians per second. **(4 Marks)**

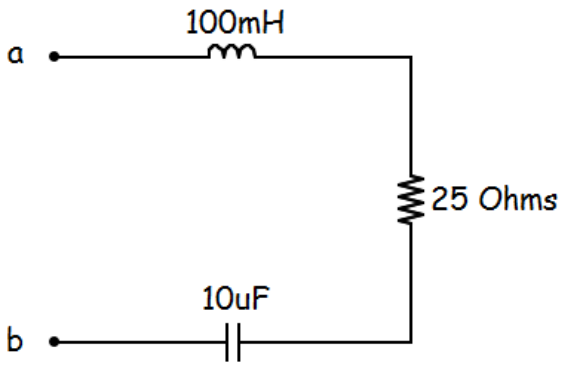

Figure 4.

c) A voltage source with output v(t) = 10cos(ωt + 30°), is connected to a load of impedance Z. The current flowing through the load, i(t), is measured and found to have a peak value of 10A and lags v(t) by 40°.

i) Draw a phasor diagram showing both v(t) and i(t) **(1 Marks)**

ii) Write an expression for i(t) in the form $I_m\cos(\omega t + \theta)$ **(1 Mark)**

iii) Calculate the impedance of the load, Z. **(2 Marks)**