UNIVERSITY OF GHANA
SECOND SEMESTER EXAMINATION 2013/2014
LEVEL 100: BACHELOR OF SCIENCE IN ENGINEERING
FAEN 106: APLLIED ELECTRICITY (3 Credits)

TIME: THREE (3) HOURS

INSTRUCTIONS

Answer Section A and Section B in separate answer booklets.

For Section A of the paper, answer all questions in section A1 and any other two (2) questions of your choice under that section. For section B of the paper, answer all questions.

SECTION A (50 Marks)

Answer all questions in A1 and any two (2) questions from this Section.

A1. **(a)** With the support of properly labelled waveform diagrams, briefly explain what DC and AC sources are and give two (2) unique properties that make AC sources different from DC sources. [4 marks]

(b) List five (5) state-owned electric utilities in Ghana and for each utility, briefly state its function in the delivery of electricity to users. [5 marks]

(c) Give four (4) reasons why electric utilities world-wide prefer to transmit electric power at high voltages rather than low voltages. [2 marks]

(d) A person was subjected to electric shock when he touched a bell switch. If a current of 30mA passed through the person for 60ms, find the number of electrons that passed through the person. [4 marks]

(e) Assume you have the following electrical devices supplied by the 240V source in your room: four (4) light bulbs each drawing a current of 0.25A, refrigerator rated at 200W, electric iron that draws current of 6.25A, TV set rated at 150W, and water heater that draws 10A. If the light bulbs, TV set, and refrigerator are each run for 12 hours in a day while the other devices are each used for 10 minutes in a day, calculate how much you will pay your Hall of residence for the period February 1, 2014 to June 6, 2014. Assume the fixed cost is GHc 12.00 and the charge for the first block of 100kWh of units of energy consumed is GHc 0.15/kWh and the charge in excess of 100kWh units is GHc 0.06/kWh. [5 marks]

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A2. **(a)** A lighting system was designed for the national theatre using different ratings (colours) of light bulbs and connections. The design has a 20V source which is connected in series to a 6Ω light bulb, which in turn is connected to a parallel combination of a 5Ω bulb and a 3Ω bulb. The 5Ω bulb is also connected to another parallel combination of a 12Ω bulb and a 4Ω bulb. The 4Ω bulb is also connected in series to an 8Ω load. Perform the following task:

(i) sketch the circuit diagram. [1 mark]

(ii) find the current that is delivered by the source. [4 marks]

(iii) compute the power that is dissipated by the 5Ω bulb. [4 marks]

(iv) determine the power delivered by the voltage source. [2 marks]

(b) List four (4) sources that are used for electricity generation in Ghana and briefly explain how each source is used to generate electricity. [4 marks]

A3. A 50Hz three-phase transmission line from the ECG station supplies an 11kV distribution transformer at the Faculty of Engineering Sciences building. The transformer has star-star winding configuration and 1200 turns at the primary and 28 turns at the secondary side. Assume the power factor is unity. If the transformer supplies a total load of 20Ω, determine the following:

(a) secondary voltage of the transformer. [2 marks]

(b) primary current and secondary current. [4 marks]

(c) sending voltage at the ECG station if the transmission line has a resistance of 0.03Ω/km and an inductance of 0.12mH/km. Assume the transformer is located 5km away from the ECG station. [6 marks]

(d) efficiency of the transmission lines. [3 marks]

A4. **(a)** With the support of a diagram, briefly describe the function of the various components at the Akosombo generating plant in relation to how hydro-electric power is produced by the VRA. [6 marks]

(b) Assume the VRA generating plant at Akosombo has a head of 80m and an average water flow of 50m³/s. If the plant has a water reservoir that covers an area of 400sqkm and the efficiency of the penstock, turbine and the generator are 100%, 88%, and 82% respectively, find the following:

(i) total power produced from the Akosombo plant. [4 marks]

(ii) number of days it will take VRA to sustain the level of power produced if the water is allowed to drop by 10cm. [3 marks]

(iii) power rating of each generator unit (kW) if the VRA has six (6) generating units at the power plant. [2 marks]

SECTION B (50 Marks)

Instruction: Attempt ALL QUESTIONS in this section in an answer booklet different from the one used for section A.

B1. **[10 MARKS]** In the following multiple choice questions, write the letter(s) corresponding to the correct answer(s) in the answer booklet provided

a) When using a standard multimeter to measure AC voltage, what type of measurement will the multimeter indicate?

    A.   peak-to-peak

    B.   peak

    C.   average

    D.   rms

b) How should a fuse be installed in a circuit to insure proper operation?

    A.   parallel to the load

    B.   series with the load

    C.   in any way possible

    D.   at the ground point

c) Which type of current Power Companies supply to our homes and why?

    A.   DC because our home appliances use DC, not AC

    B.   DC because DC is more stable than AC

    C.   AC because DC is more dangerous than AC

    D.   AC because AC is easier to transport than DC

d) What is the "power factor"?

    A.   ratio of true power to apparent power

    B.   peak power times 0.707

    C.   sin of the phase difference between voltage V and current I

    D.   cos of the phase angle between true power and apparent power

e) What can cause drives to trip offline?

    A.   the use of single-phase current for three-phase motors

    B.   the use of three-phase current for single-phase motors

    C.   harmonics

    D.   none of the above

f) Which of the followings do **not** cause harmonics in ac current?

    A.   DC motors

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B. AC motors

C. inductor motors

D. none of the above

g) Which of the followings is **not** true?

A. three-phase motors are available in larger horsepower sizes than single-phase motors

B. three-phase motors are less expensive than single-phase motors of the same horsepower rating

C. three-phase motors lighter and smaller than single-phase motors of the same horsepower rating

D. none of the above

h) Which of the followings is true?

A. an inductance is mounted in series with a tweeter

B. an inductance is mounted in series with a woofer

C. a capacitance is mounted in series with a woofer

D. a capacitance is mounted in parallel with a woofer

i) At very high frequencies a capacitor acts like

A. an open circuit.

B. a short circuit.

C. a resistance.

D. none of the above.

j) An inductor can store energy from a circuit

A. in the form of heat.

B. in the form of a magnetic field.

C. in the form of resistance.

D. in the form of capacitance.

B2. [30 MARKS] Consider the RLC circuit in *Figure B-1* below where

$$\bar{V}_s = 110\angle 0V \, ; R = 10\Omega \, ; \quad L = 0.05H \, ; \quad C = 470\mu F \, .$$

a) Compute the average power dissipated by the load and deduce the power factor.

b) Assuming that the capacitance C is now a variable, what is the value of C that would increase the power factor to 1.

c) Calculate the real power and the reactive power for the load using the originally given data.

d) What are the real power and the reactive power for the load if the capacitor C is removed from the circuit?

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e) Compare and discuss the power transfer between source and load in both cases above (**c** and **d**).
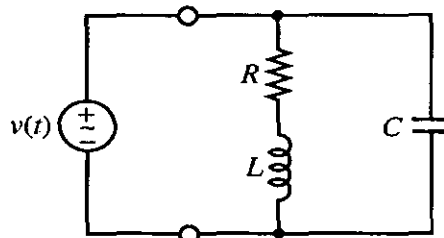

Figure B-1

B3. [10 MARKS] Consider the circuit in *Figure B-2* . Determine:

a) the source voltage V;
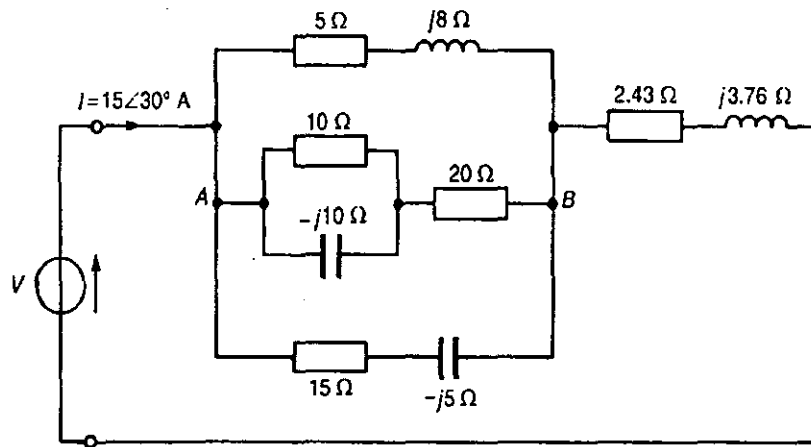
b) the difference of potential between A and B.

Figure B-2

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