UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING

SECOND SEMESTER EXAMINATIONS, 2010/2011

FAEN 106 APPLIED ELECTRICITY (3 Credits)

INSTRUCTIONS: ANSWER ALL QUESTIONS

TIME ALLOWED: THREE (3) HOURS

SECTION A [40 MARKS]

Q1. a) A simple circuit consists of a 5-kΩ resistor in series with a parallel combination of four (4) resistors each rated 20 kΩ. The whole combination is connected across a battery of 100 V.

i. Draw the circuit diagram for the connection. [1 mark]

ii. Calculate the current through the circuit. [2 marks]

iii. Calculate the voltage drop across each resistor in the circuit. [3 marks]

iv. Calculate the current through each of the resistors connected in parallel. [4 marks]

b) i. List three types of transformers you know. [3 marks]

ii. Explain why a transformer can generally operate safely at a frequency higher than its rated frequency and not below it. [4 marks]

c) i. List the six (6) parts of a simple motor. [6 marks]

ii. List four (4) domestic appliances that utilize a motor. [4 marks]

iii. State the two (2) parts that ensure that in a simple motor the clockwise movement is not interrupted after half a revolution. [2 marks]

d) An electric heater draws a steady 15.0 A on a 120-V line. How much power does it require and how much does it cost per month (30 days) if it operates 3.0 h per day and the electric company charges 10.5 GHp per KWh? [3 marks]

e) An alternating current i is represented by:

$$i = 10 \sin 942t \text{ amperes.}$$

EXAMINER: P. OKAE

Determine:

i. the frequency. [1 mark]

ii. the period. [1 mark]

iii. the time taken from t = 0 for the current to reach a value of 6 A for a first and second time. [4 marks]

iv. the energy dissipated when the current flows through a 20-Ω resistor for 30 minutes. [2 marks]

SECTION B [60 MARKS]

EACH QUESTION IN THIS SECTION CARRIES 20 MARKS

Q2 a) Draw a simple cross-sectional diagram of a transformer and label the parts. [5 marks]

b) i. What does the *turns ratio of a transformer* mean? [2 marks]

ii. Explain to a layman what we mean when we say that the *turns ratio of a transformer is 1:3*. [2 marks]

iii. A transformer has an efficiency of about 98-99%, yet it experiences 2 main kinds of losses. State these losses. [2 marks]

c) A transformer in a portable radio reduces 120-V ac to 9.0-V ac. (Such a device also contains diodes to change the 9.0-V ac to dc). The secondary contains 30 turns and the radio draws 400 mA. Calculate:

i. the number of turns in the primary; [3 marks]

ii. the current in the primary; [3 marks]

iii. the power transformed. [3 marks]

Q3 a) i. A single-phase motor takes 50 A at a power factor of 0.6 lagging from a 250-V, 50-Hz supply. What value of capacitance must a shunting capacitor have to raise the overall power factor to 0.9 lagging? [5 marks]

ii. How does the installation of the capacitor affect the line and motor currents? [1 mark]

b) Three series sinusoidal (sinewave) voltage sources at time t, are represented by

$v_1 = 100\sqrt{2} \sin 314t$ volts

$v_2 = 10\sqrt{2} \sin (314t + \pi/3)$ volts and

$v_3 = 1000\sqrt{2} \sin (314t + \pi/6)$ volts

respectively. The three voltage sources feed a 50- Ω impedance load.

Calculate:

i. The resultant r.m.s. of the voltages in rectangular form; [3 marks]

ii. The resultant r.m.s. of the voltages in polar form; [2 marks]

iii. The circuit r.m.s. current in polar form; [2 marks]

iv. The apparent power supplied by the sources in polar form; [2 marks]

v. The apparent power supplied by the sources in rectangular form; [2 marks]

vi. The active power absorbed and the power factor of the source. [3 marks]

Q4.a) A motor has a *field magnet* (*permanent magnet*) as well as a *rotor* (*electromagnet*). Explain how the *rotational motion* of the motor happens as a result of the presence of these two vital parts. [4 marks]

b) What is the reason why ECG transmits electricity at very high voltages such as 11 kV and finally stepped down by a transformer at the receiving end to 240 V for domestic use? [3 marks]

c) Explain why a multi-way adaptor rated *1000 W* should not be loaded with electrical devices whose total power output is *1200 W*. [3 marks]

d) Identify and explain the main reason why AC power transmission is more widespread than HVDC (High Voltage Direct Current) transmission globally. [3 marks]

e) State four (4) *safety precautions* that one needs to take with regards to electricity.

[4 marks]

f) The nameplate of an ECG transformer reads 600 MVA, 11 kV/240 V, 50 Hz. Explain this to a layman. [3 marks]