EXAMINATION: AUTHORISATION A

Paper I (Theory) Time Allowed - 3Hrs

February 2019

ERRATA CORRIGE

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Page 2 – Answer any **FIVE** questions

Page 3 – Last line of question 3 (c) should read as follows:

The mass of $\mathbf{1m^3}$ of water $=10^3$ kg

WRITE ALL YOUR WORK IN THE ANSWER BOOK PROVIDED. EVERY ANSWER SHOULD INCLUDE ALL WORKINGS, NECESSARY DIAGRAMS AND FORMULAE.

START EACH ANSWER ON A FRESH PAGE.

1. The following three impedances are connected in series across a 40 Volts, 20kHz supply:

   i. a resistance of 8Ω,
   ii. a coil of inductance 130 μH and 5Ω resistance
   iii. a 10Ω resistance in series with 0.25μF capacitor.

   Draw a circuit diagram showing the configuration. **(3 marks)**

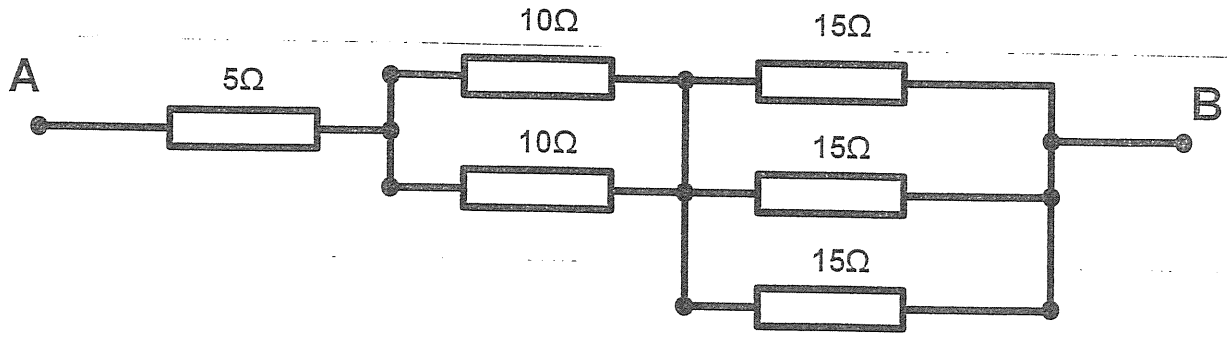
   Calculate:

   i. The current flowing in the circuit. **(4 marks)**
   ii. The circuit phase angle **(4 marks)**
   iii. The voltage drop across each impedance **(9 marks)**

2. (a) State Ohm's law as applied to a direct current (D.C.) circuit. **(3 marks)**

   (b) Resistors of 20Ω, 20Ω and 30Ω are connected in parallel. What resistance must be added in series with the combination to obtain a total resistance 10Ω? If the complete circuit expends a power of 0.36kW, find the total current flowing. Draw a circuit diagram showing the configuration of the resistance. **(10 marks)**

   (c) For the circuit shown below, find the equivalent resistance between the terminals A and B.



(7 marks)

3. (a) Define Power and give a formula to illustrate your answer. **(3 marks)**

(b) The force required to raise a certain load through a distance of 15 metres is 60 N. If the operation takes 66 seconds, calculate the power required to raise the load. **(6 marks)**

(c) Calculate the power required to raise 0.35 m^3 of water per minute through a vertical distance of 40 metres. **(11 marks)**

The mass of 1kg of water = 10^3 kg
Force due to gravity = 9.81

4. A 10m x 6m room is illuminated by lamps having an efficacy of 12.5 lumens/watt. The supply to the circuit is 240V single phase, 50Hz. The required average luminance is 500 lux with a utilization factor of 0.5 and a maintenance factor of 0.8.

Calculate:

a. i. The power in watts required at each luminaire **(4 marks)**
ii. The total power **(4 marks)**
iii. The total current. **(4 marks)**

b. i. The current rating of the fuse for each final sub-circuit if the installation is to be divided in three circuits **(3 marks)**
ii. The minimum conductor size of p.v.c insulated cable that could be used **(3 marks)**
iii. The current rating of the switches in the three-gang box **(2 marks)**

5. (a) What happens when two positively charged materials are placed together? **(3 marks)**

(b) Define the term Capacitance and Inductance? What is Mutual Inductance? **(6 marks)**

(c) A circuit with 3 resistors connected in parallel has one of the resistors which is open-circuited. Which of the following statements is correct? **(3 marks)**

i. The circuit resistance increases
ii. The circuit current increases
iii. The voltage across each of the two remaining resistors increases
iv. The amount of power consumed in the circuit remains the same.

(d) In the circuit indicate above, the voltage across the resistors is 230V whilst two of the three resistors each has a value of 10 Ω. If the current flow is 53.61A, what is the value of the third resistor? **(8 marks)**

6. (a) Define the following photometric quantities:

i. Luminous Flux F [*lm*] **(2 marks)**

ii. Illuminance E [*lx or lm/m*^{2}] **(2 marks)**

iii. Luminance L [*cd/m*^{2}] **(2 marks)**

iv. Utilisation Factor **(2 marks)**

v. Maintenance Factor **(2 marks)**

(b) The wavelength of yellow-green light passing through air is 555 nm.

The speed of light passing through vacuum is $c_o = 2.998 \times 10^8$ m/s. When passing through a medium this becomes c_o / n where n is the refractive index of the medium. In this case what is the frequency if air, n = 1.0003? **(3 marks)**

Note: 1nm = 1 nanometer or 1 x 10^{-9} metres

(c) If a certain glass has a refractive index of 1.75:

i. What is the velocity of light passing through this material? **(2 marks)**

ii. What is the wavelength of the light considered above? **(2 marks)**

(d) If a flux of 200 lm is incident on a plane area of 0.1 m^2, what is the average illuminance on this floor? **(3 marks)**

END OF PAPER