



FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
DEPARTMENT OF MECHATRONICS ENGINEERING
2017/2018 RAIN SEMESTER EXAMINATIONS

MCE 310: ELECTRICAL CIRCUIT THEORY

5th September 2018

Instruction: Answer any four questions (two questions from each section)

Time allowed: 2½ hours

SECTION A

Question 1

a) Refer to the periodic square-wave voltage shown in Fig. A1a. Find the Fourier series representation for the voltage function v expressed in the alternative trigonometric and exponential forms. [7½ marks]

b) A square-wave current given by the following truncated Fourier series

$$i_g = \frac{1}{n} \sum_{n=1,3,5}^7 \cos(n\omega_0 t - \frac{\pi}{2})$$

is applied to the circuit shown in Fig. A1b. Determine i_o and estimate the average power delivered to the 25-Ω resistor by the ideal current source. Take $T = 5\text{ms}$. [10 marks]

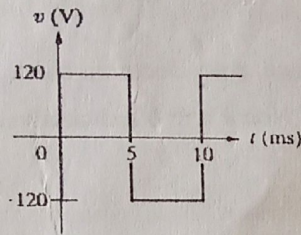


Fig. A1a

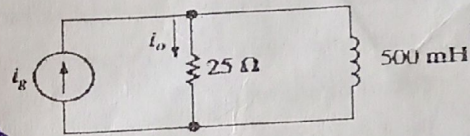


Fig. A1b

Handwritten notes: $56.386 + 17.676 = 74.062$

Handwritten notes: $V_{rms} = \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt}$

Question 2

a) The voltage and current at the terminals of a network are

$$v(t) = 30 + 60\cos 2000t + 20\sin 8000t \text{ V,}$$

$$i(t) = 3 + 4\cos(2000t - 25^\circ) + \sin(8000t + 45^\circ) \text{ A.}$$

The current is in the direction of the voltage drop across the terminals. Determine

- i. the average power at the terminals [2½ marks]
- ii. the rms value of the voltage [2½ marks]
- iii. the rms value of the current [2½ marks]

b) Using the methods of Laplace transform and Fourier transform, find $v_o(t)$ in the circuit shown in Fig. A2 given that $v_g = 50 u(t) \text{ V}$. Sketch and interpret the results. [10 marks]

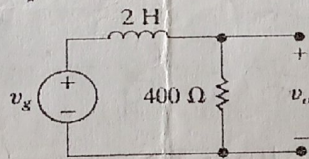


Fig. A2

Handwritten sketch of a waveform, possibly representing the output voltage v_o(t).

Question 3

a) State and explain Parseval's theorem [4½ marks]

b) Suppose the input voltage to the low-pass RC filter circuit shown in Fig. A3 is $v_i = 2e^{-5t}u(t) \text{ V}$.

- i. What percentage of the 1-Ω energy available in the input signal is available in the output signal? [8 marks]
- ii. What percentage of the output energy is associated with the frequency range $0 \leq \omega \leq 10 \text{ rad/s}$? [5 marks]

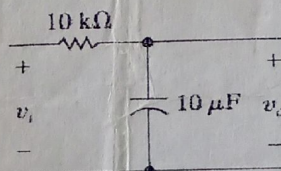
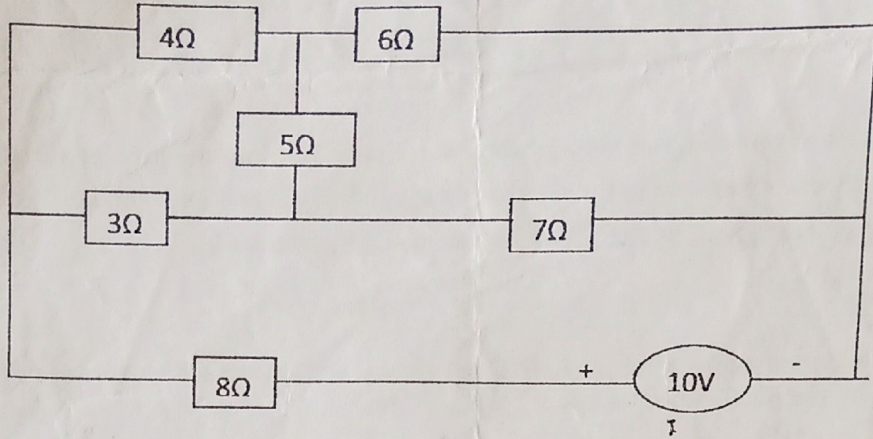


Fig. A3

Section B

1a) With the aid of appropriate equations state and derive the Kirchhoff's Laws.

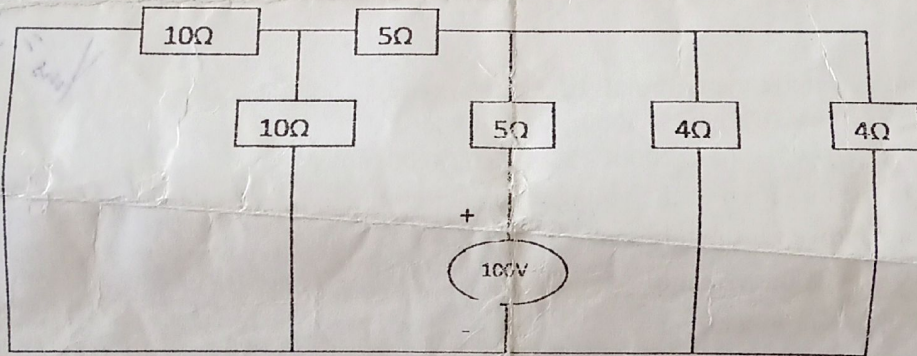
b) Calculate the current in the 50hm resistor in the Circuit Shown below.



12
12
34
 $\frac{V}{R} = I$
 $V = IR$
 $10 = 5 \times I$

2. a) Describe the implications of infinite resistance in an electrical conductor as well as that of an open circuit. b) Discuss the concept of Nodal and Mesh analysis with appropriate circuit diagrams.

3. Find the total resistance of the network shown below. Also, compute the current supplied by the 100V source.



$\frac{100}{10} = 5A$ $\frac{2 \times 5}{10} = \frac{10}{10} = 1A$

$50 + 2.5 + 4 + A$

$\frac{1}{10} + \frac{1}{2.5} + \frac{1}{4} + \frac{1}{4} = \frac{1}{10 + 2.5 + 4 + 4}$

$\frac{V}{R} = I$ $R = \frac{100}{14} = 7.14$

$R = 0.64$