MACHAKOS UNIVERSITY

University Examinations 2020/2021 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH 208: ELECTRICAL CIRCUITS

DATE: 26/8/2022 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Constants

None

SECTION A

QUESTION ONE (COMPULSORY) (30 MARKS)

a) State the following Kirchhoff's laws

i. The current law (2 marks)

ii. The voltage law (2 marks)

b) The antenna circuit of a radio receiver has resistance, inductance and capacitance given as $R = 5\ \Omega,\ \mathrm{L} = 5\ \mathrm{mH}$ and $C = 5\ \mathrm{pF},$ respectively. If it is tuned to a particular station,

i. Calculate the frequency of the station. (4 marks)

ii. If the potential difference applied to the circuit is 5×10^{-4} V, calculate the current that flows. (3 marks)

iii. If the inductance is fixed and the capacitance is varied, what should be the value of the capacitance that will tune a frequency of 800 kHz radio signal? (4 marks)

c) The circuit in Figure 1 shows three cells connected in three loops. The internal resistance of the cells is negligible. Calculate the currents I_1 , I_2 and I_3. (6 marks)

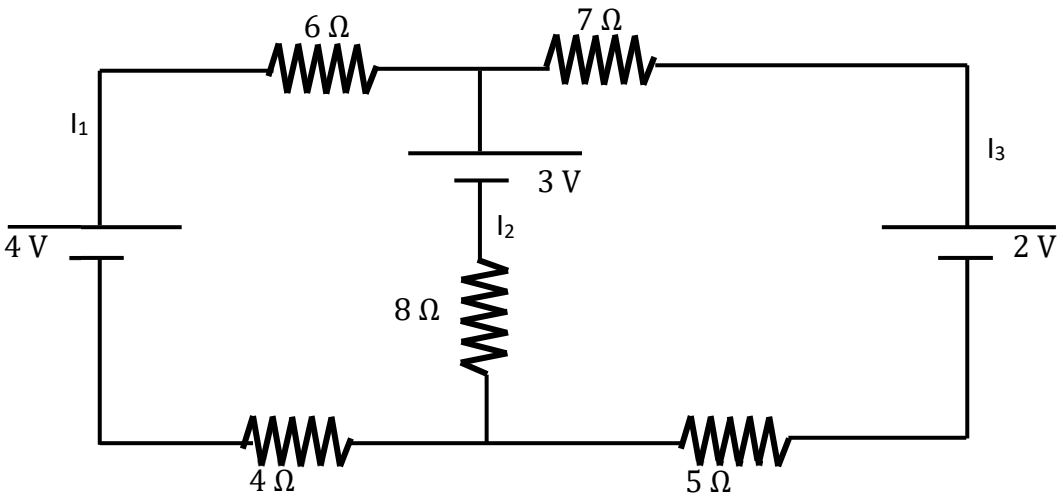

Figure 1

d) If a variable frequency e.m.f is applied to a series RLC circuit consisting of $R = 5\ \Omega$, $\mathrm{L} = 20\ \mathrm{mH}$ and $C = 0.05\ \mu\mathrm{F}$ determine the values of ω for which the current

i. Will lead the applied e.m.f by 30^0 (3 marks)

ii. Be in phase (3 marks)

iii. Lag by 30^0 (3 marks)

SECTION B

QUESTION TWO (20 MARKS)

a) For the circuit shown in Figure 2 determine equivalent circuits based on the following theorems with respect to the terminals X and Y:

i. Thevenins (4 marks)

ii. Norton equivalent circuits (4 marks)

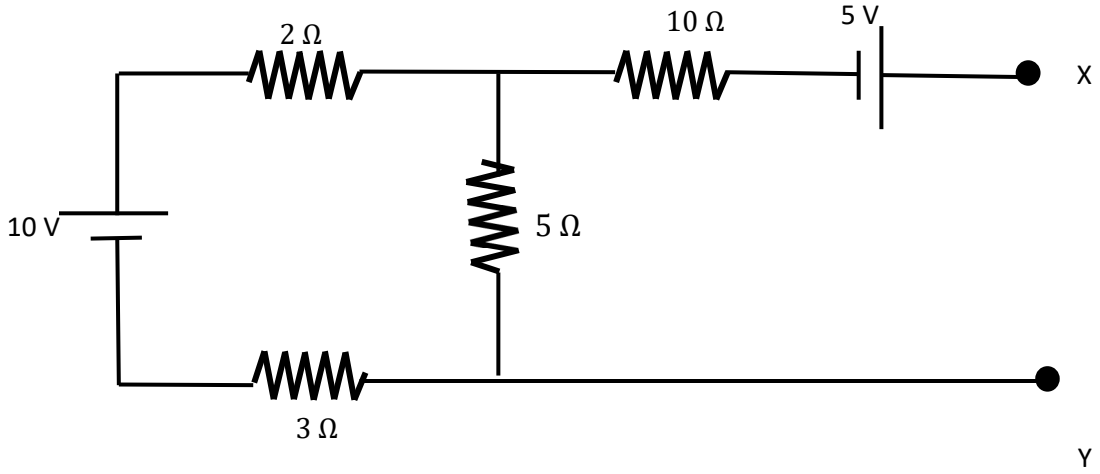

Figure 2

b) For the circuit shown in Figure 3, determine the Thevenin equivalent circuit with respect to terminals X, Y. (4 marks)

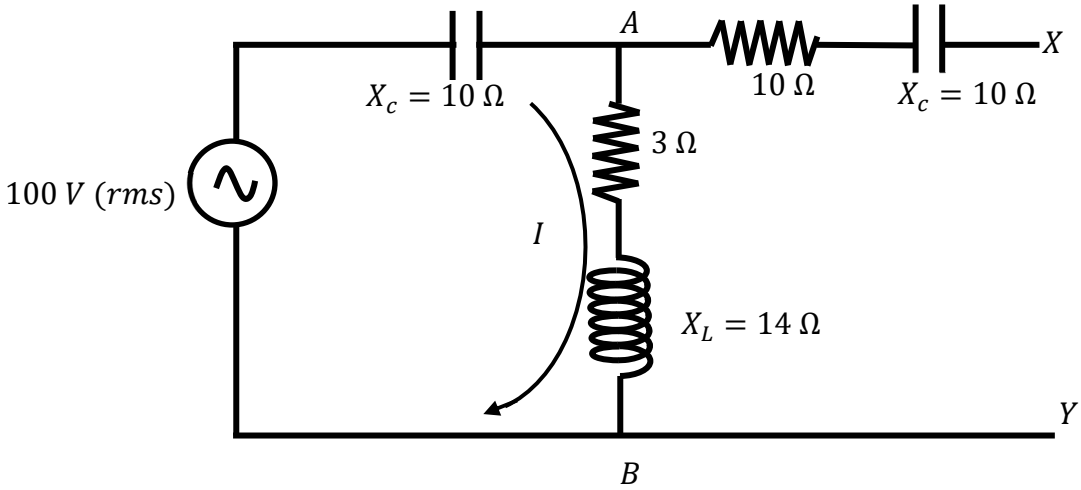

Figure 3

c) In question (b) above if a coil of reactance 12 Ω, resistance 5 Ω is connected across the terminals X,Y find the power dissipated in the coil. (4 marks)

d) For the RL circuit shown in Figure 4, determine the frequency of the ideal generator if the current flowing in the circuit is 5 mA (rms). (4 marks)

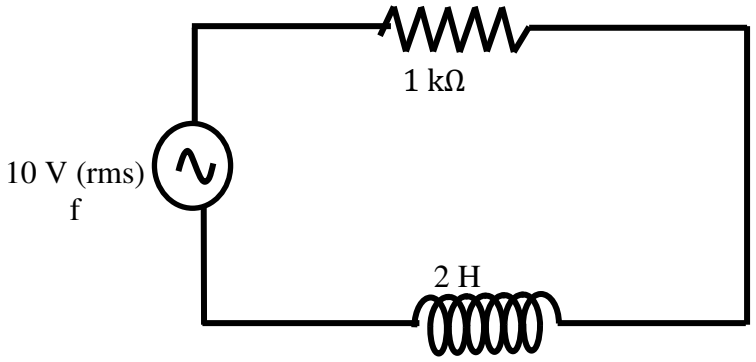

Figure 4

QUESTION THREE (20 MARKS)

a) A 250 V DC shunt motor, taking an armature current of 150 A and running f at 550 rpm is braked by reversing the connections to the armature and inserting additional resistance in series with it. Calculate

i. The value of series resistance required to limit the initial current to 240 A. (3 marks)

ii. The initial value of braking torque (3 marks)

iii. The value of braking torque when the speed has fallen to 200 rpm (3 marks)

iv. The armature resistance is 0.09 Ω. Neglect the winding friction and iron losses. (3 marks)

b) A DC series motor operating at 250 V DC mains and draws 25 A and runs at 1200 rpm. $R_a = 0.1\ \Omega$ and $R_{se} = 0.3\ \Omega$. A resistance of 25 Ω is placed in parallel with the armature of motor. Determine

i. The speed of motor with the shunted armature connection, if the magnetic circuit remains unsaturated and the load torque remains constant. (4 marks)

ii. no load speed of motor (4 marks)

QUESTION FOUR (20 MARKS)

a) Define the following terms in electrical circuits

i. Transient current (2 marks)

ii. Discharge current (2 marks)

b) A 200 V series motor runs at 1000 rpm and takes 20 A. Armature and field resistance is 40 W. Calculate the resistance to be inserted in series so as to reduce the speed to 800 rpm, assuming torque to vary as cube of the speed and unsaturated field. (4 marks)

c) A circuit of resistance 10 and inductance 0.1 H in series has a direct voltage of 200 V suddenly applied to it. Calculate

i. the voltage drop across the inductance at the instant of switching on and 0.01 s. (4 marks)

ii. the flux linkages at these instants (3 marks)

d) For the circuit shown in Figure 5 determine the value of the current I_k through the resistor R_k. The internal resistance of the battery may be neglected. (5 marks)

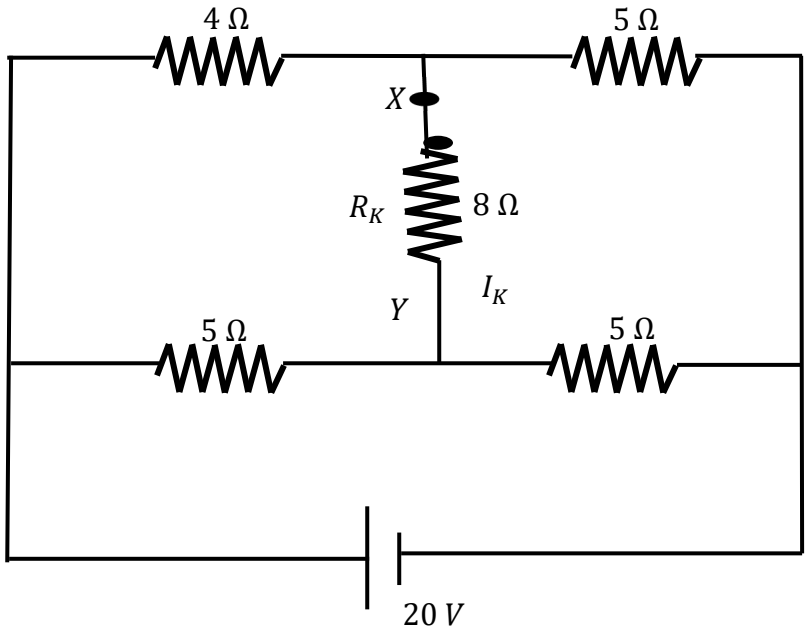

Figure 5

QUESTION FIVE (20 MARKS)

a) State the following theorems for electrical circuits

i. Thevenin's (2 marks)

ii. Norton's (2 marks)

b) A 32 V, 1000 Hz supply voltage is applied across a 100 Ω resistor, 400 mH inductor, and 20 μF capacitor connected in series. Calculate

i. The rms current in the circuit (3 marks)

ii. The peak voltage across each component (4 marks)

iii. The phase angle between E and I (3 marks)

c) The current in the series RLC circuit shown in the Figure 6 is given by $I = 5\,sin(1000t + 15^o)$ A and the applied emf is given by $E = 350\,(1000t + 60^o)$ V. Determine the values of R and C given that the value of the inductance is 1 H. (6 marks)

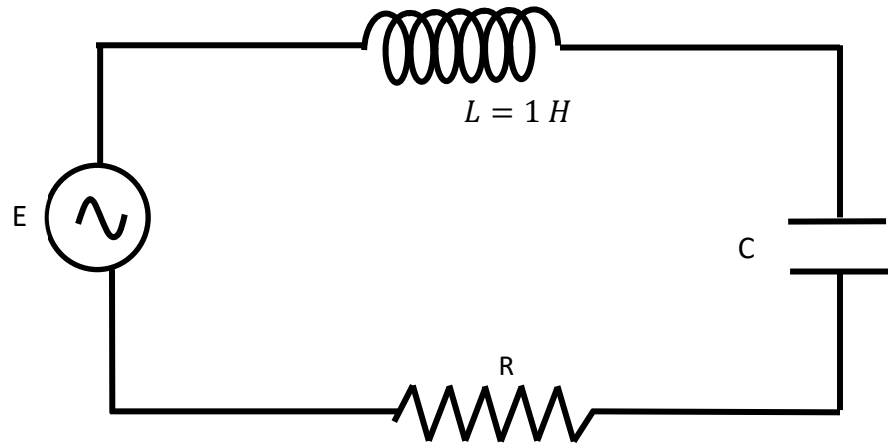

Figure 6