



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING UNIVERSITY EXAMINATION FOR: BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EEE 4221: ELECTRICAL ENGINEERING I (CIRCUITS AND NETWORKS)

SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: JULY 2025.

TIME: 2 HOURS.

DATE: JULY 2025.

Instructions to Candidates

The paper consists of five questions. Answer Question one and any other two.

Do not write on the question paper.

Question ONE.

(a)(i). Define electrical power rectification and explain the meaning of the following terms.

(I). Form Factor. (II). Rectifier efficiency.

(ii). With the aid of a diagram, explain the operation of a full wave controlled rectifier circuit connected to a resistive load through a step down transformer.

(iii). A full wave rectifier is supplied with an RMS voltage of 200V at 50Hz. If the load resistance is 20 K Ω and the firing angle is 45 degrees, determine the following.

(I). Average and RMS output voltage. (II). Rectifier Form Factor. **(10 Marks).**

(b)(i). Define a magnetic circuit, hence state any two of its applications.

(ii). State the meaning of the following terms as related to magnetism.

(I) Flux density. (II). Reluctance.

(iii). With the aid of a diagram, explain the construction and operation of a toroidal electromagnet. Explain how the magnetic polarities can be determined. **(9 Marks).**

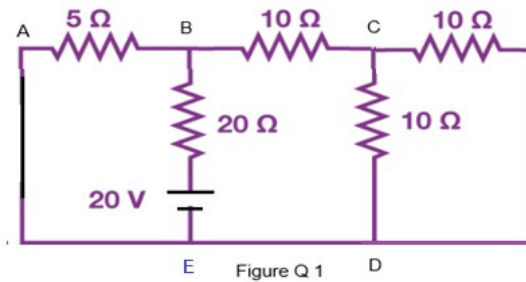
(c)(i). Define Kirchhoff's current law and explain the meaning of electromotive force.

(ii). Draw a two parallel resistance circuit connected to a DC voltage source and derive the total resistance expression for the resistors.

(iii). For the circuit of figure Q 1, determine the following.

(I). Total circuit resistance and supply current. (II). Calculate the current and voltage across the 5 Ω resistor.

(11 Marks).



Question TWO.

- (a)(i). Define Flemming right hand rule, hence draw a current carrying wire with its electric fields.
- (ii). With the aid of a diagram, Explain how to permanently magnetize a ferromagnetic material.
- (iii). State any two industrial applications of magnetic circuits.

(14 Marks).

- (b)(i). Explain the meaning of the following terms as used with magnetic circuits.

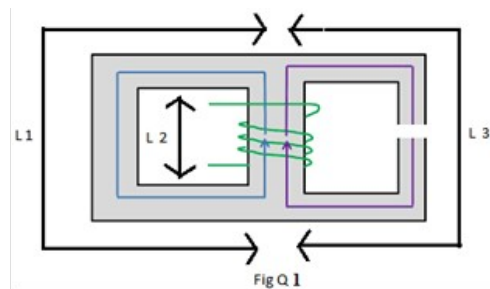
(I). Permeability. (II) Solenoid.

- (ii). Figure Q1 shows a magnetic circuit with the following data.

Length $L_1 = 25$ cm, $L_2 = 15$ cm, $L_3 = 20$ cm and the air gap is made of 2 mm. Length L_1 has a mean cross-sectional area of 500 mm^2 , $L_2 = 350 \text{ mm}^2$ and $L_3 = 200 \text{ mm}^2$. If the relative permeability of the material is 150 and the coil with 500 turns carries a current of 10 amperes, determine,

- (I). Total reluctance of the material. (II). Total magnetic flux in the material. (II). Air gap MMF.

(6 Marks).



Question THREE.

- (a). (i). Explain the need for AC power rectification, hence state any two merits of controlled rectification over uncontrolled type.

- (ii). State the meaning of the following terms as used with AC to DC converters.

(I). Delay Angle. (II). Ripple Voltage .

(7 Marks).

- (b). (i). Draw a full wave controlled rectifier circuit and explain its operation.

- (ii). Derive the RMS output voltage expression for the rectifier circuit.

(8 marks).

(c). A full wave controlled rectifier uses a centre tapped transformer with a transformation ratio of 20:1. The primary side of the transformer is connected to an RMS input voltage of 200 V and delivers power to the load resistance of 10 k Ω . If the firing angle for the thyristor is set at 30 degrees, determine the following.

- (i). Average and RMS output voltage. (ii). RMS output Current and power. **(5 Marks).**

Question FOUR.

(a) (i). Distinguish between active and reactive powers as far as ac circuits is concerned.

(ii). Explain the meaning of the following terms as relating to series AC circuits.

- (I). Reactance. (II). Q-Factor. **(8 Marks).**

(b)(i). With the aid of a diagram and appropriate components, explain the resonance curve of a series RLC circuit.

(ii). A series circuit is made of a 250 Ω resistor in series with an inductance of 0.637H. If the power supply is rated at 240V at 50 Hz, Determine,

- (I). Circuit impedance and current. (II). The potential difference across the inductance and reactive power.

(12 Marks).

Question FIVE.

(a)(i). Define capacitance of a capacitor and state any two applications of capacitors.

(ii). State the meaning of following capacitor parameters.

- (I). Electric Charge. (II). A Dielectric. **(6 Marks).**

(b)(i). Draw a basic circuit diagram made of two parallel connected capacitors connected to a power supply and derive the total capacitance expression.

(ii). Explain the effect of exchanging a dielectric material of a capacitor. **(9 Marks).**

(c). A combinational capacitor circuit charged by a single DC source is shown in in figure Q 5. Calculate the following,

- (I). Total circuit capacitance. (II). Charge through capacitor C1 and C4. (III). Voltage across C 4.

(5 Marks).

