INTERNATIONAL UNIVERSITY OF EAST AFRICA
'Learning to Succeed'

**FACULTY OF ENGINEERING**

**END OF SEMESTER EXAMINATIONS - APRIL 2025**

**PROGRAMME: BACHELOR OF ELECTRICAL AND CONTROL ENGINEERING**

**YEAR/SEM: YEAR 3/SEMESTER 2**

**COURSE CODE: ELE3222**

**NAME: POWER ELECTRONICS II**

**DATE: 2025-04-14**

**TIME: 2:00-5:00PM**

**INSTRUCTIONS TO CANDIDATES:**

1. Read the instructions very carefully
2. The time allowed for this examination is STRICTLY three hours
3. Read each question carefully before you attempt and allocate your time equally between all the Sections
4. Write clearly and legibly. Illegible handwriting cannot be marked
5. Number the questions you have attempted
6. Use of appropriate workplace examples to illustrate your answers will earn you bonus marks
7. Any examination malpractice detected will lead to automatic disqualification.

**DO NOT WRITE ANYTHING ON THE QUESTION PAPER**

## Section A Answer any two QUESTIONS FROM THIS SECTION

**Question 1:**

a) Explain the working principle of a MOSFET power transistor. Describe how it operates in both enhancement mode and depletion mode. (7marks)
b) A power MOSFET is used in a switching circuit with a drain-source voltage of **50V** and a drain cu **10A**. If the on-state resistance ($R_{DS}$ is **0.2Ω**, calculate the power dissipation when the MOSFET is turned on. (6marks)
c) Compare MOSFET power transistors with bipolar junction transistors (BJTs) in terms of switchin efficiency, and thermal performance. In what types of applications would MOSFETs be preferred BJTs? (7marks)

**Question 2:**

**a)** Describe the working principle of a cycloconverter and explain how it converts AC to A different frequency. (6mark
**b)** What are the main types of cycloconverters, and how do their operations differ in terms control and output characteristics? (7mark
c) List and explain key applications of cycloconverters, highlighting their benefits and limit industrial motor drives and power systems. (7mark

**Question 3:**

**a)** Explain the operation of a three-phase half-wave AC voltage controller and how it regula output voltage through phase control. (7mark
**b)** Derive the expression for the RMS output voltage of a three-phase half-wave AC voltage controller, given the input voltage and firing angle. (7mark
**c)** A three-phase half-wave AC voltage controller operates with a line voltage of 400 V and angle of 60°. Calculate the RMS output voltage. (6mark

**Question 4:**

a)

a) Explain the basic working principle of a chopper circuit. How does it control the output voltage in DC-D conversion? (7marks)
b) A step-down chopper operates with an input voltage of **200V** and a duty cycle of **0.4**. Calculate the averag output voltage. (6marks)
**c)** Classify chopper circuits based on their operation and quadrant of operation. Provide examples of applications for each type. (7marks)

## Section B Answer any Three QUESTIONS from this SECTION

**Question 1:**

a) List and explain at least three practical applications of voltage-controlled inverters. (7mark
b) Discuss the key factors that affect the efficiency and performance of a voltage-con inverter. (7mark
c) Explain how voltage-controlled inverters contribute to power quality improvement electrical systems. (6mark

**Question 2:**

a) Identify and explain the different types of voltage-controlled inverters. (6mark
b) Describe how Pulse Width Modulation (PWM) is used in voltage-controlled invert regulate voltage. (7mark
c) Compare the performance of Sinusoidal PWM (SPWM) and Space Vector PWM (SVPWM) in voltage-controlled inverters. (7mark

**Question 3:**

a) Identify and explain the different types of three-phase inverter topologies. (6ma
b) Compare the advantages and disadvantages of voltage source inverters (VSI) ar source inverters (CSI). (7ma
c) Discuss the impact of harmonics in three-phase inverter output and methods to them. (7ma

**Question 4:**

a) Explain the working principle of a three-phase inverter and how it converts DC to AC. (6ma

b) Describe the role of Pulse Width Modulation (PWM) in controlling the output phase inverter. (7ma

c) Discuss how a three-phase inverter achieves phase balance in the output waveform. (7ma