(PAPER 2)

TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL CAL ENGINEERING
BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING
EEE 4415: POWER ELECTRONICS 2.
SERIES: NOVEMBER 2024. TIME: 2 HOURS. DATE: NOVEMBER 2024.

Instructions to Candidates

You should have the following for this examination
Answer Booklet, examination pass and student ID.
This paper consists of FIVE questions. Answer Question one and any other two questions.
Do not write on the question paper.

Question ONE.

(a)(i). Differentiate between controlled and un-controlled rectification, hence explain why controlled rectification is preferable compared to uncontrolled type.

(ii). State any two applications of controlled rectification circuits.

(iii).A full wave un-controlled rectifier circuit using a transformer with a step down ratio of 10:1 supplies power to a resistive load of 20 Ω .If the input power supply is 240V at 50 Hz , Determine,

(I). Average and RMS output voltage. (II). Input VA power. (III). Power Factor and ripple factor.

(9 Marks).

(b) (i). Explain the need for Cyclo converters in industries, hence state any two of its applications.

(ii). Explain why cyclo converters employ controlled full bridge rectifiers.

(iii). A cyclo converter with a frequency step down ratio of 4:1 is fed with a maximum input power of 300V at 60 Hz. If the load to the cyclo converter is a 10Ωin series with a capacitor of 0.53m F, determine the following given the firing angle to β = 30 degrees,

(I). Circuit impedance. (II)RMS output voltage and current. (III). RMS output power. **(9.5 Marks).**

(c)(i). State any two industrial applications of AC voltage controllers.

(ii).Draw and explain the operation of a single phase bi-directional AC Voltage controller serving a pure resistive load.

(iii). A Uni-directional AC voltage regulator is supplied with an input voltage of 240V (Rms) at 50 Hz. If the load has an impedance of 100 Ω in series with an inductor of 480 mH, calculate the following given the firing angle $\alpha = \pi/4$.

(I). Rms output voltage (II). Dissipated Rms output power. **(11.5 Marks).**

Question TWO

(a)(i). Differentiate between a unidirectional and a bidirectional AC voltage controller.

(ii). Explain why bidirectional AC voltage controllers are more preferable to a Uni-directional type in most industrial applications.

(iii). State any two advantages of semiconductor driven AC voltage controllers compared to transformer driven types. **(6 MARKS).**

(b)(i). Draw and explain how a bidirectional AC voltage controller can be used in a light dimmer circuit.

(ii)With the aid of the waveforms generated by bidirectional AC voltage controllers, derive the expression relating to the RMS output power assuming a pure resistive load. **(11 MARKS).**

(c). An ON/OFF AC voltage controller using 60 complete cycles for on state and 40 complete cycles for off state is supplied with a stable 250V Rms supply at 50 Hz. If the load is pure resistor of 25 Ω and the forward thyristors are fired at 60 degrees, determine,

(I). Rms output voltage (II). Rms input current. **(3 Marks).**

Question THREE.

(a)(i). Explain the need for AC power rectification, hence explain how it is used in an interruptible power supply unit, (UPS) unit.

(ii.) Explain the meaning of the following terms as used with rectifier circuits.

(I). Transformer Utilization Factor. (II). Ripple Factor. **(6 Marks)**

(b). (i). Draw a full wave controlled rectifier circuit connected to a resistive load and explain its operation.

(ii). Using the output waveforms of circuit (bi), derive the Rms output voltage expression. **(10 Marks)**

(c). (i). Identify the circuit of fig Q 3.

(ii). The circuit of fig Q 3 is supplied with a voltage of 150V Rms at 50 Hz is used to charge a battery through a limiting series resistor of 15 Ω. If the battery EMF is 50V, determine the following.

(I). The start and end of charging. (II). The average battery charging current. **(4 Marks)**

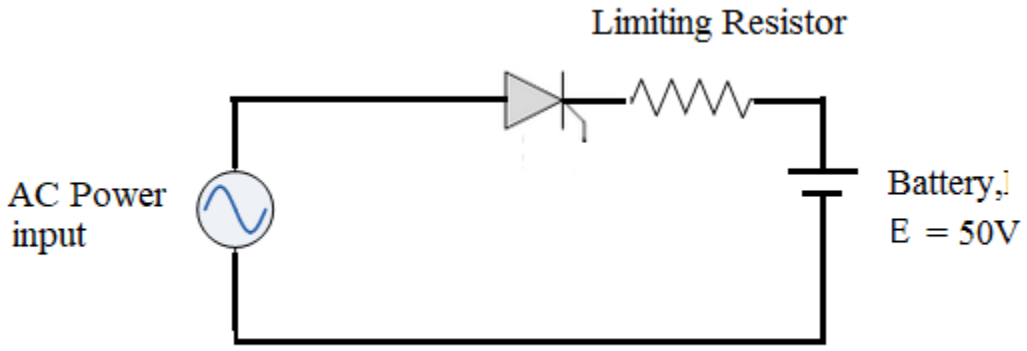

Fig Q 3

Question FOUR

(a)(i). Define an Electronic Cyclo-converter, hence differentiate between step up and step down Cyclo-converters.

(ii). Explain why cyclo-converters employ full wave controlled rectifiers instead of full wave un-controlled rectifiers in their operation. **(4 Marks).**

(b) (i). Draw a single phase cycloconverter block diagram and explain how it can operated as a 3:1 frequency ratio converter.

(ii). Using appropriate cycloconverter wave forms, derive the Rms output voltage expression for the cycloconverter. **(13 Marks).**

(c). A cycloconverter operating with frequency ratio of 3:1 has a maximum input voltage of 300 V at 60 Hz. If the load is a series RL type of a 15Ω resistor and 80 mH inductor, determine for a firing angle of $\alpha = 45$ degrees,

(i). Impedance of the circuit (ii). Cyclo converter RMS output voltage and current. **(3 Marks).**

Question FIVE

(a)(i). Differentiate between a half bridge and a full bridge inverter.

(ii). Explain the switch precautions to be taken when designing inverters. **(6 Marks).**

(b)(i). Define the following terms as used with power inverter systems.

(I). Harmonics. (II). Inverter Efficiency.

(ii). Draw a transistorized single phase full bridge inverter diagram and explain its operation.

(11 Marks).

(c). A single phase full bridge power inverter is supplied with a dc voltage of 150V and operates at a frequency of 50 Hz. If the load consists of a 200 Ω in series with an inductance of 480mH, determine the following.

(I). Fundamental RMS output voltage and current. (II). RMS output power. **(3 Marks).**