



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING
ELECTRICAL DEPARTMENT
UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING.
EEE 4314: POWER ELECTRONICS 1.
END OF SEMESTER EXAMINATION
SERIES: APRIL 2024. TIME: 2 HOURS.

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 compulsory question one and any other two.

Do not write on the question paper.

Question ONE.

(a)(i). Explain principles of power rectification, hence differentiate between controlled and un-controlled rectification.

(ii). State any two applications of a controlled rectifier circuit.

(iii). A full wave un-controlled rectifier circuit uses a transformer with a step down ratio of 20 :1 and 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). Form Factor and Ripple factor. **(10 Marks).**

(b) (i). Define and explain the role of Cyclo converters in industries, hence state any two of its applications.

(ii). With the aid of appropriate diagrams, explain how a Cyclo converter can be used to operate as 3:1 frequency transformer. **(12 Marks).**

(c)(i). Explain the meaning of the following terms as used with inverters.

(I). Switching frequency. (II). Inverters efficiency.

(ii). Explain the contribution of inverters in domestic solar power supply systems.

(iii). A full bridge single phase inverter is connected to 150 VDC power supply and serves a resistive load of 4.8 Ω , determine,

(I). The RMS output load voltage at fundamental frequency. (II). RMS Output Power. **(8 Marks).**

Question TWO.

(a)(i). Define an electronic Cyclo converter, hence differentiate between a stepping up and a stepping down Cyclo converter.

(ii). Explain why Cyclo converter circuits employ full bridge controlled rectifiers instead of uncontrolled rectifiers. **(6.5 Marks).**

(b) (i). Draw a single phase Cyclo converter block diagram and explain how it can operated to control the speed of an AC motor.

(iii). Explain how a DC link may be used to convert the frequency and amplitude of a given power supply. **(8.5 Marks).**

(c). A Cyclo converter operating with frequency ratio of 3:1 has an input of 240 V (Rms) 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). RMS output voltage and current from the Cyclo converter. **(5 Marks).**

Question THREE.

(a)(i). Explain the operational difference between uni-directional and bi-directional AC voltage controllers and state any two of its industrial applications.

(ii). Explain the operational behavior of a bidirectional AC voltage controller when one of its thyristor experiences an open circuit fault. **(6 Marks).**

(b)(i). Draw and explain how a bidirectional AC voltage controller circuit can be used as a lamp intensity controller.

(ii). With the aid of appropriate waveforms generated by the circuit of (b) (i), derive its RMS output voltage expression assuming a pure resistive load. **(10 Marks).**

(c). A bidirectional AC voltage controller is supplied a maximum input voltage of 300V at 50 Hz. If the circuit is triggered on at an angle of 60° , and delivers power to an inductive load of 0.4774H in series with a resistor of 300Ω , calculate the following.

(i). Rms output voltage and current. (ii). Input VA. **(4 Marks).**

Question FOUR.

(a)(i). Explain the operational difference between a Diac and a Thyristor.

(ii). State any two applications of power Thyristors. **(6 Marks).**

(b). (i). With the aid of waveforms, draw and explain the construction and operation of a Diac.

- (ii). Identify the circuit of figure Q 4 and explain its operation. **(11 Marks).**
- (c). Assuming the components used in the circuit of figure Q 4 are ideal, Calculate
- (i). The value of the current passing through the LED when it is on.
- (ii). The capacitor value for circuit to flash at a frequency of 10Hz given both R_1 and R_v to be $10k\ \Omega$. **(3 Marks).**

Question FIVE.

- (a)(i). Define an inverter and state the difference between a sinusoidal and a square wave inverter. **(8 Marks).**
- (ii). Name any two property requirements of inverters switches.
- (b)(i). Explain the meaning of the following terms as used with power inverter systems.
- (I). Harmonic Frequencies. (II). Waveform Distortion.
- (ii). Identify the circuit of figure Q 5 and explain its operation. **(10 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 $100\ \Omega$ in series with an inductance of 480mH, determine the following.
- (I). Fundamental RMS output voltage and circuit impedance. (II). RMS output power. **(2 Marks).**

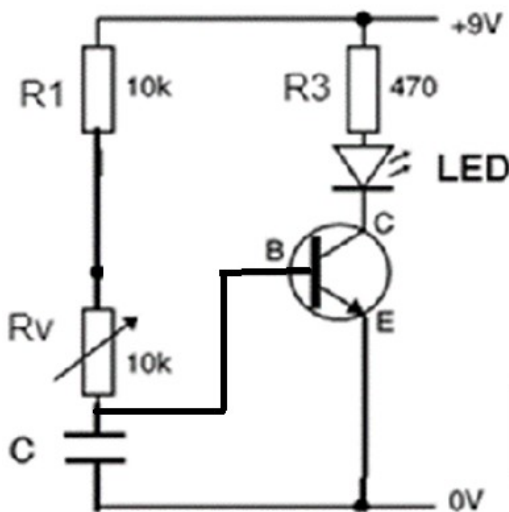


Fig Q 4

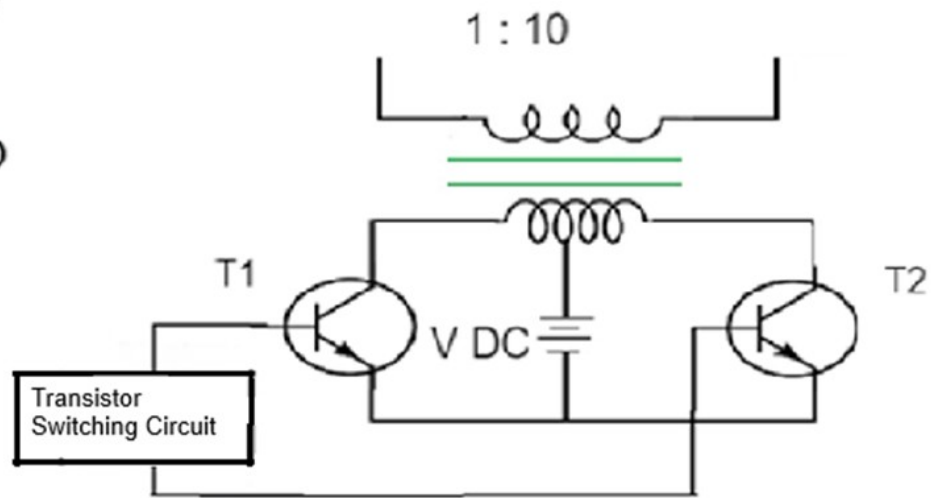


Fig Q 5