TEVETA

Technical Education Vocational and Entrepreneurship Authority

DIPLOMA IN BIOMEDICAL ENGINEERING

LEVEL 6 YEAR III EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: JULY - AUGUST 2026

SUBJECT: POWER ELECTRONICS III

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

PASS MARK: 50

INSTRUCTIONS TO CANDIDATE

1. Write your Examination number and National Registration Card (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet.
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. This paper has TWO (2) Sections.
   - Answer ALL questions in section A
   - Answer FIVE (5) questions in Section B. Question one (1) is compulsory then answer any four (4) questions from the remaining six (6) questions.
4. Diagrams may be used where necessary to clarify your answer.
5. Cell phone and programmable calculators are not allowed in the examination room.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A: MULTIPLE CHOICE QUESTIONS **TOTAL MARKS: 20**

ANSWER ALL QUESTIONS BY CHOOSING THE BEST OPTION

1. Which device is classified as a power switching device?
   A. SCR
   B. Resistor
   C. Capacitor
   D. Inductor

2. A DIAC is commonly used for...
   A. Voltage regulation
   B. Triggering TRIACs
   C. Amplification
   D. Rectification

3. The main advantage of an IGBT is...
   A. High input impedance and fast switching
   B. Low conduction losses only
   C. Works only at low frequency
   D. Requires no gate drive

4. A 555 timer in a stable mode produces...
   A. Constant current
   B. Single pulses
   C. DC voltage
   D Continuous square waves.

5. Opto-couplers are used to...
   A. Provide electrical isolation
   B. Increase voltage gain
   C. Reduce frequency
   D. Store charge

6. A UJT is mainly used in...
   A. Rectifiers
   B. Voltage regulators
   C. Relaxation oscillators
   D. Amplifiers

7. Which protection method prevents thermal runaway?
   A. Heat sinks and temperature control
   B. Pulse transformer
   C. Opto-coupling
   D. Series resistor

8. Gate triggering of an SCR involves...
   A. Removing gate current
   B. Increasing anode voltage only
   C. Reducing cathode voltage
   D. Applying a small current to the gate terminal

9. Line commutation is also called...
   A. Natural commutation
   B. Forced commutation
   C. Auxiliary commutation
   D. Resonant commutation

10. In parallel resonant commutation, the capacitor is connected ...
   A. across the load
   B. in series with the SCR
   C. across the SCR
   D. to ground

11. Self-commutation occurs when...
   A. Anode voltage is increased
   B. Gate current is removed
   C. Current naturally falls below holding current
   D. Cathode is grounded

12. Which commutation method uses an auxiliary SCR?
   A. Auxiliary turn-off
   B. Line commutation
   C. Phase commutation
   D. Natural commutation

13. A UPS system is primarily designed to...
   A. Increase voltage gain
   B. Provide backup power during outages
   C. Reduce harmonics only
   D. Store charge

14. An SMPS differs from a linear supply because it...
   A. Cannot regulate voltage
   B. Operates only at 50 Hz
   C. Requires no transformer
   D. Uses high-frequency switching

15. A DC motor control system using power electronics can...
    A. Vary speed by adjusting armature voltage
    B. Only run at constant speed
    C. Operate without feedback
    D. Eliminate commutation

16. An inverter converts...
    A. DC to AC
    B. AC to DC
    C. AC to AC
    D. DC to DC

17. Computer simulation tools like MATLAB are used to...
    A. Store data only
    B. Replace physical devices permanently
    C. Model and analyze power electronic systems
    D. Provide mechanical drawings

18. PSPICE is mainly applied in...
    A. Circuit simulation and analysis
    B. Mechanical design
    C. Thermal management
    D. Optical systems

19. A GTO (Gate Turn-Off Thyristor) differs from an SCR because it ...
    A. requires no gate drive
    B. can be turned off by gate signal
    C. cannot conduct high current
    D. is only used in low power circuits

20. A TRIAC can conduct...
    A. In both directions
    B. Only in forward direction
    C. Only in reverse direction
    D. Only when gate is grounded

SECTION B: **TOTAL MARKS: 80**

THERE ARE SEVEN (7) QUESTIONS IN THIS SECTION. ANSWER FIVE (5) QUESTIONS. QUESTION ONE (1) IS COMPULSORY.

QUESTION 1(COMPULSORY)

a) Explain **four (4)** types of power converters commonly used in electronic power systems. [8 Marks]

b) Draw clearly labelled structures and circuit schematics for the following semiconductor devices:

i) MOSFET [4 Marks]

ii) TRIAC [4 Marks]

iii) SCR [4 Marks]

[TOTAL MARKS 20]

QUESTION 2

A DC Chopper has input voltage of 220 V and output voltage of 150 V load resistance is 20Ω. Calculate the:

a) Duty cycle [4 marks]

b) Average and RMS load current [4 marks]

c) RMS thyristor current [4 marks]

d) Average input current [3 marks]

[TOTAL MARKS 15]

QUESTION 3

Figure Q3 shows how a Shockley diode may be used to trigger a SCR.

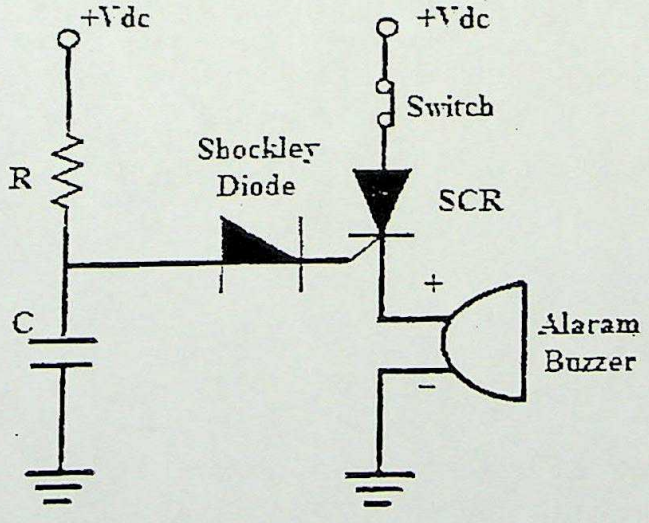


Figure Q3: SCR triggering

In point form, explain the operation of the circuit in Figure Q3. [15 marks]

[TOTAL MARKS 15]

QUESTION 4

The switch-on and turn-off characteristics of a NPN BJT are shown in Figure Q4 below.

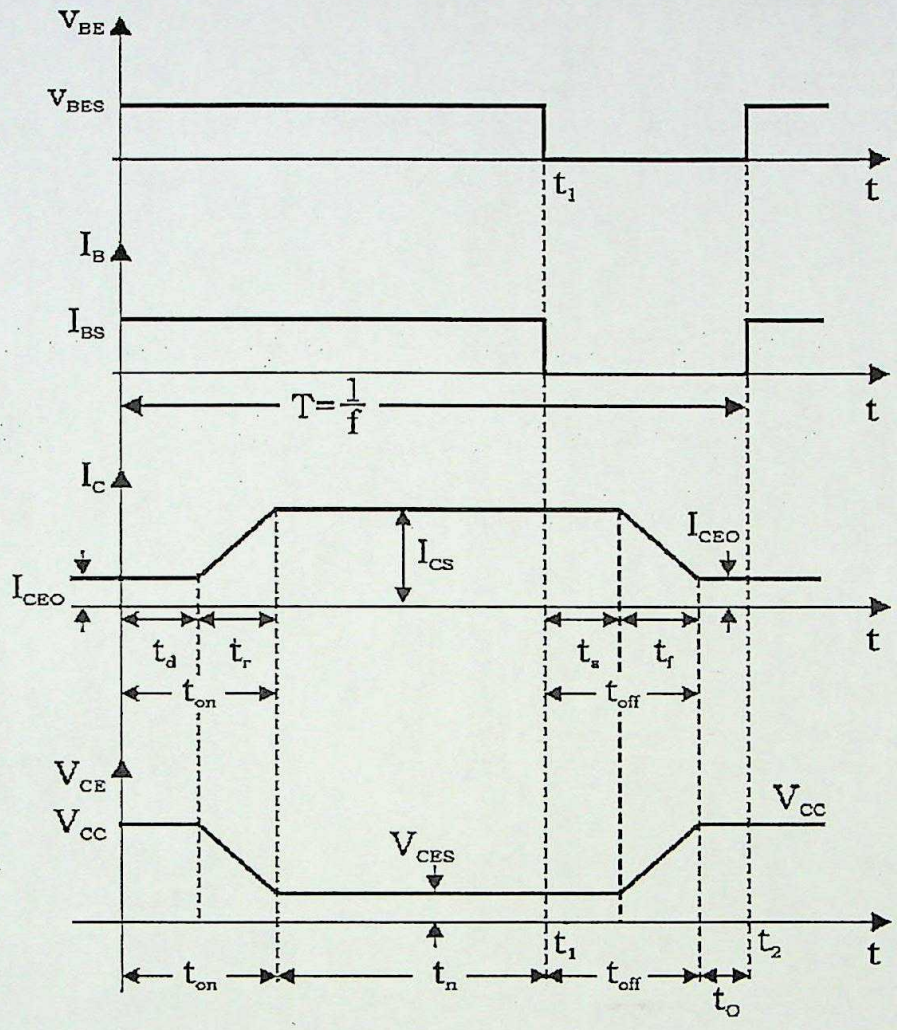


Figure Q4: Switching characteristics

With reference to Figure Q4, explain in point form, the switching characteristics of a NPN BJT.

[15 marks]

[TOTAL MARKS 15]

QUESTION 5

A single-phase, half-bridge inverter feeds a resistive load, R = 10 Ω. If the source voltage is 240 V, determine the:

a) RMS value of fundamental component of output voltage. [5 marks]

b) output power. [4 marks]

c) peak off-state voltage across each semiconductor switch. [6 marks]

[TOTAL MARKS 15]

QUESTION 6

Figure Q6 shows the internal structure of a 555-timer IC. Using Figure Q6, explain in point form the operation of the IC. [15 marks]

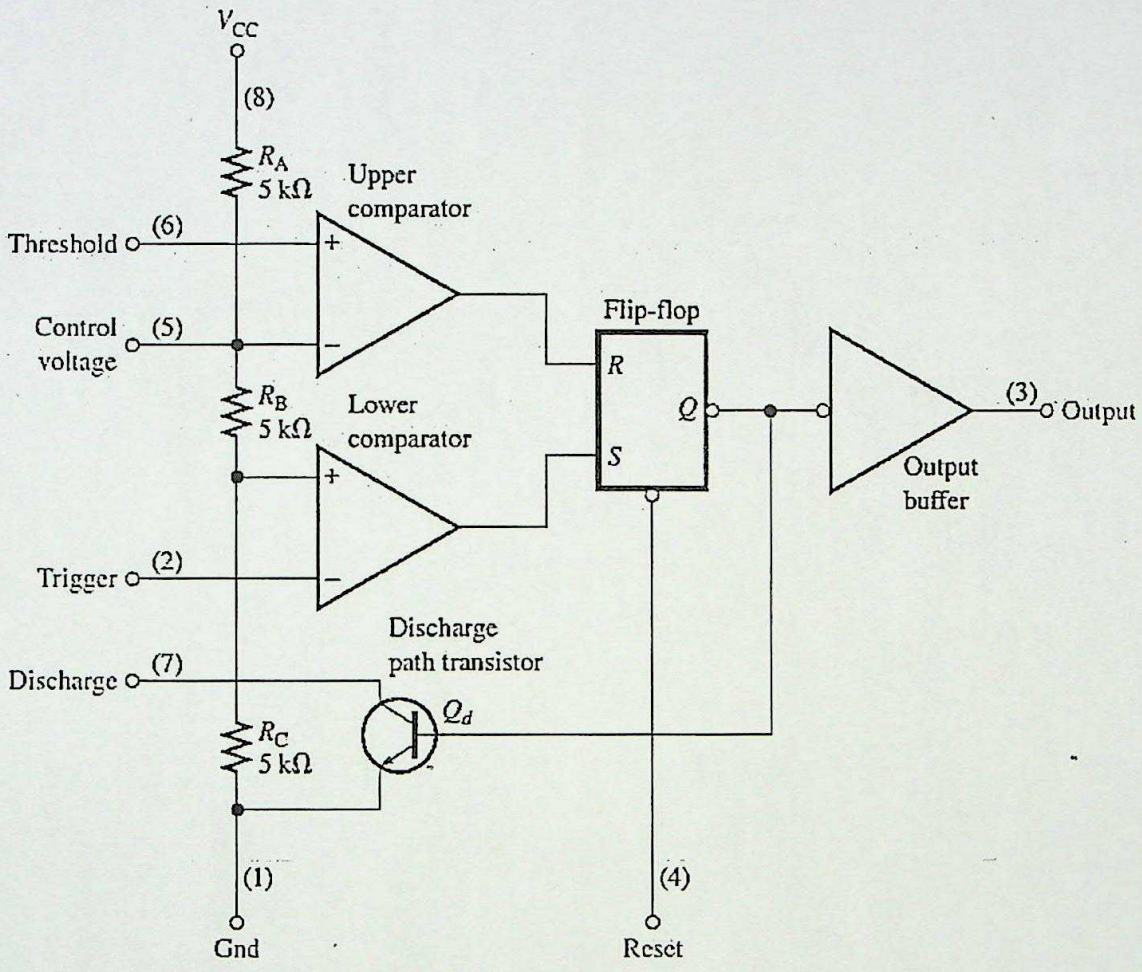


Figure Q6: Internal structure of a 555-timer

[TOTAL MARKS 15]

QUESTION 7

A type-A chopper, has a DC input voltage of 220 V, load resistance of 20 Ω. Taking a voltage drop of 1.5 V across the chopper when it is on with a duty cycle of 0.5, determine the:

i) Average output voltage [5 marks]

ii) RMS output voltage [4 marks]

iii) Chopper efficiency. [6 marks]

[TOTAL MARKS 15]