ADVANCED LEVEL NATIONAL EXAMINATIONS, 2015,
TECHNICAL AND PROFESSIONAL TRADERS

EXAM TITLE: Power Electronics

OPTION: Electronics and Telecommunication (ETL)

DURATION: 3 hours

INSTRUCTIONS:

The paper is composed of three (3) Sections:

Section I: Sixteen (16) questions, all Compulsory. 55 marks

Section II: Five (5) questions, Choose Three (3) only. 30 marks

Section III: Two (2) questions, Choose only One (1). 15 marks

Every candidate is required to strictly obey the above instructions. Punishment measures will be applied to anyone who ignores these instructions.
Section I. Sixteen (16) Compulsory questions. 55marks

01. Explain why BJT is a current controlled device while IGBT is a voltage controlled device. 3marks

02. At a fixed anode-to-cathode voltage less than the forward blocking $V_{(BR)F}$ What is the effect on the firing of the SCR as the gate current is reduced from its maximum level to zero level? 2marks

03. What is a DIAC? Differentiate the structure of a DIAC from that of a Bi-polar Junction Transistor. 5marks

04. State two (2) widely uses of a which a TRIAC. 4marks

05. What are different types of power transistors? 2marks

06. Differentiate latching current from holding current in case of a thyristor. 3marks

07. Which type of output voltage is obtained from the cyclo converters compared to the input signal? 2marks

08. A chopper supplied by a 200V dc has ON time of 30 ms and OFF time of 10 ms. Determine the value of the average output voltage. 3marks

09. What are the different ways of turning off a SCR? 3marks

10. Explain the classification of choppers according to their circuit operation. 3marks

11. Outline the main functions of DC to DC converters. 6marks

12. What are the advantages of GTO over SCR? 4marks

13. What is meant by PWM control in dc chopper? 2marks

14. What is a Unijunction transistor? Compare it with an ordinary diode. 3marks

15. Draw the Unijunction transistor circuit symbol with equivalent circuit and briefly describe its construction. 6marks

16. What are the advantages of single phase bridge converter over single phase mid-point converter? 4marks
Section II. Answer any three (3) questions of your choice  
(Do not choose more than three questions).  30marks

17. In following figure, the switch is closed.

If the triac has fired, what is the current through 50Ω resistor when:
(i) Triac is ideal.  
(ii) Triac has a drop of 1V?  10marks

18. a. A unijunction transistor has 10 V between the bases. If the intrinsic standoff ratio is 0.65, find the value of standoff voltage. What will be the peak-point voltage if the forward voltage drop in the pn junction is 0.7 V?

b. An a.c. voltage \( v = 240 \sin 314t \) is applied to an SCR half-wave rectifier. If the SCR has a forward breakdown voltage of 180 V, find the time during which SCR remains off.  10marks

19. Write fully and correctly the sentence by filling in the following statements:

a) A triac has three terminals which are.............
   (i) drain, source, gate,
   (ii) two main terminal and a gate terminal,
   (iii) cathode, anode, gate.

b) A triac is equivalent to two SCRs.................
   (i) in parallel,
   (ii) in series,
   (iii) in inverse-parallel.
c) A diac has ........... terminals.
   (i) two
   (ii) three,
   (iii) four.

d) A UJT has..................
   (i) two \(pn\) junctions,
   (ii) one \(pn\) junction,
   (iii) three \(pn\) junctions.

e) A diac is simply..................
   (i) a single junction device,
   (ii) a three junction device,
   (iii) a triac without gate terminal.

20. A. In figure bellow, the switch is closed. A diac with breakover voltage \(V_{BO} = 30V\) is connected in the circuit.

   ![Circuit Diagram]

If the triac has a trigger voltage of 1V and a trigger current of 10mA, what is the capacitor voltage that triggers the triac?

B. Write fully and correctly the sentence, by Filling in the following statements:

a) An SCR has .............. \(pn\) junctions.
   (i) two
   (ii) three,
   (iii) four.

b) An SCR has three terminals \textit{viz.} ..............
   (i) cathode, anode, gate,
   (ii) anode, cathode, grid,
   (iii) anode, cathode, drain.
c) An SCR behaves as a ....................... switch.
   (i) unidirectional,
   (ii) bidirectional,
   (iii) mechanical.

d) An SCR is sometimes called ..............
   (i) triac,
   (ii) diac,
   (iii) unijunction transistor,
   (iv) thyristor.

e) After peak point, the UJT operates in the ................. region.
   (i) cut-off,
   (ii) saturation,
   (iii) negative resistance.

21 a. The power electronic converters can be classified into six types:
   List out them.

   b. From the symbols of the figures below, write the terminal for each.

   ![Diagrams of power electronic components]

   i) ii) iii) iv)
Section III. Answer any one (1) question of your choice  
(Do not choose more than one question). 15marks

22. a. The SCR of figure below has gate trigger voltage $V_T = 0.7V$, gate trigger current $I_T = 7mA$ and holding current $I_H = 6mA$.

(i) What is the output voltage when the SCR is off?
(ii) What is the input voltage that triggers the SCR?
(iii) If $V_{CC}$ is decreased until the SCR opens, what is the value of $V_{CC}$?

![SCR Circuit Diagram]

b. What are the two main methods of turning off a thyristor? 15marks

23. a. A half-wave rectifier circuit using an SCR is adjusted to have a gate current of 1mA. The forward breakdown voltage of SCR is 100 V for $I_g = 1mA$. If a sinusoidal voltage of 200 V peak is applied, find:

(i) firing angle
(ii) conduction angle
(iii) average current. Assume load resistance = 100Ω and the holding current to be zero.

b. What are the two most common phase controller configurations? 15marks

24. a. State the different thyristor turn-on methods.

b. DC/AC converters named inverters are used to convert a dc supply to ac level of a definite frequency and value. Which controlled semiconductor devices are used?

c. Determine the maximum and minimum peak-point voltage for a UJT with $V_{BB} = 25$ V. Given that UJT has a range of $\eta = 0.74$ to 0.86. 15marks