

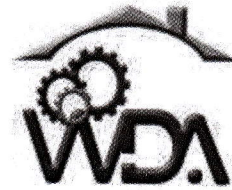
ETL – Power Electronics

**T099**

Thursday, 12/11/2015

08:30 – 11:30

WORKFORCE DEVELOPMENT AUTHORITY



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**ADVANCED LEVEL NATIONAL EXAMINATIONS, 2015,  
TECHNICAL AND PROFESSIONAL TRADES**

**EXAM TITLE: Power Electronics**

**OPTION: Electronics and Telecommunication (ETL)**

**DURATION: 3hours**

**INSTRUCTIONS:**

The paper is composed of **three (3) Sections:**

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

**55marks**

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

**30marks**

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

**15marks**

**Every candidate is required to strictly obey the above instructions. Punishment measures will be applied to anyone who ignores these instructions.**

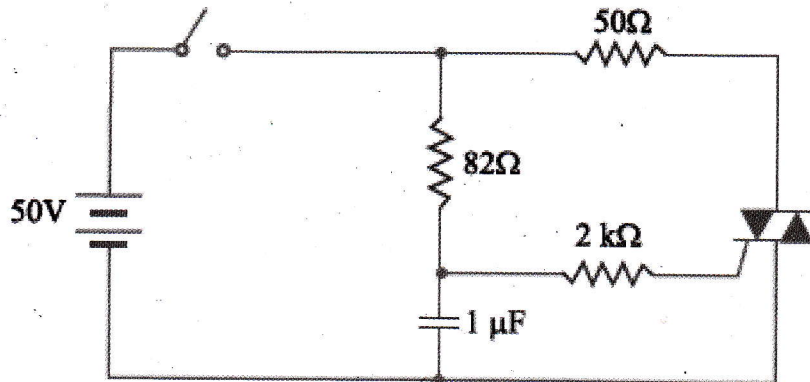
**Section I. Sixteen (16) Compulsory questions. 55marks**

- 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  $v = 240 \sin 314 t$  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.....

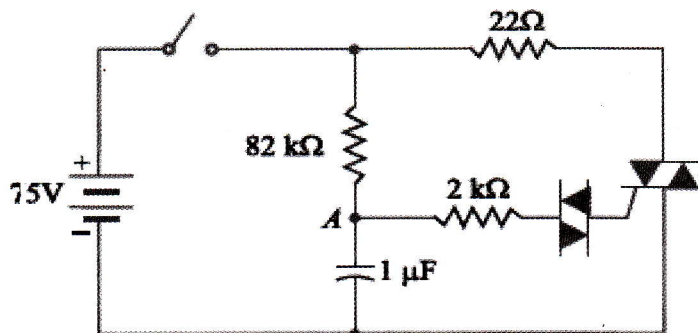
- (i) two *pn* junctions,
- (ii) one *pn* junction,
- (iii) three *pn* junctions.

e) A diac is simply.....

- (i) a single junction device,
- (ii) a three junction device,
- (iii) a triac without gate terminal.

**10marks**

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



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 *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.

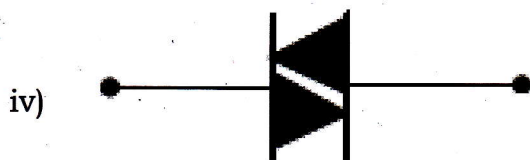
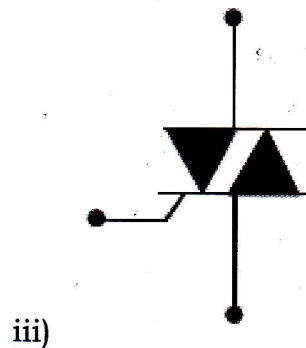
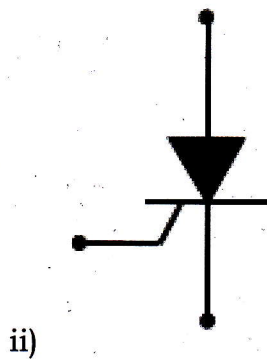
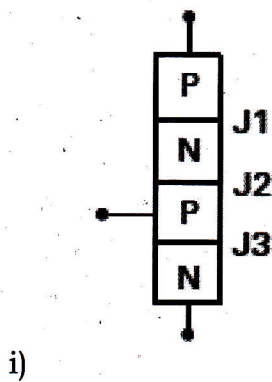
- (i) cut-off,
- (ii) saturation,
- (iii) negative resistance.

**10marks**

**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.



**10marks**

**Section III. Answer any one (1) question of your choice**

**(Do not choose more than one question).**

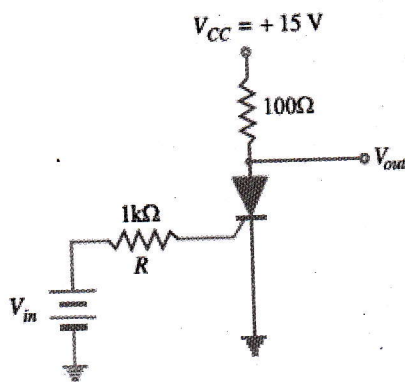
**15marks**

**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  $V_{CC}$ ?



**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  $V_{BB} = 25V$ . Given that UJT has a range of  $\eta = 0.74$  to 0.86.

**15marks**