

**CEL –Power Electronics and
Electromechanical Systems**

T007

Thursday, 10/11/2016

08:30 – 11:30

WORKFORCE DEVELOPMENT AUTHORITY



P.O. BOX 2707 Kigali, Rwanda Tel: (+250) 255113365

**ADVANCED LEVEL NATIONAL EXAMINATIONS, 2016,
TECHNICAL AND PROFESSIONAL STUDIES**

**EXAM TITLE: Power Electronics and Electromechanical
Systems**

OPTION: Computer Electronics (CEL)

DURATION: 3hours

INSTRUCTIONS:

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

Section I: Fourteen (14) compulsory questions. 55 marks

Section II: Attempt any three (3) out of five questions. 30 marks

Section III: Attempt any one (1) out of three questions. 15 marks

Note:

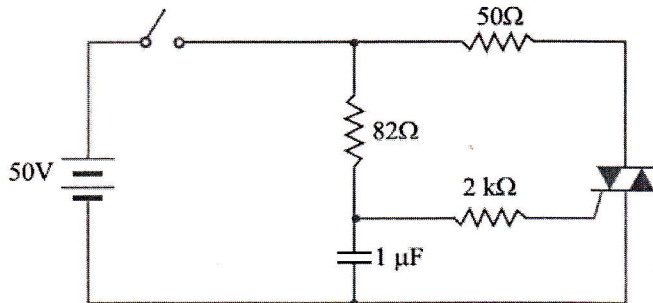
Every candidate is required to carefully comply with the above instructions. Penalty measures will be applied on their strict consideration.

Section I. Fourteen (14) Compulsory questions

55marks

- 01.** Define the following terms: **5marks**
- a. Thyristors
 - b. Triacs
- 02.** Give at least **four** types of power semiconductor devices can be divided broadly into five types. **4marks**
- 03.** Put the appropriate response in the dotted line place. **5marks**
- A.** A UJT has
- two pn junctions
 - one pn junction
 - three pn junctions
 - none of the proposed answers
- B.** The normal way to turn on a diac is by.....
- gate current
 - gate voltage
 - breakover voltage
 - none of the proposed answers
- C.** The device that does not have the gate terminal is
- Triac
 - FET
 - SCR
 - diac
- D.** A diac is turned ON by
- breakover voltage
 - gate voltage
 - gate current
 - none of the proposed answers
- E.** When the temperature increases, the interbase resistance (RBB) of a UJT
- increases
 - decreases
 - remains the same
 - none of the proposed answers
- 04.** What is the purpose of connecting antiparallel power diode across the load in power electronics circuit? **3marks**
- 05.** What is the normal way of turning ON the SCR? **2marks**
- 06.** How can you control an AC power in a load? **2marks**
- 07.** Which part of SCR loses all controls when that SCR starts conducting? **2marks**
- 08.** A thyristor is a Charge controlled device. Explain. **5marks**
- 09.** Give at least **four** important applications of silicon controlled rectifier (SCR). **4marks**
- 10.** Give at least **four** features of an ideal power switch device. **4marks**

11. Briefly discuss the requirements of power supplies. **3marks**
12. In the figure below shows 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 $1V$? **6marks**

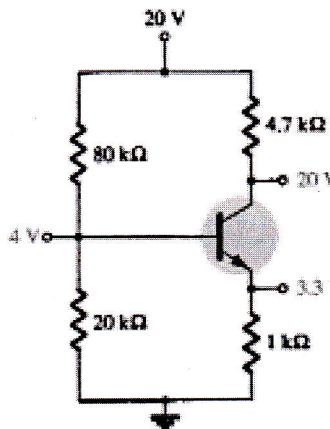


13. The intrinsic stand-off ratio for a Unijunction Transistor (UJT) is determined to be 0.6 . If the inter-base resistance R_{BB} is $10k\Omega$, what are the values of base-one resistance R_{B1} and base-two resistance R_{B2} ? **6marks**
14. What will be the effect of connecting the impedance connected to one side of a transformer? **4marks**

Section II. Choose and answer any three (3) questions.

30marks

15. What are advantages and disadvantages of bipolar junction transistors (BJT'S)? **10marks**
16. Explain the working operation of Triac. **10marks**
17. Why do we use transistors connected (a) in series? (b) In parallel? **10marks**
18. Based on the readings appearing in circuit below, determine whether the transistor is "ON" and the network is operating properly. **10marks**



19. Calculate the peak-load current in an SCR half-wave rectifier circuit that will occur if we measure an average (d.c.) load current of 1A at a firing angle of 30° ?

10marks

Section III. Choose and answer any one (1) question.

15marks

20. Explain the methods of turning ON Thyristor?

15marks

21. The light of a 100W, 220V tungsten lamp is to be varied by controlling the firing angle of an SCR in a half-wave rectifier circuit supplied with 220V a.c.

(a) What r.m.s (root mean square) voltage and current are developed in the lamp at firing angle $\alpha = 60^\circ$?

(b) What r.m.s (root mean square) voltage and current are developed in the lamp at firing angle $\alpha = 60^\circ$? For an SCR in a half-wave rectifier circuit while other parameters remain unchanged.

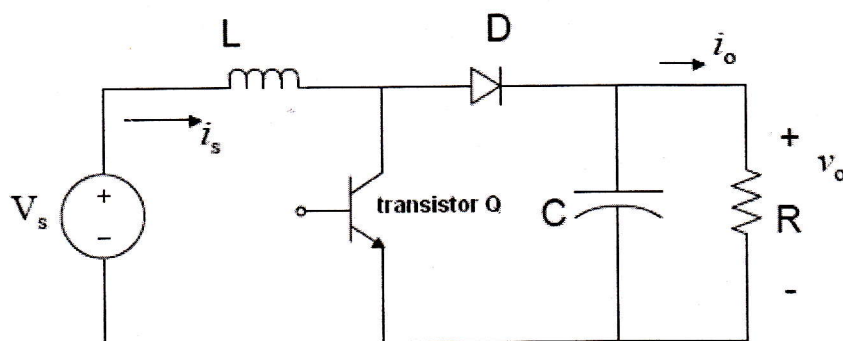
15marks

22. The step-up dc-dc converter shown in the circuit below is operated at a switching frequency of $f_s = 20$ kHz.

(a) For $R = 20 \Omega$ find the duty ratio k so that the average power supplied to the load is measured at $P_{av} = 500$ W.

(b) For $k=0.7$ find the maximum value of the load resistance R so that the source current is becomes continuous.

15marks



The step-up dc-dc converter circuit

With:

$V_s = 40$ V

$L = 500$ μ H