WORKFORCE DEVELOPMENT AUTHORITY
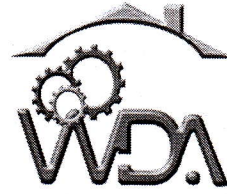
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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2018, TECHNICAL AND PROFESSIONAL STUDIES

EXAM TITLE: POWER ELECTRONICS

OPTION: Electronics and Telecommunication (ETL)

DURATION: 3 hours

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   **55 marks**

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01. Define the duty-cycle of a chopper. What is the effects of increase of duty-cycle on the output voltage for both step down and step up choppers?   **(4 marks)**

02. Differenciate inverter from converter.   **(4 marks)**

03. Here is a condition that is applied in one type of inverter:

$R^2 < \dfrac{4L}{C}$. In which type of inverter is the condition applied?   **(4 marks)**

04. How can a thyristor be turned Off?   **(4 marks)**

05. Differenciate latching current from holding current as applied to thyristors.   **(4 marks)**

06. What do you mean by Phase Controlled Rectifier?   **(4 marks)**

07. Why SCR cannot be used as bidirectional switch?   **(4 marks)**

08. Give the various triggering devices for thyristors.   **(3 marks)**

09. What is a DIAC? Give two applications of DIACs.   **(4 marks)**

10. Complete the following statement with appropriate words:Phase,Trigger and Neutral :

When connecting a TRIAC into the circuit, we connect MT1 to the ......trigger......., MT2 to the .....neutral......... and the gate is used to feed the ....p.............. pulse .   **(3 marks)**

11. Write a short comment on holding current for SCR.   **(4 marks)**

12. State three ways of turning off a SCR.   - over current   - over voltage   **(3 marks)**

13. a) State four methods of control in ac voltage controller.

speed control , motor control, reactive control, light timing

b) Write down the expression of duty cycle for ON-OFF control.

$\dfrac{T_0}{T}$ **(6 marks)**

14. Write a short note on the Shockley diode (5 lines max.)   **(4 marks)**

* rectifier
* Lighting


15. The latching current of a thyristor circuit in figure below is 50mA. The duration of the firing pulse is 50µs. Will the thyristor get fired?

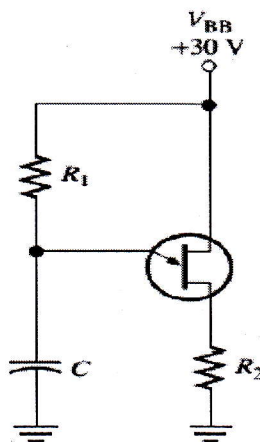   **(10 marks)**

16. In an SCR half-wave rectifier circuit, what peak-load current will occur if you measure an average (d.c.) load current of 1A at a firing angle of 30°?   **(10 marks)**

17. **A.** Determine the gate trigger current and the anode current when the switch, SW1, is momentarily closed in figure below. Assume V_{AK}=0.2V, V_{GK}=0.7V, and I_H = 5mA.
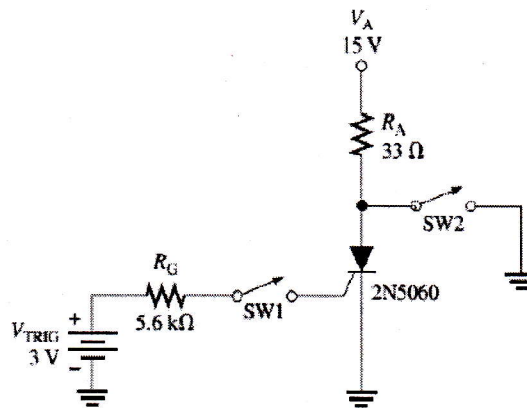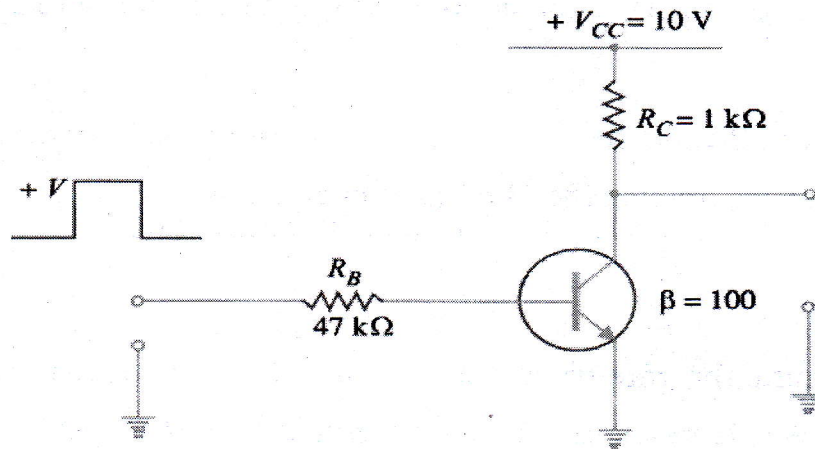

B. Determine a value of R_1 in figure below that will ensure proper turn-on and turn-off of the UJT. The characteristic of the UJT exhibits the following values: η= 0.5, V_V=1V, I_V=10mA, I_P =20mµ, and V_P=14V.

                                                                    (10 marks)

18. A. Determine the minimum high input voltage (+V) required to saturate the transistor switch shown in figure below. Assuming the transistor to be ideal.

B. A transistor is used as a switch. If V_{CC} = 10V, R_C = 1 kΩ and I_{CBO} = 10µA, determine the value of V_{CE} when the transistor is (i) cut off and (ii) saturated.

(10 marks)

19. For a class B amplifier providing a 20V peak signal to a 16Ω load (speaker) and a power supply of V_{CC} = 30 V, determine:

   a) the input power,

   b) output power and,

   c) Circuit efficiency.

V=90
L=16
Vcc=30

(10 marks)

20. An SCR has a Vg-Ig characteristics given as Vg= 1.5+ 8Ig. In a certain application, the gate voltage consists of rectangular pulses of 12V and of duration 50µs with duty cycle 0.2.

  (a) Find the value of Rg series resistor in gate circuit to limit the peak power dissipation in the gate to 5watts.

  (b) Calculate average power dissipation in the gate.

<div align="right">**(15 marks)**</div>

21. In the rectifier shown in figure below, it has a load of R= 15Ω and, Vs=220sin314t and unity transform ratio. If it is required to obtain an average output voltage of 70% of the maximum possible output voltage, calculate:

  (a) The firing angle, α

  (b) The efficiency,

  (c) Ripple factor,

  (d) Transformer utilization factor,

  (e) Peak inverse voltage(PIV) of the thyristor and,

  (f) The crest factor of input current.

Hint:
$$V_n=(V_{dc}/V_{dm})=0.5(1+\cos\alpha)$$
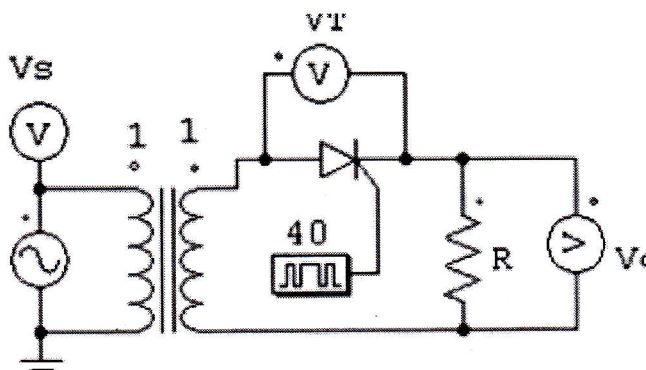
<div align="right">**(15 marks)**</div>

22. The figure below shows a simple triac circuit. Explain: **(15 marks)**

    a) What happened when switch S is open?

    b) What happened when switch S is closed?

    c) What happened if terminal MT2 is positive w.r.t. MT1?

    d) What happened if the terminal MT2 is negative w.r.t. MT1?

    e) Does a triac act as an *ac* contactor to switch on or off alternating current to a load?