BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ENGINEERING AND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEN5204 **POWER ELECTRONICS**

Duration: 3 hours **Total marks: 100**

INSTRUCTIONS

This paper contains seven questions each carrying 20 marks.

Answer any **FIVE** questions.

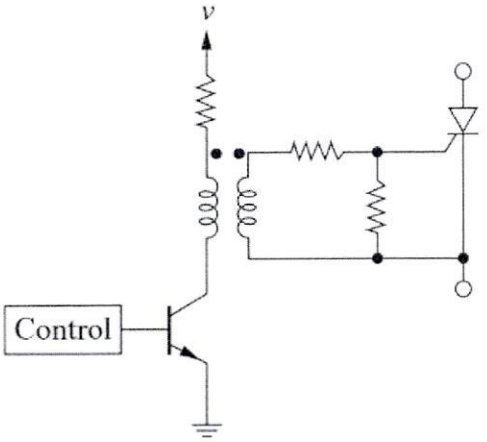
Question 1

a) (i) Draw the block diagram of the VFD, hence explain the purpose saved by the respective stages. [9]

(ii) Highlight how the Variable speed drive is able to handle the effect of stator resistance at low frequencies. [1]

(iii) Explain any three advantages of using the Variable Frequency Drive. Hence state any two disadvantages. [8]

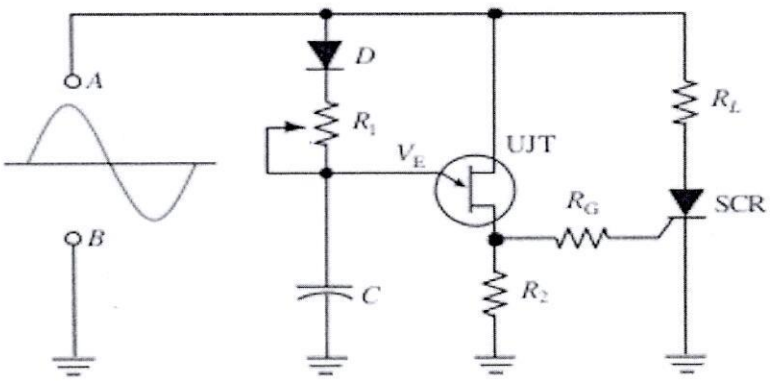
b) Describe the operation of the circuit below. [2]



Question 2

a) State the two classes of IGBTs, Hence, explain why the PT IGBTs cannot be as easily paralleled as MOSFETs, while the NPT IGBTs can be paralleled. [7]

b) Describe the principle of operation of the circuit below. [5]



c) Draw the tree diagram showing the classification of frequency converters. [4]

d) A 500 V shunt motor runs at its normal speed of 250 r.p.m. when the armature current is 200 A. The resistance of armature is 0.12 ohm. Calculate the speed when a resistance is inserted in the field reducing the shunt field to 80% of normal value and the armature current is 100 ampere. [4]

Question 3

a) With the aid of a schematic diagram, describe the operation of the power BJT. Hence determine the total gain if the gain of the first and second transistor is 20 and 100 respectively. [10]

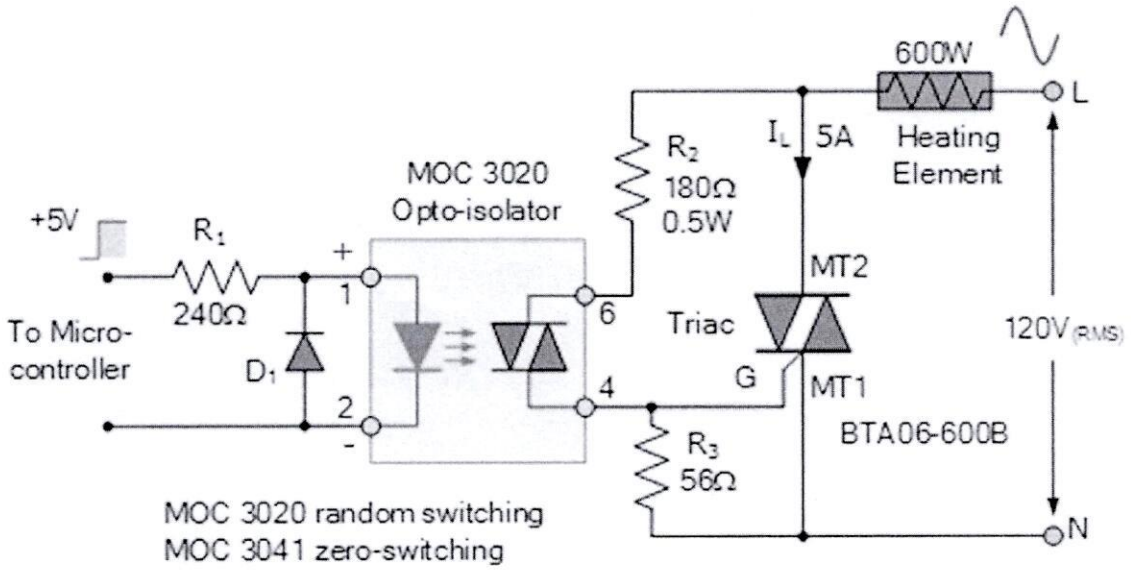
b) With the aid of waveforms and circuit diagram, describe the principle of operation of the flyback converter. [10]

Question 4

a) With the aid of a block diagram, describe the operation of the Doubly-fed induction generators for wind-electric systems. [9]

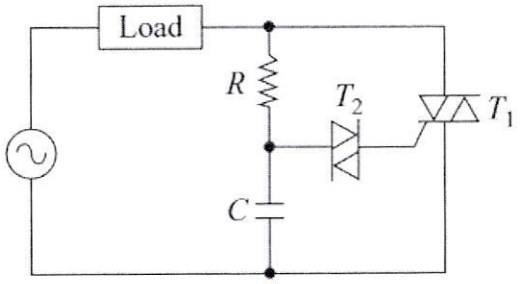
b) With the aid of formula, highlight the factors used for speed control of the DC motor. [5]

c) Briefly describe the operation of the circuit below. [6]



Question 5

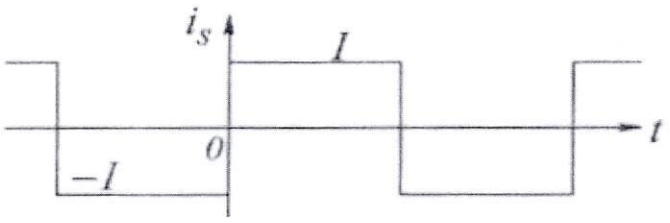
a) Describe the operation of the circuit below. [4]



b) A current i_s, of square waveform is shown in Figure below. Hint, [4]

From Fourier analysis, $i_s(t)$ can be expressed as

$$i_s = \frac{4}{\pi} I(\sin \omega_1 t + \frac{1}{3}\sin 3\omega_1 t + \frac{1}{5}\sin 5\omega_1 t + \frac{1}{7}\sin 7\omega_1 t + ...)$$



(i) Calculate and plot its fundamental frequency component and its distortion component.
(ii) What is the %THD associated with this waveform?

c) Briefly describe how thyristor protection is achieved. [5]

d) The converter and snubber in Figure below has V_s = 100 V and I_L = 5 A. The switching frequency is 100 kHz with a duty ratio of 50 percent, and the transistor turns off in 0.5 s.

(i) Determine the turnoff losses without a snubber if the transistor voltage reaches Vs in 0.1 s. [2]

(ii) Design a snubber using the criterion that the transistor voltage reaches its final value at the same time that the transistor current reaches zero. [3]

(iii Determine the transistor turnoff losses and the resistor power with the snubber added. [2]

Question 6

a) Explain in detail, how conductors are affected by Harmonics. [5]

b) With the aid of the Insulated-Gate Bipolar Transistor (IGBT) equivalent circuit diagram, describe its principle of operation. [8]

c) (i) Describe regenerative braking. [4]

(ii) Hence, highlight any three advantages of regenerative braking. [3]

Question 7

a) State and explain the four types of Bipolar Junction transistor (BJT) Power Losses. [6]

b) With reference to the simple thyristor chopper circuit diagram below, briefly describe the circuit operation. [4]

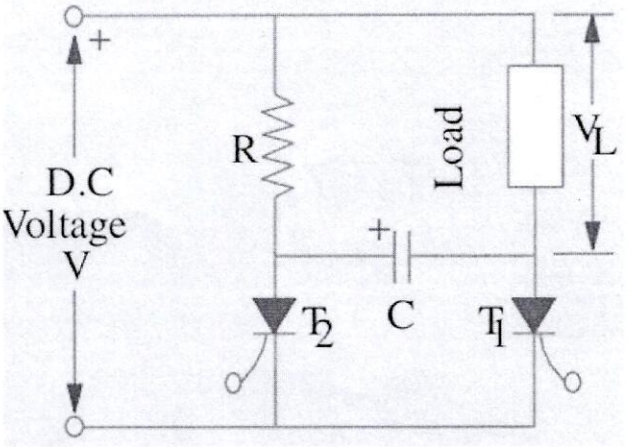


Fig 30.30a

c) Briefly describe the, Deleterious Effects of Harmonic Distortion and a Poor Power Factor. [6]

d) Highlight any two parameters to be adjusted to achieve Electronic Speed Control for a DC Motor. [2]

e) In electronic circuits, briefly describe the purpose saved by the snubber circuits. [2]