NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRONIC ENGINEERING

POWER ELECTRONICS APPLICATIONS

EEE 5212

Examination Paper

March 2025

This examination paper consists of 5 pages

Time Allowed : 3 hours

Special Requirements : Fourier Transform Tables

Examiner's Name : Dr. L. Matindife

External Examiners :

INSTRUCTIONS TO CANDIDATES

1. **Section-A** is **compulsory** with total **twenty five** marks.
2. In **Section-B** attempt any **three** questions out of **four** each **twenty five** marks.
3. Start the answers for each question on a fresh page.
4. Marks will only be awarded for answers that **directly** relate to the questions asked.

MARK ALLOCATION

	QUESTION	MARKS
SECTION-A	1.	25
SECTION-B	2.	25
	3.	25
	4.	25
	5.	25
TOTAL	4	100

Section- A

Question 1

a) What do you understand by freewheeling Diode? Discuss any two modes of operation with equivalent circuit diagram. [5]

b) Ten thyristors are used in a string to withstand a dc voltage of 15 kV. Determine the derating factor given that the worst case steady state voltage across the thyristor is 1800V. [2]

c) Explain the operation of the diagram in Fig. 1a [3]

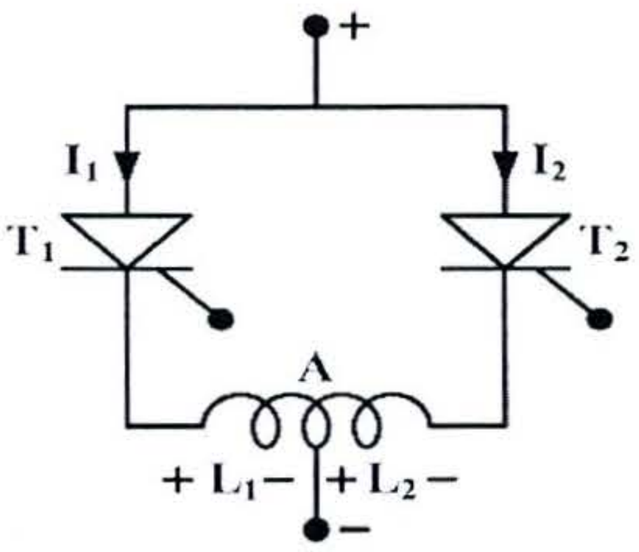

Fig. 1a

d) Identify the circuit given in Fig. 1b and explain its operation. [4]

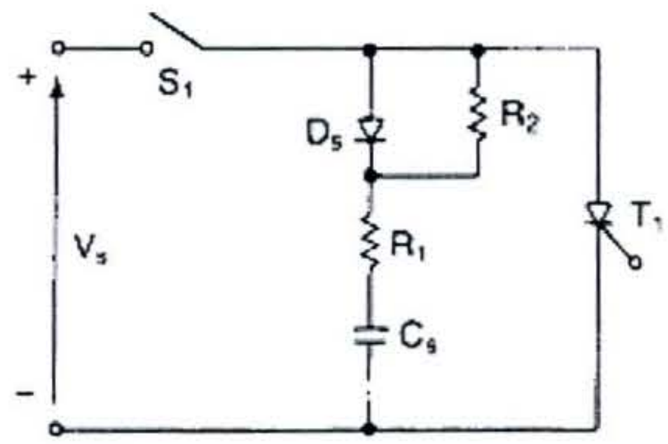

Fig. 1b

e) What is the difference between asynchronous and synchronous PWM? [1]

f) Give a brief description the Time-shifted waveform harmonic cancellation methods. [2]

g) What are the typical reactive VAR requirements of HVDC converters? [2]

h) Give two advantages and two disadvantages of switching power supplies. [2]

i) Define the terms DPF, THD and explain its significance. [2]

j) What is meant by ZVS and ZCS. [2]

Section B

Question 2

a) Consider a snubber configuration across a thyristor operating at 400 V (peak) supply such that the repetitive peak current, I_p is 250 A. If the value of $\frac{di}{dt}\max = 60\ A/\mu sec$ and $\frac{dV}{dt}\max = 200\ V/\mu sec$ as shown in Fig.2. Determine the value of Rs considering a safety factor of 2. [8]

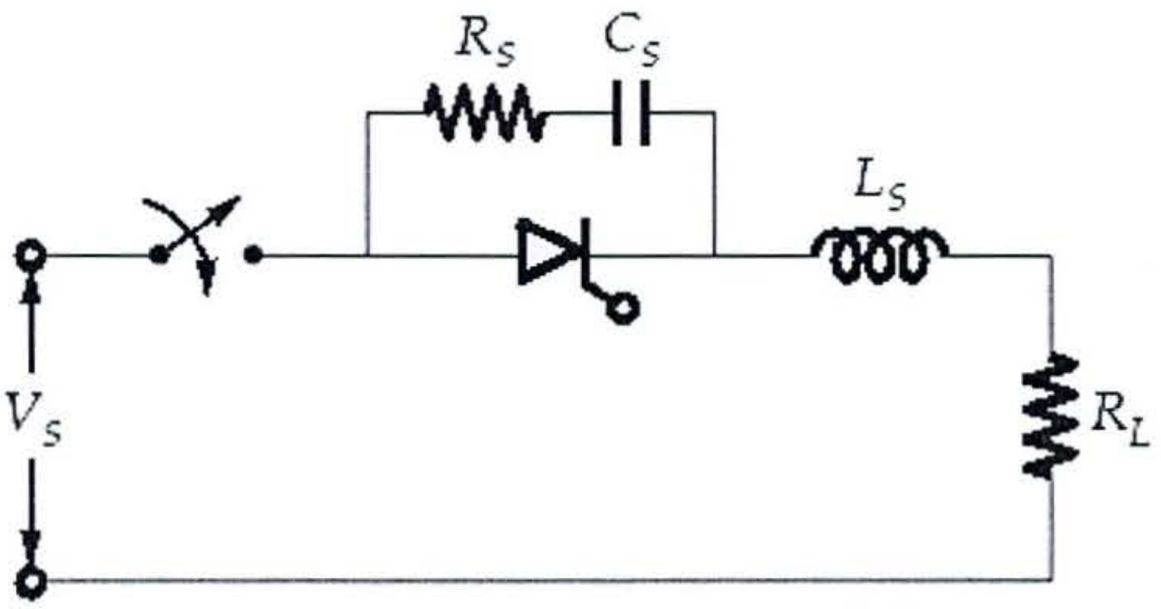

Fig. 2

b) Explain the principle operation of a fly back and pushpull converter. [12]

c) Explain the normal specifications of power supplies. [5]

Question 3

a) A full bridge inverter has bi-directional switches employed in a manner that their switching sequence produces a square wave voltage across a series *R-L* load. If the switching frequency is 50 Hz, dc supply voltage, Vdc = 100 V, R = 10 Ω and L = 25 mH. Determine the power absorbed by the load and rms value of current respectively. [8]

b) A single phase inverter is operated in PWM mode generating a single pulse of width '2d' in the centre of each half cycle as given in Fig. 3a,

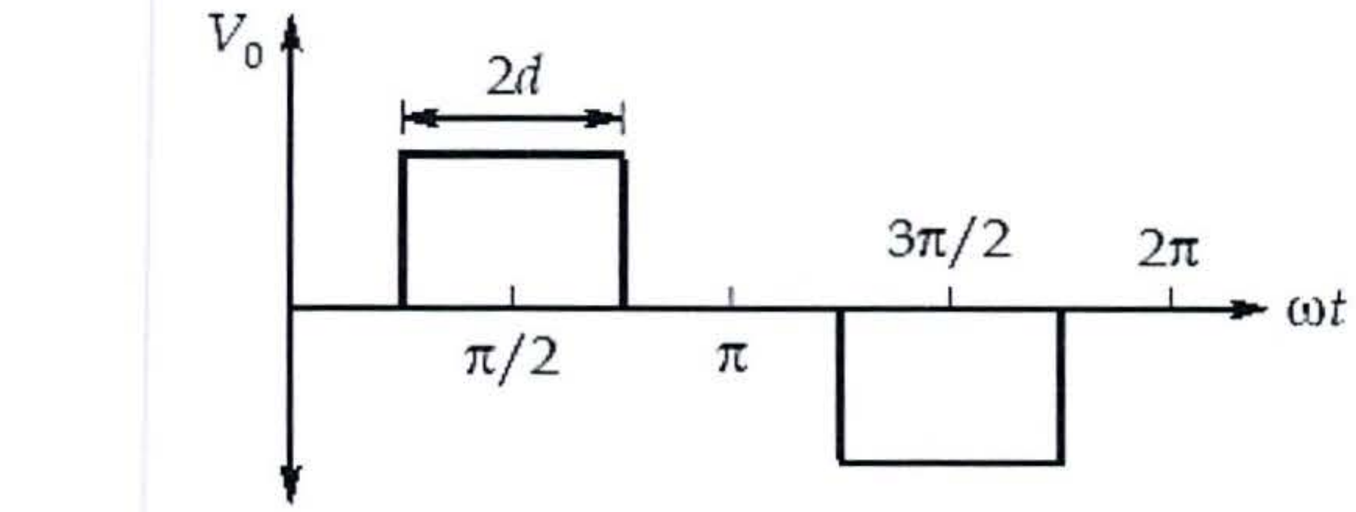

Fig. 3a

If the pulse width is 140°, determine the ratio of maximum value of third harmonic output voltage to maximum value of fundamental output voltage. [6]

c) With the help of neat diagram explain the three phase inverter operation, also discuss the effect of blanking time on voltage in PWM inverters. [13]

Question 4

a) List the various classification of resonant converters [5]

b) The zero current resonant switching of T1 in Fig. 4 can be analyzed in five distinctive stages. Give a detailed explanation of these stages with the help of waveforms and equivalent circuits. [10]

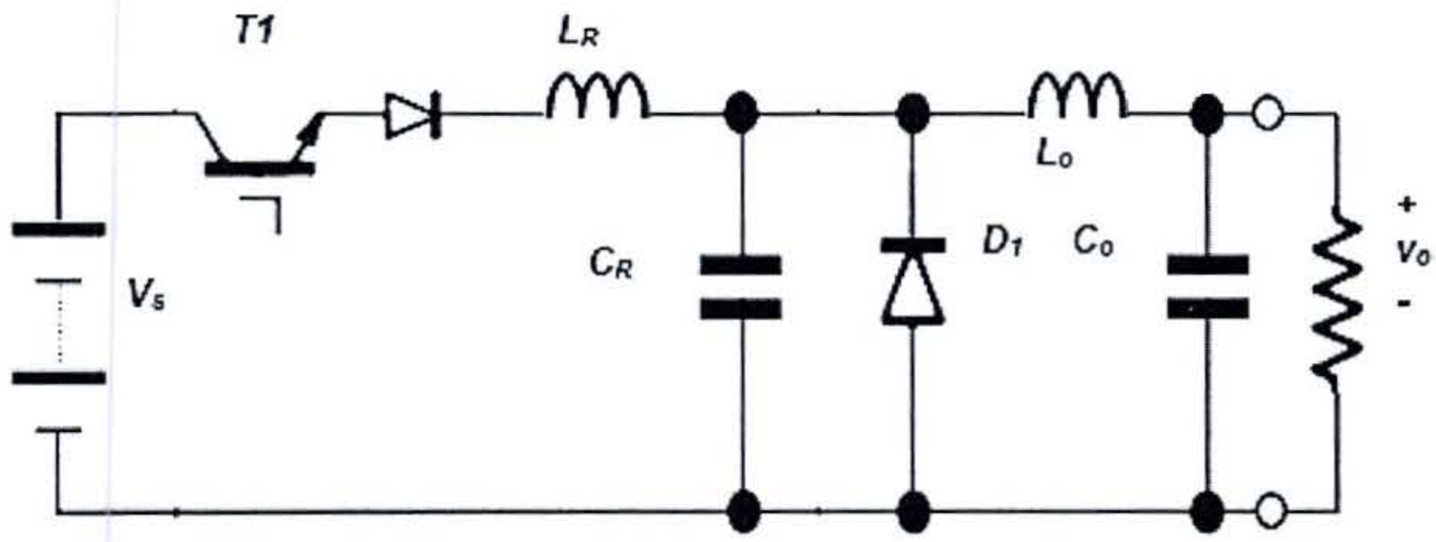

Fig. 4

c) Explain operation of static voltage compensator (SVC). [10]

Question 5

a) A 50 Hz 400V ac transmission line has line reactance of X_L 2.2 Ω and is delivering 100 KW. A Shunt TCR is to be specified. Calculate:

i) The load angle δ [1]

ii) The line current [2]

iii) The TCR and line reactive powers. [2]

iv) The TCR current and reactance and inductance at this current. [2]

b) In block diagram form show the major components of a HVDC converter station. [3]

c) Explain briefly about different types of HVDC links. [3]

d) What is the space vector modulation technique (SVM)? [3]

e) Develop the voltage space vectors with reference to a three phase inverter topology. [9]