Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
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I SEMESTER M. TECH (POWER ELECTRONICS & DRIVES)
END SEMESTER EXAMINATIONS, NOVEMBER- DECEMBER 2023

POWER ELECTRONIC CONVERTER [ELE 5113]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 02 DECEMBER 2023** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Describe how two series connected SCRs are subjected to unequal voltage distribution during their dynamic conditions. *(04)*

1B. What is the significance of a safe operating area of power IGBT? Explain the switching behavior of power *IGBT*. *(04)*

1C. Why is it necessary to use fast-recovery diodes for high-speed switching? *(02)*

2A. Consider the single-phase full wave converter with resistive load. Switches T1 and T2 are given pulses at every α, and T3 and T4 are given pulses at every α+180°. Unknowingly the gate drives of T3 and T4 are removed and T1 and T3 are given by the pulses. Now analyze the output voltage, output current, and voltage across the switches, and also derive the output voltage. *(04)*

2B. A converter is operated with a 5kW power and the source inductance is 5% of the rated voltage and the rated volt Amp.10KVA. Determine the commutation angle and $\frac{Vd}{Vd0}$ with the rated input voltage as shown below Fig.Q.no.2B.

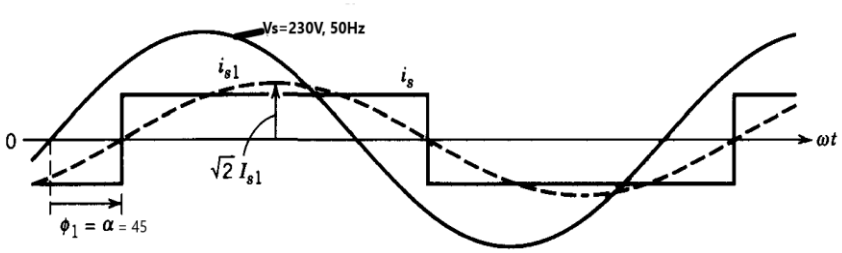

Fig.Q.no.2B. *(03)*

2C. A single-phase half-controlled converter is used to control the power of 1000 watts heater. The source voltage is 230V,50Hz. Determine the heater power for a firing angle of 45°. *(03)*

3A. Three phase full converter fed from a 3-phase, 400V, 50Hz source, is connected to a separately excited DC motor. The armature resistance is 10Ω and back emf is 300V, and large inductance so that the output current is ripple-free. Determine the power delivered to load and input power factor for firing angle $\alpha = 30°$. *(04)*

3B. In the full-bridge DC-AC converter circuit, the source voltage is 350V, m_a=0.8, m_f =31 and the fundamental frequency is 50Hz. Calculate the RMS values of the fundamental frequency voltage and the same of the dominant harmonics in the output voltage, if a PWM bipolar voltage switch scheme is used. Plot its harmonic spectrum. Refer the Table 1: Generalized Harmonics of V_{A0} for Large m_f of Q.no.3B. *(04)*

3C. A single-phase bridge-type cyclo converter feeds a resistive load. For an output frequency equal to one-third of the input frequency, analyze output voltage waveform for a firing angle of about 30°. Assume continuous load current *(02)*

4A. Analyze the output voltage harmonics spectrum analysis of pulse width modulated switching scheme of a single-leg switch-mode inverter. *(03)*

4B. Analyze the waveforms for two cycles of supply voltage, supply current, load voltage, and load current for a firing angle of about 45° for the two thyristors, as shown below in Fig.Q.no.4B, and also derive the average output voltage.

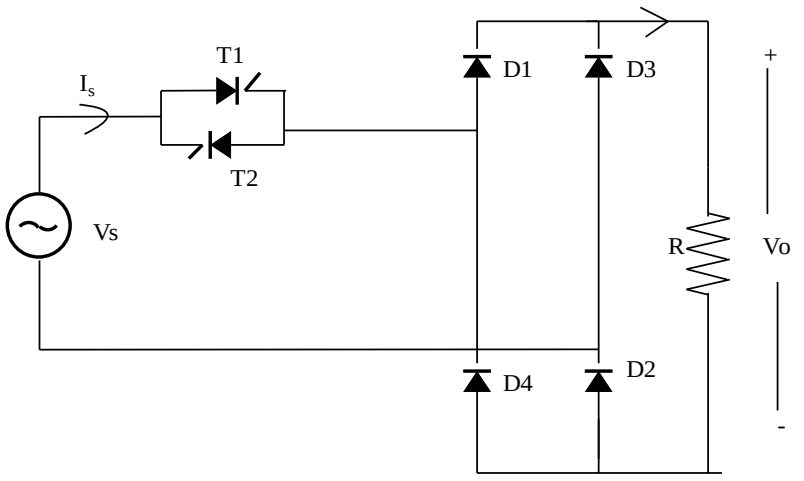

Fig.Q.no.4B *(04)*

4C. Analyze a five-level cascaded H-Bridge multilevel inverter topology used in medium power applications. *(03)*

5A. Discuss the working of a load-commutated chopper. Derive an expression from which the value of the commutating capacitor of this chopper can be computed. *(03)*

5B. Analyze the output voltage and current waveform of a two-quadrant type B chopper supplying a separately excited DC motor. Consider T_{on} is less than T_{off}. *(03)*

5C. Explain the working of the three-phase square wave inverter controlled by 120° mode of operation. Analyze the phase and line voltage waveforms. *(04)*

Table 1: Generalized Harmonics of VA0 for Large mf

Generalized Harmonics of v_{Ao} for a Large m_f.

h \ m_a	0.2	0.4	0.6	0.8	1.0
1 Fundamental	0.2	0.4	0.6	0.8	1.0
m_f	1.242	1.15	1.006	0.818	0.601
$m_f \pm 2$	0.016	0.061	0.131	0.220	0.318
$m_f \pm 4$					0.018
$2m_f \pm 1$	0.190	0.326	0.370	0.314	0.181
$2m_f \pm 3$		0.024	0.071	0.139	0.212
$2m_f \pm 5$				0.013	0.033
$3m_f$	0.335	0.123	0.083	0.171	0.113
$3m_f \pm 2$	0.044	0.139	0.203	0.176	0.062
$3m_f \pm 4$		0.012	0.047	0.104	0.157
$3m_f \pm 6$				0.016	0.044
$4m_f \pm 1$	0.163	0.157	0.008	0.105	0.068
$4m_f \pm 3$	0.012	0.070	0.132	0.115	0.009
$4m_f \pm 5$			0.034	0.084	0.119
$4m_f \pm 7$				0.017	0.05(