Modified

CBCS SCHEME

USN | | | | | | | | | | |

17EE53

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Power Electronics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Explain any five types of power electronics converter system and also specify the form of input and output waveform. **(10 Marks)**

b. With block diagram, explain the peripheral effects of power electronic equipments. **(06 Marks)**

c. Discuss the major industrial applications of power electronic converter circuits. **(04 Marks)**

OR

2 a. Briefly explain the different types of power diodes. **(08 Marks)**

b. With circuit diagram and waveform explain uncontrolled single phase full wave rectifier with RL load. **(08 Marks)**

c. Compare the advantages and disadvantages of bridge rectifier and rectifier with center tapped transformer. **(04 Marks)**

Module-2

3 a. With neat circuit diagram, explain steady state and switching characteristics of power MOSFET. **(12 Marks)**

b. A BJT is specified to have β in the range 8 to 40 load resistance $R_C = 11\Omega$, the DC supply voltage is $V_{CC} = 200$volts and the input voltage to the base circuit is $V_{BB} = 10$ volts. If $V_{CE(sat)} = 1$ volt and $V_{BE(sat)} = 1.5$ volt, find :

i) The value of R_B that result in saturation with an ODF of 5.

ii) The forced β value and

iii) Power loss in the transistor. **(08 Marks)**

OR

4 a. With necessary waveform explain the switching characteristics of IGBT. **(06 Marks)**

b. Discuss the importance of providing isolation of gate/base drive from power circuits and explain the two methods. **(06 Marks)**

c. Sketch the structure of n-channel enhancement type MOSFET and explain its working principle. **(08 Marks)**

Module-3

5 a. Explain the V-I characteristics of SCR also define : i) Holding current ii) Latching current. **(06 Marks)**

b. Explain different methods of turning ON of thyristor. **(08 Marks)**

c. For the circuit shown in Fig.Q5(c). If the latching current is 4mA calculate the minimum width of gate pulse required properly turn ON the SCR. **(06 Marks)**

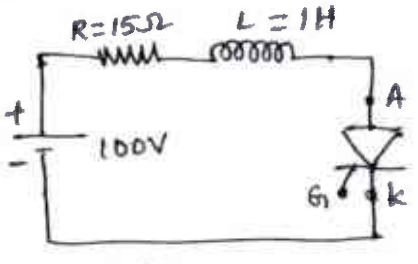

Fig.Q5(c)

OR

6 a. Derive an expression for the anode current of thyristor with the help of two transistor analogy. **(10 Marks)**

b. With circuit diagrams and waveforms, explain the methods of protection of SCR. **(10 Marks)**

Module-4

7 a. With the help of circuit diagram and wave forms, explain the working of single – phase full converter with R–L load. **(10 Marks)**

b. A single phase full wave AC voltage controller has an input voltage of 230V and load resistance of 10Ω. The firing angle is 45°, calculate :

i) RMS output voltage
ii) The output power
iii) The input power factor. **(10 Marks)**

OR

8 a. With circuit diagram and waveforms explain 1ϕ dual converter. **(10 Marks)**

b. With circuit diagram and waveform, explain the operation of 3ϕ full converters. **(10 Marks)**

Module-5

9 a. Explain the working of step-up chopper. Draw the relevant waveforms, derive an expression for average output voltage. **(08 Marks)**

b. Write a note on performance parameters of chopper. **(04 Marks)**

c. A stepdown chopper with resistive load has a resistive load of 10Ω and the input voltage is V_S = 220V. When the converter switch remains ON its voltage drop is 2V and the chopping frequency is f = 1KHz, if the duty cycle is 50% determine :

i) Average output voltage
ii) RMS output voltage
iii) Chopper efficiency
iv) Effective input resistance. **(08 Marks)**

OR

10 a. With circuit diagram, explain the operation of a single phase–full bridge inverter suppling a resistive load. **(10 Marks)**

b. Explain any two modulation technique available for voltage control of a single phase inverter. **(10 Marks)**

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17EE53

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Scheme and solutions EEE

1 message

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Sat, Jan 4, 2020 at 11:26 AM

Good Morning
the Scheme and solutions of following subjects are not having any modification and approved from my end
17EE53-Power Electronics
Q 7a.circuit-2M, Waveforms 3M,Derivation3m,Explanation 2M

Q 9c. V_{avg}=109v and V_{rms}=154.15v

Dr.A.manjunatha.
Chairman BOE, EEE

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Signature of Scrutinizer

Scheme & Solution

Subject Title : POWER ELECTRONICS Subject Code : 17EE53

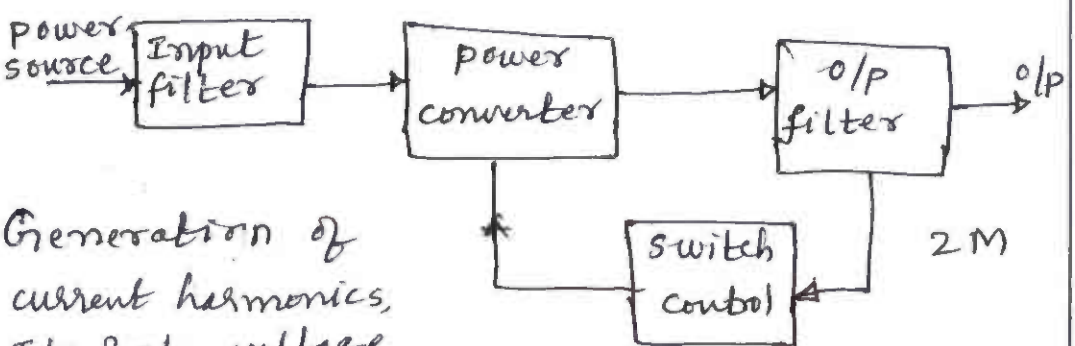
Question Number	Solution	Marks Allocated

Module-1

1(a) i) Diode rectifier
ii) AC-DC converter
iii) A.C-A.C —11—
iv) D.C-D.C —11—
v) static switches

} circuit with I/p & o/p waveforms with presence of gate waveform/signals
5X2M = 10M — 10M

(b)

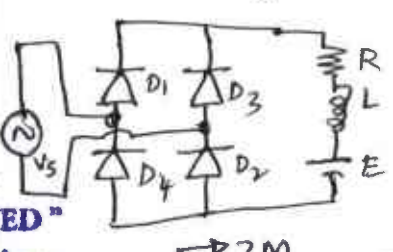


Generation of current harmonics, I/p & o/p voltage THD, Displacement factor, etc → 4M — 2M — 2+4

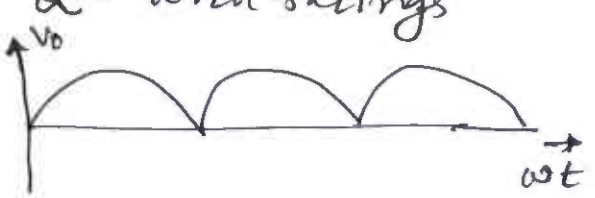
(c) SMPS is an A.c adapter, variable speed drives, HVDC power transmission, DC/AC converters (Inverters), D.C Motor drives, power distribution networks, Boilers, circuit breakers ----etc — 4

2(a) Explanation about (i) General purpose diode →3M
(ii) High speed (or) fast recovery diode - 3M
(iii) schottky diode - 2M with ratings — 8M

(b)



→2M



ckt with E or without E can also be consider. — 2M

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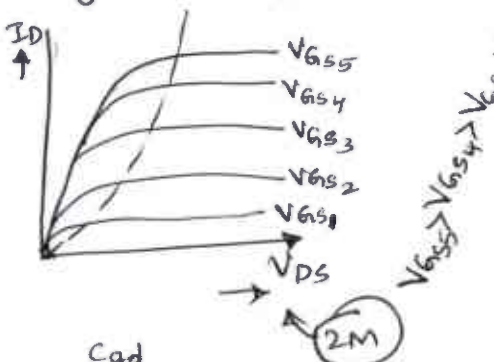
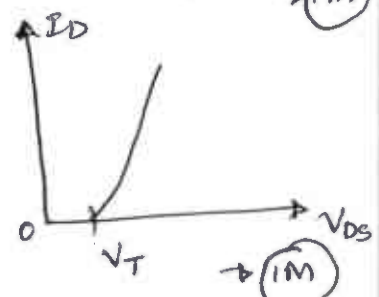
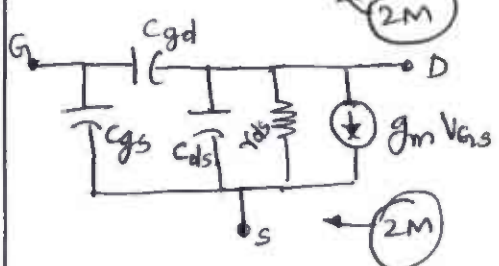
Question Number	Solution	Marks Allocated
	$L\frac{di_L}{dt} + Ri_L + E = \sqrt{2}V_s \sin\omega t \rightarrow (1) \rightarrow$ (1M)	
	$I_o = \left\lvert \frac{\sqrt{2}V_s}{Z} \sin(\omega t - \theta) \right\rvert$	8M
	$I_{rms} = (I_r^2 + I_a^2)^{1/2} = \sqrt{2}I_r$; $I_d = \frac{1}{2\pi}\int_0^{\pi} I_L \, d(\omega t)$	
	W/F & derivation → (5M)	
(c)	Advantages → 2M Disadvantages → 2M	4M
3(a)	Steady state of MOSFET	
	 (2M)	
	$g_m = \frac{\Delta I_D}{\Delta V_{GS}}\Big\rvert_{V_{DS}=\text{constant}}$ → (1M)	
	 (1M)	
	 (2M)	
	Switching model w/F → (3M)	
	$t_{ON} = t_{d(on)} + t_r$	
	$t_{off} = t_{d(off)} + t_f$	
	Explanation → (3M)	
(b)	$I_{CS} = \frac{V_{CC} - V_{CE(sat)}}{R_C} = \frac{200-1}{11} = 18.1A$ ← 1M	
	$I_{B(sat)} = \frac{I_{C(sat)}}{\beta_{min}} = \frac{18.1}{8} = 2.2625A$ ← 1M	
	$ODF = \frac{I_B}{I_{BS}}$; $I_B = 11.3125A$ ← 1M ; $I_B = 5 \times 2.2625$	
	(i) $R_B = \frac{V_B - V_{BE}}{I_B} = 0.7514\,\Omega$ (ii) $\beta_F = 1.6$	
	(iii) $P_T = V_{BE}I_B + V_{CE}I_C$	
	$= 35.07\,W$ → 2M	

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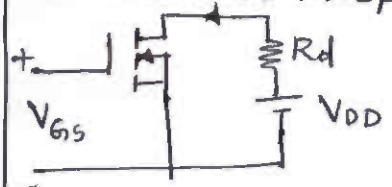
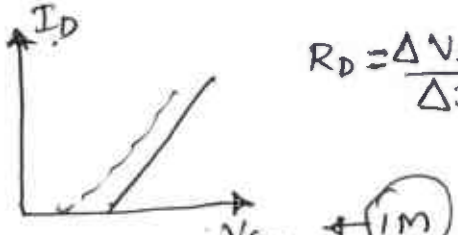
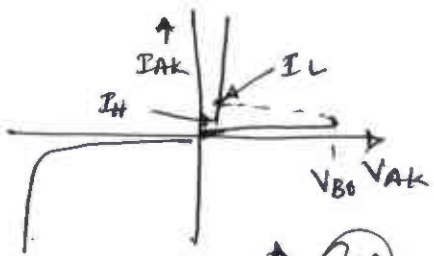
Question Number	Solution	Marks Allocated
4(a)	waveform : $t_{ON} = t_{d(ON)} + t_r$ (3M) $t_{OFF} = t_{df} + t_{f_1} + t_{f_2}$ explanation of td, tr, tf, etc → (3M)	6M
(b)	Isolation using (i) pulse transformer → fig & explanation & (ii) opto coupler → fig & explan	6M
(c)	n-channel MOSFET 3X2 = 6M  (1M)  $R_D = \frac{\Delta V_{DS}}{\Delta I_D}$ (1M) Enhancement fig with p type substrate, metal -oxide fig → (3M) & explanation → (3M)	8M
5(a)	V-I characteristics of SCR  (2M) (i) Explanation of I_L → (1M) (ii) —"— I_H → (1M) explanation of SCR with fig → (2M)	6M
(b)	i) Thermal Triggering ii) Light —"— iii) High V/g —"— iv) $\frac{dV}{dt}$ —"— v) Gate —"— } Explanation of any 4 4X 2M = (8M)	8M
(c)	Fig Q5C $i(t) = \frac{V_s}{R}(1 - e^{-\frac{tR}{L}})$ → (2M) $e^{-15t} = 0.99$ → (2M) ; $t = 0.04ms$ → (2M)	6M

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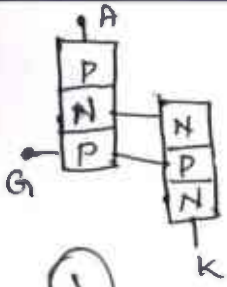
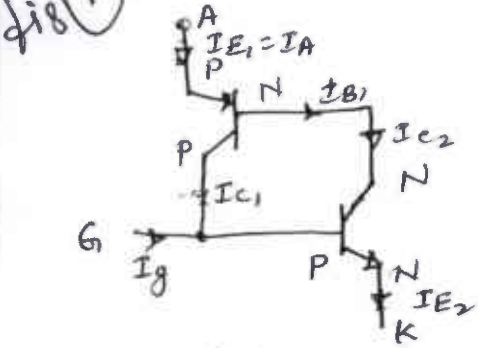
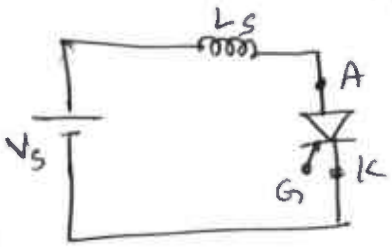
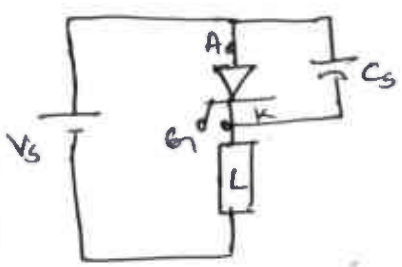
Question Number	Solution	Marks Allocated
6 (a)	 $I_C = \alpha I_E + I_{CBO}$ $I_{C_1} = \alpha_1 I_{E_1} + I_{CBO_1}$ $I_{C_2} = \alpha_2 I_{E_2} + I_{CBO_2}$ → (2M) $I_A = I_{C_1} + I_{C_2}$ $I_{B_1} = I_{C_2}$ $I_{E_1} = I_{B_1} + I_{C_1}$ $I_{E_2} = I_A + I_g$ → (2M) $I_A = \frac{I_{CBO_1} + I_{CBO_2} + I_g}{1 - (\alpha_1 + \alpha_2)}$ ← 2M	10M
	fig (1)  Fig → (2M) Explanation → (2M) fig (1) mark	
(b)	 $L \geq \frac{V_S}{\frac{di}{dt}}$ $\frac{di}{dt} = \frac{V_S}{L_S}$ Fig → 2M explanation → (3M)	10M
	 $I = C_S \frac{dv}{dt}$ Fig → (2M) Explanation → 3M Circuit — (2)	
7 (a)	1-ϕ Full converter with RL load (5) ckt → (2) o/p, I/p, I_o, waveform (3) Derivation $V_o = \frac{2V_m}{\pi}\cos\alpha$, where $\alpha \to 0°$ to $90°$ (3) explanation → 2M,	10M
(b)	$V_m = \sqrt{2}V_S = \sqrt{2} \times 230 = 325.26V$ ← (2M) (3) (i) $V_o = \frac{V_m}{2}\sqrt{\frac{2\pi - \alpha + \frac{\sin 2\alpha}{2}}{\pi}} = \frac{325.26}{2}\sqrt{\frac{2\pi - 45° + \frac{\sin 2\times 45}{2}}{\pi}}$ → (1M) $V_o = 215.315V$ ← (2M) (ii) $P_o = \frac{V_o^2}{R} = 4636W$ ← (3M) (iii) I/p p.f $= \frac{V_o}{V_S} = 0.936$ ← (2M)	10M

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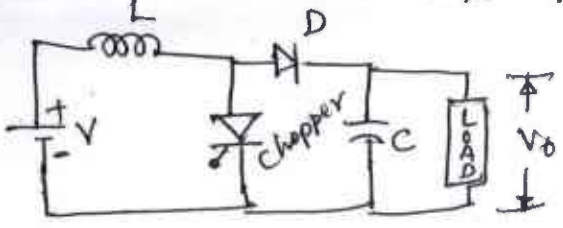
8 (a)	circuit diagram of 1φ dual converter → (3M) V_o, I_o equations derivation → (4M) explanation → (3M)	10M
(b)	3φ full converter circuit → (3M) $V_{avg}, V_{rms} = \sqrt{2}V_m\left(\frac{1}{2} + \frac{3\sqrt{3}}{4\pi}\cos 2\alpha\right)^{1/2}$ → (3M) operation of ckt based on α → delay angle → (2M) $V_{RN}, V_{YN}, V_{BN}, V_{RY}, V_{YB}$ & V_{BR} → (2M)	10M
9 (a)	 $V_o = V + L\frac{di}{dt}$ $V_o > V$ ckt diagram → (2M) ; derivation and explanation → (3M) waveforms → (3M)	08
(b)	performance parameters of chopper (i) Turn ON & turn OFF (ii) k → duty cycle can be varied b/w min to max value (iii) Ripple in the load $\propto \frac{1}{f}$ (iv) To reduce load ripple current, 'f' should be high as possible, etc	4M
(c)	(i) $V_{avg} = k(V_s - V_{ch}) = 0.5(220-2) = 154.15V$ → (2M) o/p power $P_o = [k(V_s - V_{ch})^2]/R = 2376.2W$ → (2M) $P_i = [k V_s (V_s - V_{ch})]/R = 2398W$ → (1M) (iii) chopper $\eta = P_o/P_i = \frac{2376}{2398} = 99.08\%$ (iv) $R_i = \frac{10}{0.5} = 20\Omega$ → (1M)	8M

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Question Number	Solution	Marks Allocated
10 (a)	Bridge Inverter ckt → (3 M) W/f - V_s, V_o → (4 M) explanation → (3 M)	10M
(b)	PWM technique (i) 1ϕ PWM (ii) Multiple PWM (iii) sinusoidal PWM (iv) phase displacement (v) Modified sinusoidal PWM explain any 2 with W/F 2×5 = (10M)	10M

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