Modified

CBCS SCHEME

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

15EC73

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. What is a converter? How are power converters classified? Explain briefly. **(08 Marks)**

b. Give symbol, characteristic features of the following devices:
GTO, TRIAC, MOSFET, UJT **(08 Marks)**

OR

2 a. With necessary waveforms, explain the steady state characteristics of a power transistor. **(08 Marks)**

b. Draw the switching model of MOSFET and explain its switching characteristics with neat figure. **(08 Marks)**

Module-2

3 a. With a neat figure, explain the dynamic turn-on and turn-off characteristics of a thyristor. **(08 Marks)**

b. Derive expression for anode current using two-transistor model in case of SCR. **(08 Marks)**

OR

4 a. What is forced commutation? With the help of circuit diagram and waveform, explain the operation of class-A commutation. **(08 Marks)**

b. With neat circuit diagram and waveforms, explain RC – Half wave firing circuit. **(08 Marks)**

Module-3

5 a. With a circuit diagram and waveform, explain the working of a single-phase full converter with RL load. Derive an expression for the average voltage across the load. **(08 Marks)**

b. What is a dual converter? Explain its operation with a neat circuit diagram. **(08 Marks)**

OR

6 a. What is an AC voltage controller? With the help of waveform, explain ON-OFF AC voltage controller. **(08 Marks)**

b. Explain the operation of single phase bi-directional AC voltage controller for inductive load with the help of circuit diagram and waveforms. **(08 Marks)**

Module-4

7 a. Explain the working principle of step-down chopper and derive expression for :
(i) Average output voltage
(ii) Output power
(iii) Effective input resistance in terms of chopper duty cycle. **(08 Marks)**

b. Explain the operation of a step-up chopper with resistive load. **(08 Marks)**

OR

8 a. With the help of circuit diagram, explain four quadrant type E Chopper. **(08 Marks)**

b. With the help of circuit diagram and waveforms, explain the working of a Buck regulator. Derive the expression for peal-peak-ripple current of the inductor. **(08 Marks)**

Module-5

9 a. Explain the operation of single-phase half bridge inverter with feedback diodes, derive the expression for r.m.s output voltage. **(08 Marks)**

b. With the help of circuit diagram and waveform, explain the operation of transistorized current source inverter. What are the advantages and disadvantages of CSI? **(08 Marks)**

OR

10 a. Explain the performance parameters of inverters. **(08 Marks)**

b. Explain the variable DC link inverter with circuit diagram and waveforms. **(04 Marks)**

c. Write short note on static switches. **(04 Marks)**

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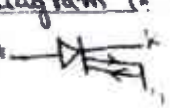
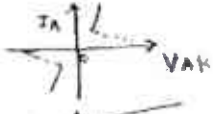
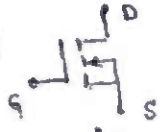
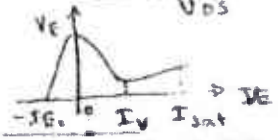
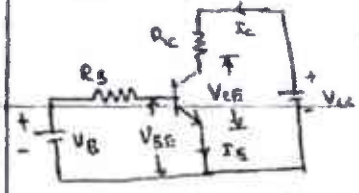
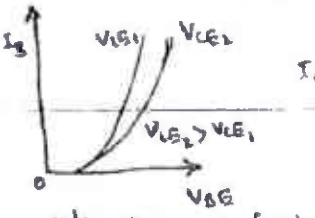
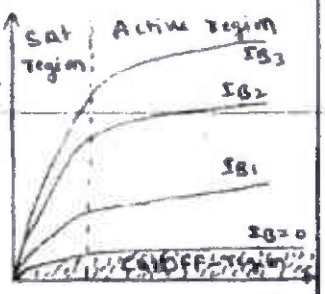
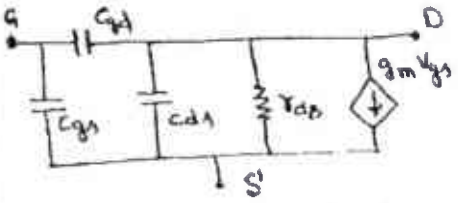
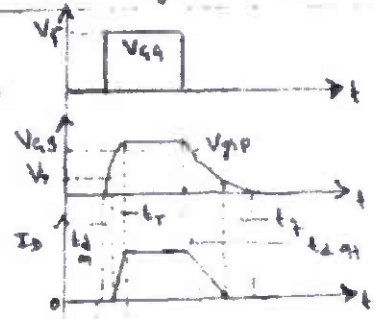
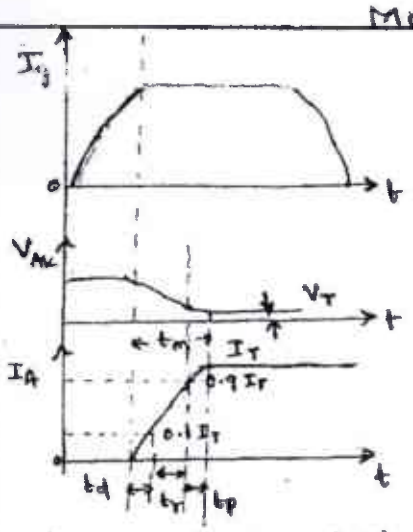
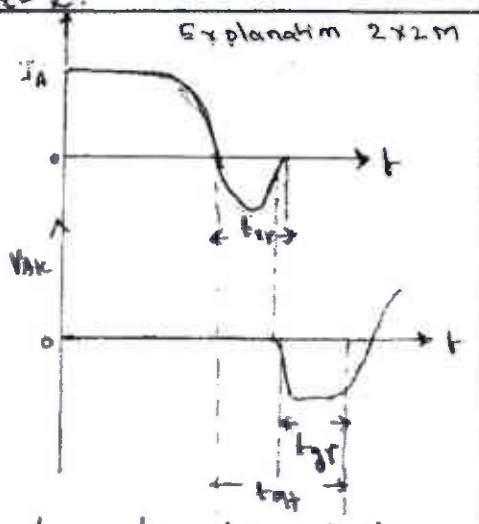
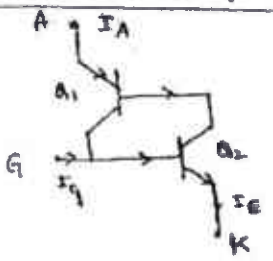
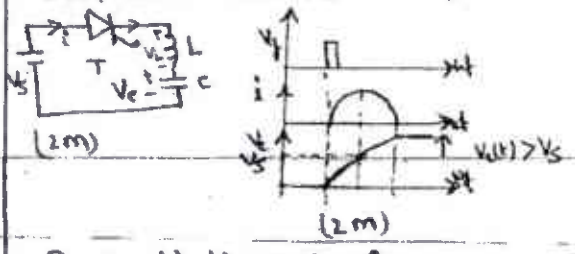
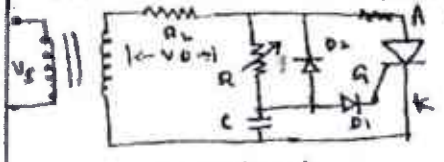
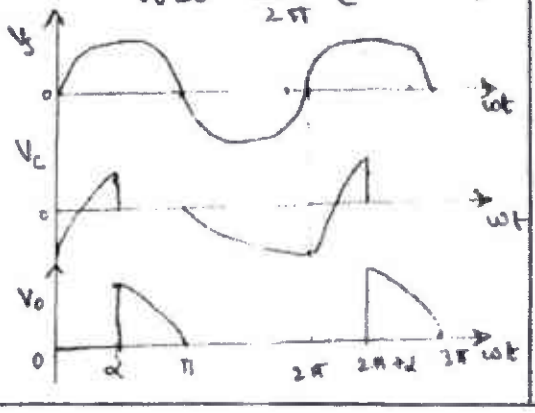
Subject Title: POWER ELECTRONICS **Subject Code:** 15EC73

Question Number	Solution	Marks Allocated
	Module - 1	
1 a.	Power Conversion: Conversion of power from one form to other	01
	• 6 types: 1) diode rectifier, 2) AC-dc (Controlled rectifier)	
	3) AC-AC (AC voltage controllers) 4) DC-dc (choppers)	01
	5) DC-AC (Inverters) 6) Static switches	
	• Circuit diagram & explanation any three (3×2M)	06
b.	• G.T.O:  	2M
	• TRIAC:  	02
	• MOSFET:  	02
	• UJT:  	02
2 a.	Steady - state characteristics of BJT	
	  	04
	Circuit - diagram (1m) I/p - characteristics (1m) O/p - characteristics V_{CE} (2m)	
	Explanation: I/p - characteristics - (1m).	
	O/p - Characteristics with three regions (3M)	04
b.	 	2+3+3
	Switching model (2M) (3M)	
	Explanation (3M)	
	$t_m = t_{d(on)} + t_r$ t_m t_{on} $t_{on} = t_{d on} + t_r$	

Subject Title: **Subject Code:**

Question Number	Solution	Marks Allocated
3 a.	Module - 2.  $t_m = t_d + t_r + t_p$ (2m)  $t_{off} = t_{rr} + t_{gr}$ (2m) Explanatim 2×2M	04 04
b.	 Ckt - (2M) Derivatim - (4M) Explanatim (2M) $I_A = \frac{\alpha_2 I_g + I_{CBO_1} + I_{CBO_2}}{1 - (\alpha_1 + \alpha_2)}$	2+4+2
4 a.	Turning off an SCR using external ckt components L & C Self commutatim (class-A)  (2m) (2m) operatim - (3m) $V_s = L\frac{di}{dt} + \frac{1}{C}\int i(t)dt$ $V_c(t=0) = 0$ $i(t) = V_s\sqrt{\frac{C}{L}}\sin\left(\frac{t}{\sqrt{LC}}\right)$ $t = \pi\sqrt{LC}$ at $i(t) = 0$ $\therefore$ commutatim time $t = \pi\sqrt{LC}$	01 2+2+3
b.	R.C. Half wave firing ckt:  Ckt - (2M) Explanatim of operatim. Explanatim - (4M) $V_{o\,dc} = \frac{V_m}{2\pi}(1 + \cos\alpha)$ 	2+4+2

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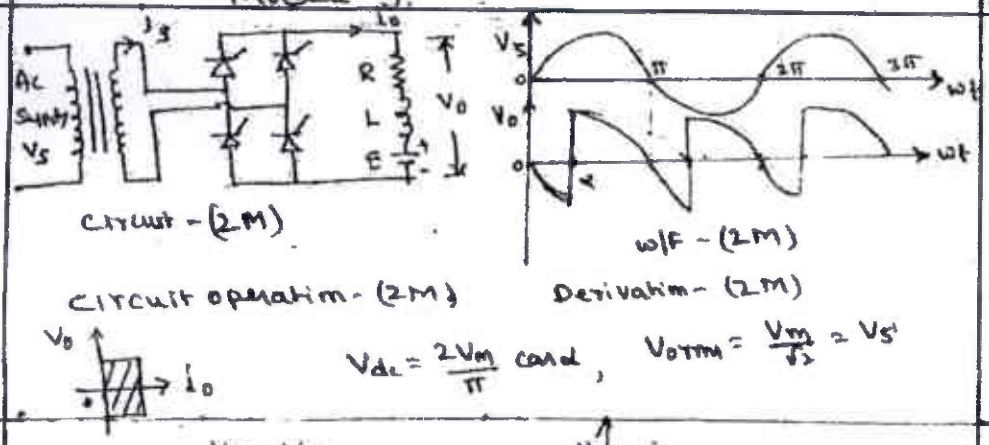
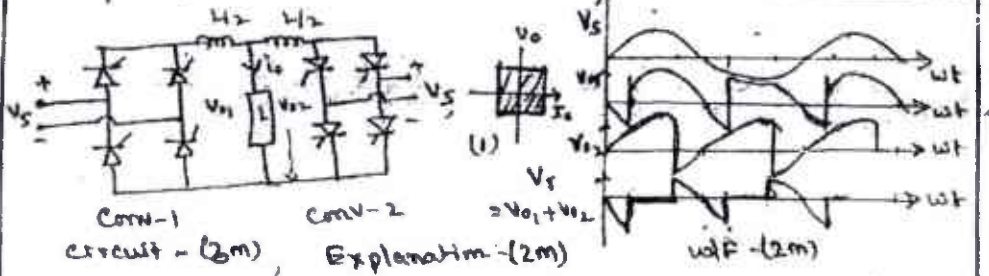
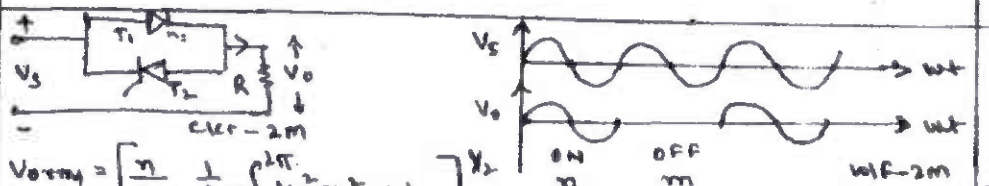
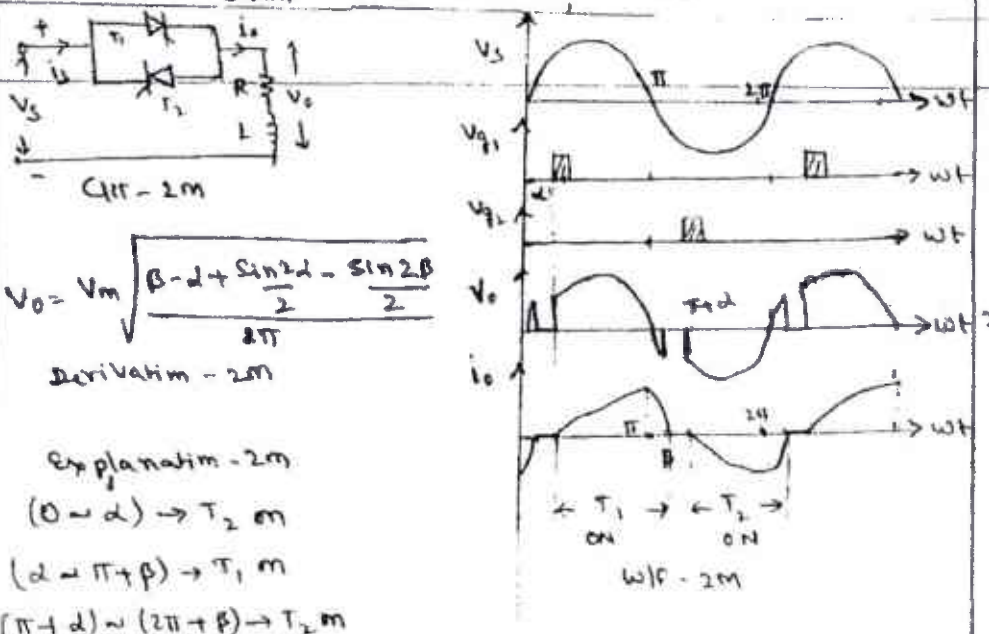
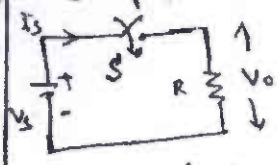
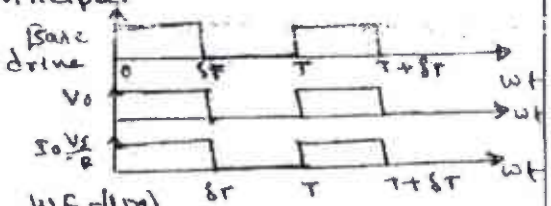
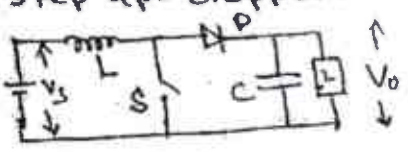
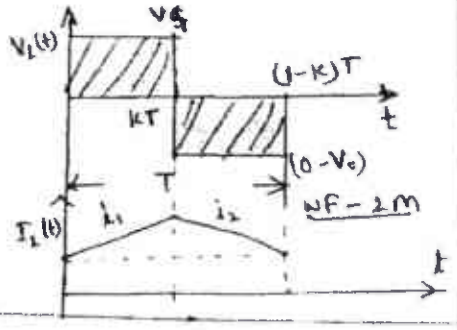
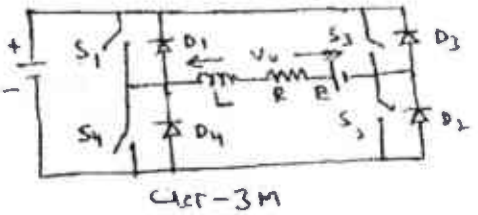
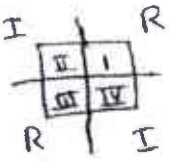
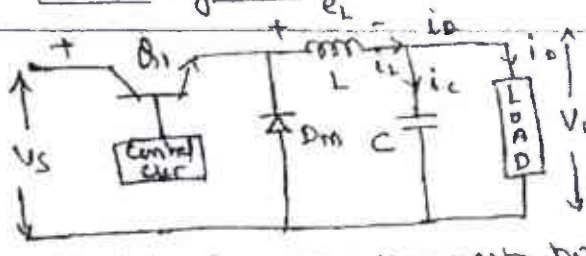
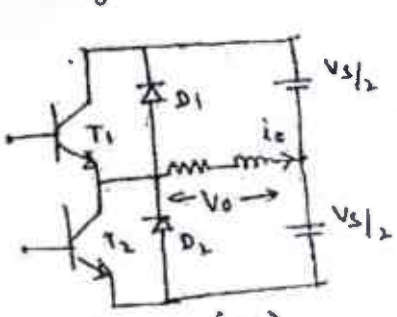
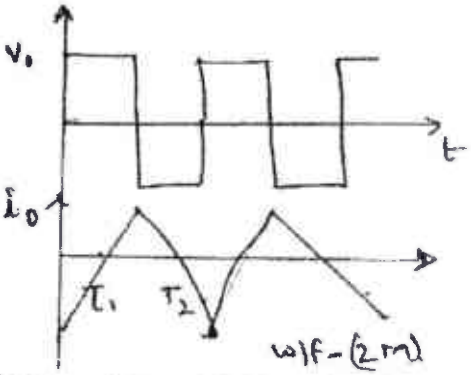
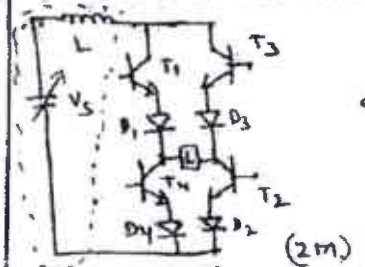
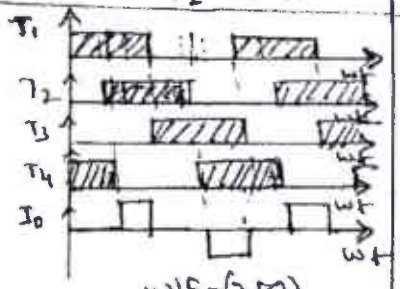
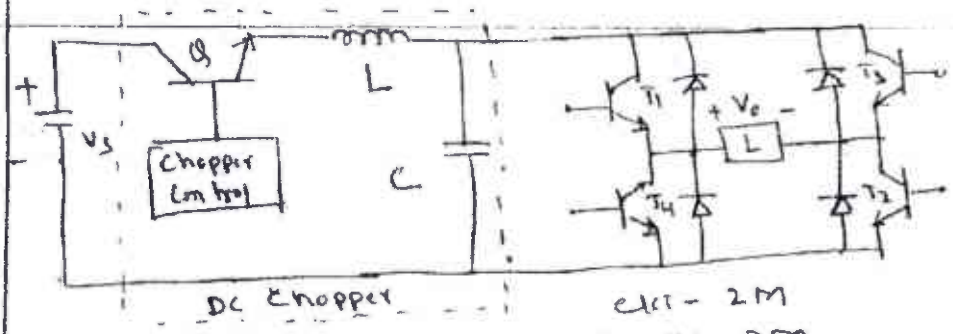
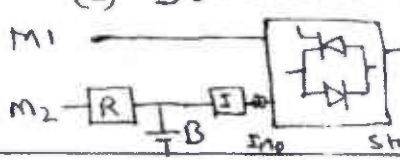
Question Number	Solution	Marks Allocated
5 a.	Module-3.  Circuit - (2M) w/F - (2M) Circuit operation - (2M) Derivation - (2M) $V_{dc} = \frac{2V_m}{\pi}\cos\alpha$, $V_{o rms} = \frac{V_m}{\sqrt{2}} = V_s$	2+2+2+2
5 b	 Circuit - (3m), Explanation - (2m) w/F - (2m)	3+1+2+2
6. a	 Ckt - 2m $V_{o rms} = \left[\frac{n}{n+m}\frac{1}{2\pi}\int_0^{2\pi} V_m^2 \sin^2\omega t\, d\omega t\right]$ $V_{o rms} = \sqrt{k}\cdot V_{s rms}$ Derivation - 2m Explanation - 2m	2+2+2+2
b.	 Ckt - 2m $V_o = V_m\sqrt{\frac{\beta - \alpha + \frac{\sin 2\alpha}{2} - \frac{\sin 2\beta}{2}}{2\pi}}$ Derivation - 2m Explanation - 2m $(0 \sim \alpha) \rightarrow T_2$ on $(\alpha \sim \pi+\beta) \rightarrow T_1$ on $(\pi+\alpha) \sim (2\pi+\beta) \rightarrow T_2$ on w/F - 2m	2+2+2+2

Subject Title: **Subject Code:**

Question Number	Module-4 Solution	Marks Allocated
7 a.	Step down chopper principle.  Ckt – (1M)  WF – (1M) • operation: (3M) $0-\delta T \rightarrow$ ON, $\delta T - T \rightarrow$ OFF • Derivation: $V_{o\,avg} = \delta . V_s$, $P_o = \frac{\delta V_s^2}{R}$, $R_{in} = \frac{R}{\delta}$ (3M)	1+1+3+3
b.	Step up- chopper:  Ckt – 2M Derivation – 2M Explanation – 2M $V_o = \frac{V_s}{1-K}$  WF – 2M	2+2+2+2
8 a.	Class E- Chopper  Ckt – 3M  (1M) Explanation each Quadrant 1 × 4 = 4M	3+1+4
b.	Buck- regulator:  Ckt-2M. • Explain the operation with two ext circuit and w/f → 3M • Derivation – 3M Expression for peak to peak ripple current $\Delta I = \frac{(V_s - V_a)\, t_1}{L} = \frac{V_a t_2}{L}$ t_1 = ton time t_2 = toff time	2+3+3

Question Number	Module - 5 Solution	Marks Allocated
9 (a)	Single-phase - Half bridge inverter.   Circuit - (2M) w/f - (2M) Explanation - (2M). Derivation - $V_{0rms} = V_s/_2$ - (2M)	2+2+2+2
(b)	CSI (Current Source - Inverter)  (2M) const. current source Explanation (2M)  w/f - (2M) Adv: I/p current is const. No shoot ckt, No freewheeling diode. Disadv: Need large inductance, Dynamic response is low (2M)	2+2+2+2
10 (a)	Performance parameters: HF = V_n/V_1, THD, DF, LOH 4x2M	8M
(b)	Variable D.C. Link inverter:  DC Chopper ckt - 2M explanation - 2M	2 + 2
(C)	Short note on static switches. (1) AC - static switch (2) DC - static switch  Static bypass switch Main - 1, 2, R - Rectifier B - Battery I - Inverter ∞ - Isolation T/F	04