BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: VIth Date: 26/04/2022 (MORNING)

Subject with Code: EE353 POWER ELECTRONICS

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: UG **SEMESTER: 6TH**

BRANCH: EEE (MESRA/PATNA/DEOGHAR/JAIPUR) **SESSION: SP22**

SUBJECT: EE353 Power Electronics

TIME: 2Hrs **FULL MARKS:50**

INSTRUCTIONS:
1. The question paper contains Two (2) sections. Section A comprises 30 Marks, and Section B consists of 20 marks.
2. Both Section A and Section B are compulsory.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.

SECTION (A)

Note: - All questions are compulsory from this section Marks

Q1. The value of S for fast recovery diode is **[1]**
(a) S=1 (b) S<1 (c) S>1 (d) S=0

Q2. A thyristor with the standard terminals of anode(A), cathode(K), gate(G) and the different junctions named J1, J2 & J3. When the thyristor is turned on and conducting, then- **[1]**
(a) J1 and J2 are forward biased & J3 is reverse biased.
(b) J1 and J3 are forward biased & J2 is reverse biased.
(c) J1 is forward biased and J2 & J3 is reverse biased.
(d) J1, J2 and J3 are all forward biased.

Q3. A dc-to-dc transistor chopper supplied from a fixed voltage dc source feeds a fixed resistive-inductive load and a free-wheeling diode. The chopper operates at 1 kHz and 50% duty cycle. Without changing the value of the average dc current through the load, if it is desired to reduce the ripple content of load current, the control action needed will be: **[1]**
(a) increase the chopper frequency keeping its duty cycle constant
(b) increase the chopper frequency and duty cycle in equal ratio
(c) decrease only the chopper frequency
(d) Decrease only the duty cycle.

Q4. A PWM switching scheme is used with a three-phase inverter to **[1]**
(a) reduce the total harmonic distortion with modest filtering
(b) minimize the load on the DC side
(c) increase the life of the batteries
(d) reduce low order harmonics and increase high order harmonics

Q5. As compared to BJT, a power MOSFET has- **[1]**
(a) higher switching losses but lower conduction losses
(b) higher switching losses and higher conduction losses
(c) lower switching losses but higher conduction losses
(d) neither switching losses nor lower conduction losses

Q6. "Six MOSFETs connected in a bridge configuration (having no other power device) MUST be operated as a voltage source inverter (VSI)" this statement is, **[1]**
(a) True, because being majority carrier devices. MOSFETs are voltage driven
(b) True, because MOSFETs have inherently anti-parallel diodes
(c) False, it can be operated both as Current Source Inverter (CSI) or a VSI

(d) False, because MOSFETs can be operated as excellent constant current sources in the saturation region

Q7. In class D commutation technique applied for step down chopper, the PIV of freewheeling diode is **[1]**
(a) V_S (b) $2V_S$ (c) $V_S/2$ (d) Square root of V_S

Q8. Resonant converters are basically used to **[1]**
(a) Generate large peaky voltage (b) Reduce the switching losses
(c) Eliminate harmonics (d) Convert a square wave into a sine wave

Q9. The MOSFET switch in its ON state may be considered equivalent to **[1]**
(a) Resistor (b) Inductor (c) Capacitor (d) Battery

Q10. A thyristor based, three-phase, fully controlled converter feeds a dc load that draws a constant current. Then the input ac line current to the converter has **[1]**
(a) a rms value equal to the dc load current
(b) an average value equal to the dc load current
(c) a peak value equal to the dc load current
(d) a fundamental frequency component, whose rms value is equal to the dc load current

Q11. In a thyristor DC chopper, which type of communication results in best performance? **[1]**
(a) Voltage commutation (b) Current commutation
(c) Load commutation (d) Supply commutation

Q12. The output voltage waveform of a three-phase square-wave inverter contains **[1]**
(a) Only even harmonics (b) both odd and even harmonics
(c) Only odd harmonics (d) only triplen harmonics

Q13. Which of the following statements is true regarding thyristor switching characteristics- **[1]**
(a) Total turn-off time of SCR can be divided into three intervals-delay time, rise time, and spread time.
(b) The turn-on time of SCR can be reduced by using higher values of gate current.
(c) For reliable turn-off process, circuit turn-off time must be lesser than the thyristor turn-off time.
(d) The dynamic process of the SCR from conduction state to forward blocking state is called turn-on process.

Q14. If a diode is connected in anti-parallel with a thyristor, then **[1]**
(a) Both turn-off power loss and turn off time decreases
(b) Turn-off power loss decreases but turn-off time increases
(c) Turn-off power loss increases, but turn-off time decreases.
(d) none of the above

Q15. The conduction loss versus device current characteristic of a power MOSFET is best approximated by **[1]**
(a) a parabola (b) a straight line
(c) a rectangular hyperbola (d) an exponentially decaying function

Q16. For series connected SCRs, dynamic equalizing circuit consists of- **[1]**
(a) resistor R and capacitor C in series but with a diode across C
(b) series R and D circuit but with C across R
(c) series R and C circuit but with D across R
(d) series C and D circuit but with R across C

Q17. A single-phase full bridge VSI operating in square-wave mode supplies a purely inductive load. If the inverter time period is T seconds, then the time duration for which each of the feedback diodes conduct in a cycle is- **[1]**
(a) T second (b) (T/2) seconds

(c) (T/4) seconds (d) (T/8) seconds

Q18. A single-phase full bridge inverter can operate in load commutation mode in case load consists of- **[1]**

(a) RL (b) RLC underdamped
(c) RLC critical damped (d) RLC overdamped

Q19. In a 3-phase bridge inverter for 180-degree mode, line to neutral output voltage waveform is- **[1]**

(a) square wave (b) stepped staircase wave
(c) triangular wave (d) exponential wave

Q20. A chopper has input voltage of 660V and output voltage of 220 V. If the non-conducting time of thyristor-chopper circuit is 200 microseconds, then calculate the total time period (T). **[1]**

(a) T=150 microseconds (b) T=300 microseconds
(c) T=660 microseconds (d) T=330 microseconds (e) none of the above

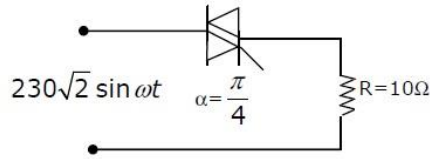
Q21. A three phase 440 V, 50 Hz ac mains fed thyristor bridge is feeding a 440 V dc, 15 KW, 1500 rpm separately excited dc motor with a ripple free continuous current in the dc link under all operating conditions. Neglecting the losses, the power factor of the ac mains at half the rated speed is **[2]**

(a) 0.354 (b) 0.372 (c) 0.90 (d) 0.955

Q22. Latching current for an SCR, inserted in between a dc voltage source of 200 V and the load, is 100 mA. Calculate the minimum width of gate pulse current required to turn-on this SCR, when the load consists of only L=0.4 H. **[2]**

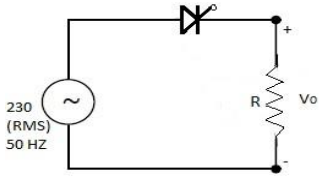
(a) 100 microseconds (b) 200 microseconds
(c) 100 milliseconds (d) 500 milliseconds

Q23. The TRIAC circuit showed in figure controls the ac output power to the resistive load. The peak power dissipation in the load is **[2]**



(a) 3968 W (b) 5290 W (c) 7935 W (d) 10580 W

Q24. Consider a phase-controlled converter shown in Fig. The thyristor is fired at an angle α in every positive half cycle of the input voltage. If the peak value of the instantaneous output voltage equals 230 V, the firing angle a is close to **[2]**



(a) 450 (b) 1350 (c) 900 (d) 83.60

Q25. A single phase full controlled converter is supplied from 230 V,50 Hz ac source. The load consists of R=20 ohms and a large inductance to render the load current constant. For a firing angle delay of 30 degree, the approximate average output voltage (Vo) and average output current (Io) is- **[2]**

(a) Vo=479.30 V & Io=47.93 A (b) Vo=179.30 V & Io=8.965 A
(c) Vo=230 V & Io=23 (d) Vo=79.30 V & Io=7.965 A

SECTION (B)

Note: - Attempt any five questions from this section Marks

Q1. (a) What is the significance of latching current, holding current, and gate signal? **[2]**

(b) What happens if a positive signal is given to reverse biased thyristor? **[2]**

Q2. A diode is connected in series with LC circuit. If the circuit is switched on to DC source of voltage V_S at t=0. Derive the expression for current through circuit, voltage across capacitor and inductor when (a) capacitor is initially charged with zero voltage, and (b) capacitor is charged with V_O volt and draw the relevant waveforms. **[4]**

Q3. A single-phase half-controlled converter (symmetrical connection) is connected to a highly inductive load with a series resistance such that load current is continuous and its ripple content is negligible. Draw the input voltage, load voltage, load current, thyristor current, and source current wave form corresponding to a sinusoidal input for RL load. (Take $\alpha=60^\circ$). Derive average and rms load voltage. **[4]**

Q4. Derive the performance parameters of single-phase full converter using Fourier series analysis on both AC and DC sides. **[4]**

Q5. Derive the mathematical formulation of maximum ripples present in load current when a DC motor is fed using the step-down chopper. **[4]**

Q6. Explain the operating principle of three phase VSI with a diagram proper power circuit, switching sequence waveform, and load voltage waveform for 120^o conduction mode. **[4]**

Q7. Discuss the operation of single-phase full bridge inverter and draw output current waveforms for R, RL, and RLC (underdamped & overdamped) loads. **[4]**