

16303(D)

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**B. Tech 8th Semester Examination**

**Advanced Power Electronics (NS)**

EEE-421(b)

**Time : 3 Hours**

**Max. Marks : 100**

*The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.*

**Note :** Attempt all questions.

1. (a) What is need of electrical isolation in power electronics circuit. Explain opto-coupler isolated and transformer isolated driver circuit. (10)
- (b) Explain following mode conduction of buck converter with waveform and mathematical analysis.
  - (i) Continuous conduction.
  - (ii) Boundary between continuous and discontinuous conduction.
  - (iii) Discontinuous conduction mode. (10)

OR

- (a) Explain working of ideal and practical forward converter with mathematical analysis. (10)
  - (b) Derive the input-output voltage relation in terms of the duty ratio of DC-DC converters working in DCM. (Consider both BUCK and BOOST topologies). (10)
2. (a) Write comparison between VSI and CSI. Draw circuit and waveform of three phase CSI with three phase star connected resistive load. (10)

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- (b) A three phase inverter has a Y connected load of  $R = 5\text{ohms}$  and  $L = 23\text{mH}$ . The inverter frequency is  $f_o = 60\text{ Hz}$  and the dc input voltage is  $V_s = 220\text{V}$ . (a) Express the instantaneous line to line voltage  $v_{ab}(t)$  and line current  $i_a(t)$  in a Fourier series. Determine (b) The rms line voltage  $V_1$  (c) the rms phase voltage  $V_p$  (d) the rms line voltage  $V_{L1}$  at the fundamental frequency (e) the rms phase voltage at the fundamental frequency  $V_{p1}$  (f) the total harmonic distortion (THD) (g) the DF (h) the HF and DF of the lower order harmonics (i) the load power (j) the average transistor current (k) the rms transistor current. (10)

OR

- (a) (i) A Single phase full bridge PWM inverter,  $V_d$  varies in the range of 295-325 V. the output voltage is required to be constant at 200V (rms), and the maximum load current (assumed to be sinusoidal) is 10A (rms). Calculate the combined switch utilization ratio (under these idealized condition, not accounting for any over current capability).
  - (ii) Explain Peak current control or Hysteresis current control for boost converter in the application of power factor correction from given list. Also write advantage and disadvantage. (10)
- (b) Analyze the working of single-phase full bridge inverter with  $R_L$  load with the help of suitable waveforms. Express output voltage, output current and output power in Fourier series. Draw harmonic spectra of output voltage. (10)
3. (a) (i) Write limitation of passive filters.
  - (ii) A three phase diode bridge rectifier is supplied from 415 V, 50Hz ac mains with dc load resistance and inductance is 10 ohms and 10 mH respectively. Design a dc side LC filter so that the ripple factor of the output voltage is less than 10%. (10)

- (b) Draw any two topology of DSTATCOM in three phase three wire and three phase four system. Explain control algorithm based instantaneous symmetrical component theory for DSTATCOM. (10)

OR

- (a) Write the comparison between right shunt and left shunt universal power quality conditioner (UPQC). Also draw and explain structure of left shunt UPQC. (10)
- (b) Mention in brief the advantages of Active Power filters. Draw a circuit diagram of Shunt Active Power Filter. (10)
4. (a) (i) Write comparison between different types of synchronous motor drives.  
(ii) A single phase, 220 V, 50Hz, 1425 rpm induction motor has following parameters:  
 $R_s = 2$  ohms,  $R_r' = 5$  ohms,  $X_s = X_r' = 6$  ohms and  $X_m = 60$  ohms. It drives a fan load at rated speed when full voltage is applied. Motor speed is controlled by the stator voltage control. Calculate the motor terminal voltage for a speed of 1200 rpm. (10)
- (b) What is the principle of vector control? Explain vector control of induction motor with rotor flux orientation. (10)

OR

- (a) A synchronous motor is controlled by a load commutated inverter, which in turn is fed from line commutated converter. Source voltage is 6.6kV, 50Hz, load commutated inverter operates at a constant firing angle  $\alpha_1$  of 140 degree and when rectifying  $\alpha_1 = 0$  degree. The DC link inductor resistance  $R_d = 0.1$  ohms. Drive operates in self control mode with a constant (v/f) ratio. Motor has the details: 8MW, 3 phase, 6600V, 6 pole, 50Hz, unity power factor, star connected.  $X_d = 2.8$  ohms,  $R_s = 0$  ohms. Determine source side converter firing angles for following.
- (i) Motor operation at the rated current and 500 rpm. What will be the power developed by motor?
- (ii) Regenerative braking operation at 500 rpm and rated motor current. Also calculate power supplied to the source. (10)

- (b) Explain sensor-less control of BLDC and PMSM motor with suitable equations and block diagrams. (10)
5. Attempt all the Questions.
- (a) In a DC-DC converter the input voltage is derived from a single phase. 50Hz AC supply, what is the lowest frequency component present in the output voltage other than the average component? Give Explanation.
- (b) In a forward converter derived from buck-topology, a demagnetizing winding is essential to prevent converter failure. Give reason.
- (c) How will you select the voltage and current rating of the switch used in flyback converter?
- (d) Explain how the 'CUK' converter improves the input power factor.
- (e) In a single pulse modulation used in PWM inverters,  $V_s$  is the input dc voltage. For eliminating third harmonic, the magnitude of rms value of fundamental component of output voltage and pulse width is respectively\_\_\_\_\_.
- (f) In multiple pulse modulation used in PWM inverters, the amplitudes of reference square wave and triangular carrier wave are respectively 1V and 2V. For generating 5 pulse per half cycle, pulse width should be\_\_\_\_\_.
- (g) In sinusoidal-pulse modulation used in PWM inverters, amplitude and frequency for triangular carrier and sinusoidal reference signals are respectively 5 V, 1kHz and 1V, 50Hz. If zeroes of triangular carrier and reference sinusoid coincide, then the modulation index and order of significant harmonics are respectively\_\_\_\_\_.
- (h) State advantages of SMPS over conventional linear supply.
- (i) Explain how a voltage source inverter fed induction motor is operated in dynamic braking.
- (j) Variable frequency control yields high torque to current ratio during starting. Why? (10×2=20)