

# Department of Electrical and Electronics Engineering

## PX7103 ANALYSIS AND DESIGN OF INVERTERS

### UNIT-1 SINGLE PHASE INVERTERS

#### 2-MARKS

1. List techniques employed for the reduction of harmonics from the output voltage of an inverter.
2. What is the need of connecting diodes in anti-parallel with switches?
3. Write the Fourier series expression for the output voltage and current obtained from single phase full bridge inverter.
4. Define commutation. How they are generally classified?.
5. Give reason to vary the output voltage of inverter, for industrial application.
6. Why energy flows from load to source for a fraction of the period in a single phase bridge inverter with RL load?
7. Name the various PWM technique used in Single phase inverters.
8. What is the need for voltage control and harmonic elimination in single phase inverter?
9. What are the factors to be considered in the selection of switching devices for inverters.
10. what are the features of bridge inverter configuration employed in inverters.
11. What are the gating requirements of the thyristor in an inverter?
12. What is need for voltage control and harmonic elimination in single phase inverter?
13. State the advantages of IGBT over MOSFET?
14. What should be the pulse width for the elimination of 3<sup>rd</sup> harmonic in the output voltage waveform of single phase inverter?
15. Draw the switching characteristics of MOSFET.
16. Draw the switching characteristics of IGBT.
17. What is mean by RLC under damped load?
18. What is mean by RL and RLC over damped load?
19. What are the advantages and disadvantages of PWM?
20. Explain the operation of single phase bridge inverter with the help of voltage waveforms?
21. Draw circuit of auxiliary-commutated single phase bridge inverter?
22. Draw the waveform of single pulse-width modulation?

#### 16-MARKS

1. Explain with the help of waveforms the operation of a single phase half bridge inverter.
2. Explain with the help of waveforms the operation of a single phase full bridge inverter.
3. Explain various voltage control method in single phase inverter using various PWM techniques with necessary diagram and waveform.
4. Discuss the different techniques adopted to eliminate harmonics generated by inverter circuits.
5. A single phase bridge inverter has a resistive load  $R=2.4$  ohm and the DC input voltage of 48 V. determine a) RMS output voltage at fundamental frequency. b) Output power

- c)  $I_{av}$  and  $I_m$  of each transistor d) Peak reverse blocking voltage of each transistor e) HF and DF at the LOH.
6. With necessary diagram describe the single, multi pulse used to control the output voltage of single phase inverter.
  7. With necessary diagram describe the sinusoidal, multi pulse used to control the output voltage of single phase inverter.
  8. With necessary diagram describe the single, sinusoidal used to control the output voltage of single phase inverter.
  9. Describe modified McMurray half bridge inverters with appropriate voltage and current waveforms. Derive the expressions for the commutating components L and C.
  10. Describe modified McMurray full bridge inverters with appropriate voltage and current waveforms. Derive the expressions for the commutating components L and C.
  11. Explain in details the operation of a half bridge inverter with single phase.
  12. Explain in details the operation of a full bridge inverter with single phase.
  13. Different types of eliminate harmonics elimination single phase inverter circuits
  14. Different types of forced commutated Thyristor inverters.
  15. Derive and explain the forced commutated Thyristor inverters.

## **UNIT-II THREE PHASE VOLTAGE SOURCE INVERTERS**

### **2-MARKS**

1. What are the methods used to control the output voltage in a three phase inverter?
2. Compare 120 degree mode with 180 degree mode operation of a three phase inverter?
3. Different types of voltage control of three phase inverter?
4. Define space vector modulation techniques.
5. What is limiting factor for the operating frequency of an inverter.
6. Define voltage control of three phase inverter?
7. What is mean by harmonic reduction of three phase inverter?
8. Why the harmonics reduction of single-pulse width modulation of three phase voltage source inverter.
9. Draw the sinusoidal pulse-width modulation of three phase inverter.
10. What are disadvantages of harmonics reduction three phase voltage source inverter?
11. Draw the basic diagram of three phase bridge inverter?
12. Draw the voltage waveform for 180 degree conduction mode?
13. Draw the gating signals and voltage waveform for 120 degree conduction mode?
14. Draw the sinusoidal pulse-width modulation for three phase inverter?
15. What is harmonic conduction by single-pulse width modulation?
16. Draw the circuit and waveform of harmonic reduction by transformer connection?
17. What are the advantages and disadvantages of multi pulse width modulation?

### **16-MARKS**

1. With a neat circuit diagram and waveforms explain the working of 180 degree conduction mode operation of three phase inverter with star and delta connection load.
2. With a neat circuit diagram and waveforms explain the working of 120 degree conduction mode operation of three phase inverter with star and delta connection load
3. With necessary diagram describe the space vector modulation used to control the output voltage of three phase inverter.
4. With necessary diagram describe the single, multi pulse used to control the output voltage of three phase inverter.
5. With necessary diagram describe the sinusoidal, multi pulse used to control the output voltage of three phase inverter.
6. With necessary diagram describe the single, sinusoidal used to control the output voltage of three phase inverter.
7. Write short notes on
  - (i).modified sinusoidal PWM
  - (ii) Feedback operation in inverter
  - (iii).harmonic distortion in inverter
8. With necessary diagram describe the single pulse used to control the output voltage of three phase inverter.
9. With necessary diagram describe the multi pulse used to control the output voltage of three phase inverter.
10. With necessary diagram describe the sinusoidal pulse used to control the output voltage of three phase inverter
11. Drive and operation modes of 180 degree conduction with resistive and inductive load.
12. Drive and operation modes of 120 degree conduction with resistive and inductive load.
13. Types of space vector modulation and different output waveforms.

### **UNIT-III CURRENT SOURCE INVERTERS**

#### **2-MARKS**

1. Draw the diagram of single phase CSI.
2. Define load commutated inverter?
3. Compare VSI and CSI.
4. What is partial and full overlapping in a three phase auto sequential commutated inverter?
5. Define current Source Inverter
6. State the reason why low power devices cannot be used in a CSI.
7. List the main features of CSI
8. What are the drawbacks of load commutated inverter?
9. What is a six step thyristor Inverter?
10. What are the advantages and disadvantages of ACSI?
11. What is the purpose of hysteresis modulation?
12. What are the application of load commutated inverter
13. Write the relation between input and output voltage frequencies of a single phase capacitor commutated CSI?
14. What is the function of series connected diodes in a auto sequential CSI?

15. What are the applications of CSI?
16. Draw the power diagram and A.C output current waveform and equivalent circuit?
17. Draw waveform of voltage and current single phase capacitor commutated CSI?
18. Draw the ASCI with series R-L load?
19. Draw the ASCI voltage and current waveform?
20. Draw the circuit diagram of phase-controlled thyristor rectifier operating as a controlled CSI for CSI?
21. What is mean by induction motor voltage waveforms?
22. Draw and explain commutating circuit analysis?
23. What is mean by feedback diode?

### 16-MARKS

1. Describe elaborately the single phase auto sequential commutated CSI with relevant mode diagrams and waveforms.
2. Draw and explain the operation of single phase capacitor commutated CSI with resistive load Draw the related voltage and current waveforms.
3. Describe in detail the operation of single phase CSI with purely inductive load.
4. Describe in detail the operation of single phase transistorized CSI.
5. A single phase auto sequential CSI is fed from 220V DC source. The load is  $R=10$  ohm. Thyristor have taken a factor of safety of 2. Determine the value of source inductance assuming a maximum current change of 0.5 in one cycle. Neglect all losses. Find also the values of commutating capacitors
6. Explain the operation of six step current source inverter with inductive load.
7. Write the comparison of 120 degree and 120 degree modes of conduction?
8. A star connected load of 25 ohm/phase is fed from 600V dc through a three phase bridge inverter per both  $180^0$  and  $120^0$  mode. Determine
  - a. RMS value of load current
  - b. RMS value of thyristor Current
  - c. Load power.
9. A single phase bridge inverter fed from 230V dc is connected to load  $R=20$  ohm &  $L=0.06H$ . Determine power delivered to load in case inverter is operating at 50 Hz with (a) square wave output. (b) Quasi square wave output with on period of 0.5 (c) Two symmetrically spaced pulses per half cycle on period of 0.5 of cycle.
10. What is mean by commutated CSI? And explain the different types.
11. Drive and explain operation of single phase CSI with purely inductive load.
12. Drive and explain the six step current source inverter with inductive load and waveforms.
13. Compare VSI and CSI

## UNIT-IV      MULTILEVEL INVERTERS

### 2-MARKS

1. What is the basic concept of multilevel inverter?
2. What is the flying capacitors multilevel inverter?
3. What is back to back intertie system?
4. List the applications of multilevel inverter?
5. What does the capacitor voltage UN balancing means?
6. What are the disadvantages of diode clamped multilevel inverter?
7. What are the types of multilevel inverter?
8. In a m-level diode clamped inverter how many main switching devices and clamping diodes are present?
9. Draw the circuit diagram of single pole of multilevel inverter by a switch?
10. What are features of diode-clamped inverter?
11. Draw the circuit diagram of five-level flying capacitor of single phase inverter?
12. What are the advantages and disadvantages of flying capacitor?
13. What are the features of cascaded inverter?
14. What are the advantages and disadvantages of cascaded inverter?
15. What is a diode-clamped multilevel inverter?
16. What are the disadvantages of a modified diode-clamped multilevel inverter?

### **16-MARKS**

1. With neat diagram describe the operation of cascaded multilevel inverter. Also explain applications of multilevel inverter
2. Explain the operation of flying capacitor multilevel inverter with necessary details. Also discuss its features advantages and disadvantages.
3. Compare and explain the different types of multilevel inverter.
4. Explain the application of multilevel inverter and diode clamped?
5. With neat diagram describe the operation of diode-clamped multilevel inverter. Also explain applications of multilevel inverter?
6. Drive and explain the different waveforms of diode-clamped multilevel inverter.
7. Draw and explain the Basic concept of multilevel inverter?
8. Draw and explain the diode-clamped multilevel inverter with diode in series?
9. Application of multilevel converter connected to a power system for reactive power compensation?
10. Draw and explain the switching device currents?
11. With neat diagram describe the operation of dc-link capacitor voltage balancing?
12. Different types of cascaded multilevel inverter.
13. Drive and explain the flying capacitor multilevel inverter.
14. Drive and explain the different waveforms of flying capacitor multilevel inverter.

## **UNIT-V      RESONANT INVERTERS**

### **2-MARKS**

1. What is a Class E resonant inverter?
2. What is the necessary condition for series resonant oscillation?
3. What are the advantages of parallel resonant inverters?
4. Name the methods of voltage control of resonant inverters.
5. What is a non overlap control of resonant inverters?
6. What is the dead zone of a resonant converter?
7. List the types of resonant inverters.
8. What are the advantages of ZCS resonate converter?
9. What is an overlap control of resonant inverter?
10. Draw the circuit diagram of series loaded resonant inverters
11. What is mean by resonant pulse converter?
12. How the output voltage is controlled in a series resonant inverters?
13. What is the principle of series resonant inverter?
14. What are the advantages and disadvantages of resonant inverters with bidirectional switches?
15. What are the advantages and disadvantages of resonant inverters with unidirectional switches?
16. What is necessary condition for series-resonant oscillation?
17. What is the purpose of coupled inductor in half-bridge resonant inverters?
18. What are the methods of voltage control series- resonant inverters?
19. What are the advantages and limitations of class E resonant inverter?
20. What are the advantages and limitations of class E resonant rectifier?
21. What is the principal of zero-voltage switching resonant converters?
22. What is the principal of zero-current switching resonant converters?
23. What are advantages of ZVS resonant converter?
24. Draw the circuit diagram of resonant dc-link inverter.

### **16-MARKS**

1. Explain the operation of resonant DC link inverter.
2. Describe the operation of Class E resonant inverter with neat wave forms.
3. Explain methods for voltage control of series resonant inverters? Explain any one method in details.
4. Explain the operation of parallel resonant inverter.
5. Drive and explain the series resonant inverters with unidirectional switches?
6. Drive and explain the series resonant inverters with Bidirectional switches?
7. Drive and explain the frequency response of series resonant inverters?
8. Describe the operation of Class E resonant rectifier with neat wave forms.
9. Draw and explain the zero-current switching resonant converters?
10. Draw and explain the zero-voltage switching resonant converters?
11. Comparisons b/w ZCS and ZVS resonant converters?
12. With neat diagram describe the operation of dc-link capacitor voltage balancing?