Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

II SEMESTER M.TECH. (PED & EVT)

END SEMESTER EXAMINATIONS, MAY 2024

POWER QUALITY ISSUES & MITIGATION [ELE 5411]

Time: 3 Hours **Date: 07 May 2024** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Describe the effects of power quality problems on customers with suitable examples and justifications. ***(03)***

1B. A single phase 240V, 50Hz, AC distribution system has a feeder impedance of $3.1623\angle 71.56\Omega$ supplying an industrial load with $Z_L = 10\angle 36.86\Omega$. Determine the voltage across the load. Design suitable value of passive compensator element (L or C) and its rating if a shunt compensator is incorporated to realize UPF load. ***(03)***

1C. With the relevant phasor diagram, explain the operation of three phase three wire capacitor supported DVR to protect the sensitive loads against voltage sag. ***(04)***

2A. Design the value of the shunt compensator to achieve the zero-voltage regulation across a three-phase three-wire balanced star connected induction motor operating lagging p.f. load supplied from the three phase AC mains with source impedance. ***(06)***

2B. A three phase four-wire 415 V, 50 Hz AC supply has a single phase 12 kW resistive load connected across line (say R-phase) and neutral terminal. If it is required to eliminate the neutral current using a shunt compensator. Design (i) the values of compensator elements (L or C) and (ii) kVA rating of compensator. ***(04)***

3A. Based on the types of converters employed, how series active power filters are classified and which type is generally preferred with proper justifications. ***(03)***

3B. A three-phase three-wire PWM controlled DSTATCOM is used at 415V, 50Hz distribution system to provide load balancing and reactive power compensation for unity power factor. A single-phase load of 75kVA, 0.8 lagging p.f. load is connected between two lines of the system and design the rating of the DSTATCOM. ***(05)***

3C. With proper justification, explain why an indirect current control approach is superior to direct current control scheme of a DSTATCOM. ***(02)***

4A. A three-phase three-wire 415 V, 50 Hz AC supply feeds power to three-phase delta connected 25kW, induction motor (operating with 0.8pf lagging). If a PWM based 415V, DSTATCOM is used to provide reactive power compensation for UPF operation of motor, design the values of (i) DC bus voltage (ii) DSTATCOM current and (iii) The value of interfacing inductance if the switching frequency is 2.5kHz and ripple current is 15%. ***(04)***

4B. For a three-phase, four-wire VSC based UPQC for the operation of the DSTATCOM and DVR, describe the synchronous reference frame theory-based control algorithm mitigating both power quality problems of voltages and currents with a neat block diagram. ***(06)***

5A. A three phase 415V, 50Hz supply with feeder impedance of (1+j4)Ω/ph feeds a balanced star connected load having Z_L=(8+j6)Ω/ph. If a PWM based DVR is used to regulate the load voltage to the input voltage (415V), design a) The voltage and current rating of the DVR and b) kVA rating of the DVR ***(05)***

5B. Explain right shunt and left shunt UPQC used for mitigating multiple PQ problems of voltages and currents with neat block diagrams. ***(03)***

5C. For a VSI based three-phase, three-wire UPQC, how are the values of DC bus voltage and capacitor of the VSC of the DSTATCOM estimated? ***(02)***