Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH (POWER ELECTRONICS & DRIVES)

END SEMESTER EXAMINATIONS, APRIL-MAY 2024

POWER ELECTRONICS IN MODERN POWER SYSTEM [ELE 5213]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 03 May 2024** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Derive the expressions for midpoint voltage, current and power when a shunt capacitor is connected at the midpoint of a lossless symmetrical transmission line. ***(03)***

1B. Compare series compensation with shunt compensation regarding the following (i) Rating (ii) Power flow capability and (iii) Cost. Give proper justification. ***(03)***

1C. With the help of block diagram & explanation, implement an SVC controller to

(i)maintain the bus voltage constant.

(ii) what modifications must be done for case(i) if it is also required to damp power oscillations. ***(04)***

2A. With neat diagrams and waveforms, analyze the operation of TCSC in the capacitor vernier mode of operation. ***(03)***

2B. Derive the expression for midpoint voltage, current and power when a STATCOM is connected at the midpoint of a symmetrical lossless transmission line. The power flow through the line with a STATCOM at the midpoint of the line is given by $P_m=940\sin\delta+37\sin(\delta/2)$ MW. Calculate the maximum power flow through the line ***(07)***

3A. A nonlinear load is connected to a balanced, sinusoidal, 1-phase supply voltage of 240 V. The load current is given by

$i(t)=2+10\sin\omega t+2\sin5\omega t+0.5\sin7\omega t$.

(i)Determine the total harmonic distortion of the load current.

(ii)Compute the power factor, apparent power, active power and reactive power of the load.

I(iii) If a linear load is connected across this load, comment on the THD of total current. ***(04)***

3B. With neat phasor diagrams, compare the following methods of DVR voltage injection i) Pre-sag compensation, ii) In-phase injection & iii) minimum energy injection clearly stating the load condition under which they can be used. Consider a distribution system with feeder impedance 0.01+j0.2 pu and load impedance 0.75+j0.3 pu connected in series with a supply voltage 220V, 50Hz. Compute the DVR voltage if the load voltage is to be brought to 220V using minimum energy compensation. ***(06)***

4A. With a neat block diagram, explain the generation of compensating signals using synchronous reference frame theory in a shunt active filter. ***(03)***

4B. With neat waveforms & circuit diagram, derive an expression for dc output voltage of a 3-phase, 6-pulse bridge converter with firing angle. Ignore the effect of source inductance. ***(03)***

4C. A 3-phase, 48-pulse bridge rectifier is fed from a transformer with transformation ratio 0.45 and primary voltage 220 kV. Determine (i) the output voltage of rectifier when firing angle is 20° and extinction angle is 40° (ii) fundamental component of ac line current, commutation resistance, power factor, active and reactive power at primary side of transformer if the dc current is 1.7 kA. ***(04)***

5A. A 3-phase, 12-pulse bridge rectifier is fed from a transformer with transformation ratio 0.5 has a dc output voltage of 270 kV when the firing angle is 18°. The commutation resistance/6-pulse bridge=6Ω and the dc line current is 2 kA. The rectifier is initially operating in CC mode. The current margin=15% and the minimum limiting value of α is 5°. Compute the dc output voltage when the rectifier HT bus voltage drops by (i) 5% and (ii) 15%. Comment on the results obtained. ***(05)***

5B. With neat diagrams, discuss various power configurations of PV inverter. ***(05)***