MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : EE-801A

HVDC TRANSMISSION

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) The lowest current harmonic produced in 12-pulse converters is

   a) 11 b) 13

   c) 23 d) none of these.

ii) During commutation in a converter with very high inductive load

a) voltage is exchanged

b) current is transferred from one valve to the other

c) *dc* voltage is blocked

d) *dc* current is blocked.

iii) Peak to peak ripple in a 12-pulse converter is

a) 0·5236 V_d b) 0·114 V_d

c) 0·3206 V_d d) 0·0345 V_d.

iv) For an existing *ac* transmission line, the string efficiency is 80%. If *dc* voltage is supplied for the same set up, the string efficiency will be

a) 100% b) 90%

c) 80% d) 50%.

v) For a six-pulse converter with source reactance $X\ \Omega$ per phase, the equivalent resistance of the converter is given by

a) $3X$ b) $\frac{3X}{\pi}$

c) $\frac{X}{\pi}$ d) $3\pi X$.

vi) Fault current level is highest for

a) converter internal fault

b) *dc* line fault

c) commutation failure

d) lightning stroke on lines.

vii) Voltage dependent current order limit controlling is done and it is necessary

a) when low voltage due to faults

b) to regulate *dc* current depending on *dc* voltage due to fault on *ac* side

c) to regulate *dc* current when *dc* voltage dips

d) to regulate *ac* current under faults.

viii) Valve group protection is done using

a) overcurrent protection

b) differential protection

c) current control limiter

d) HRC fuses in each group.

ix) Converter faults are cleared by

a) tripping of *ac* side CBs

b) blocking the rectifier and inverter

c) opening the ground or neutral CB

d) using backup protection schemes.

x) Basic control philosophy in MTDC systems is

a) total rectifier current is constant

b) total inverter current is constant

c) total current, both rectifier and inverter is zero

d) none of these.

xi) Which of the following faults is self-clearing ?

a) DC line fault

b) single commutation failure

c) multiple commutation failure

d) arc back and arc through.

xii) In a bipolar system

a) both conductor and positive

b) both conductor are negative

c) one conductor is positive and the other is negative

d) one conductor is positive or negative and the other is at ground potential.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What are the various sources for generation of harmonics in HDVC systems ? Mention the adverse effects caused due to the presence of harmonics.

3. Explain the equidistant pulse control scheme used in HVDC systems.

4. What are the different losses in HVDC system ? Compare it with *ac* systems.

5. With a neat schematic diagram, state the various apparatus required for HVDC station and explain the purpose of each.

6. Why are multi-terminal *dc* systems needed ? What are the different types of MTDC systems used ?

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) With the help of a schematic diagram, explain the principle of operation of 12-pulse converter.

   b) Obtain the expression for PIV, peak to peak ripple and valve volt ampere rating of a 6-pulse Graetz converter circuit. 9 + 6

8. a) What are the different types of faults that can occur in HVDC systems ?

   b) Discuss protection scheme in HVDC system for (i) protection against overcurrent & overvoltage, (ii) protection of filter unit. 5 + 10

9. a) Explain characteristic variation of harmonic currents with variation of firing angle and overlap angle.

   b) What are non-characteristic harmonic in HVDC systems ?

   c) The *ac* system voltage at the rectifier end is 220 kV. Estimate the six harmonic voltage of a 6-pulse converter when $\alpha = \frac{\pi}{2}$ & $\mu = 0$. 7 + 3 + 5

10. a) What are the various control schemes employed for HDVC converters ?

    b) Explain the vector control scheme of HVDC-VSC schemes. 7 + 8

11. a) Explain with schematic diagram, the principle of operation of FACTS converters.

    b) What is meant by 'multi-level *dc* system' ? Explain.

    c) Discuss parallel operation of MTDC. 7 + 4 + 4