

2012

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 × 1 = 10

i) A DC reactor is connected in series with each pole of a converter station in order to

- a) prevent communication failures in the inverter
- b) supply reactive power to the converter
- c) improve system stability
- d) increase the power transfer capability.

ii) The power transmission capability of bipolar lines is approximately

- a) half that of 3-phase single circuit line
- b) the same as that of 3-phase single circuit line
- c) twice that of 3-phase single circuit line
- d) thrice that of 3-phase single circuit line.

iii) HVDC transmission voltage in India is

- a) ± 400 kV b) ± 500 kV
- c) ± 600 kV d) ± 765 kV.

iv) For an SCR, $\frac{dv}{dt}$ protection is achieved through use of

- a) RL in series with SCR b) RC across SCR
- c) L in series with SCR d) RC in series with SCR.

v) The effect of source inductance on performance of three phase full converters is to

- a) reduce the ripples in the load current
 - b) make discontinuous current as continuous
 - c) reduce the output voltage
 - d) increase the load voltage.
- vi) Southern Regional Grid is connected with New Grid through
- a) HVDC Back-to-Back b) HVDC Bi-pole
 - c) both (a) and (b) d) none of these.
- vii) If the firing angle of the rectifier bridge is greater than 90°
- a) the bridge acts as a rectifier operation
 - b) the bridge acts as an inverter operation
 - c) the bridge does not operate
 - d) none of these.
- viii) Which of the following is not true regarding HVDC transmission ?
- a) Corona loss is much more
 - b) Power transmission capability of bipolar line is almost same as 3-phase single circuit line
 - c) HVDC link can operate between two *ac* system whose frequencies need not be equal
 - d) No distance limitation for HVDC underground cable.
- ix) Presently how many HVDC bi-poles are in operation in India ?
- a) Two b) Three
 - c) Four d) Five.
- x) The effect of increasing firing angle in thyristorised controlled reactor is
- a) to increase the effective inductance of the reactor
 - b) to reduce the effective reacting power
 - c) both (a) and (b)

d) none of these.

xi) Which of the following HVDC bi-poles is longest in distance ?

a) Rihand-Anpara b) Chandrapur-Phadge

c) Talcher-Kolar d) None of these.

xii) Power transfer capability of HVDC B/B single link in India is

a) 500 MW b) 1000 MW

c) 1500 MW d) 2000 MW.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Draw single line diagram & describe briefly the typical arrangement of main components of HVDC transmission system.

3. What are the advantages & disadvantages of HVDC system over AC transmission system ?

4. Draw single line diagram & describe briefly the typical arrangement of main components of HVDC Back-to-Back system.

5. How the harmonics are filtered out & minimized in the HVDC system ? Describe briefly.

6. Describe 3-phase Graetz bridge rectifier circuit used for converting *ac* into *dc* for HVDC transmission.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Show that harmonics generated in the AC side of the transformer is $6N \pm 1$? How these orders of harmonics can be eliminated. 10

b) A bridge connected rectifier is fed from 220 kV/110 kV transformer with primary connected to 220 kV.

Determine the dc output voltage when the commutation angle is 15° & the ignition delay angle is 30° . 5

8. With suitable assumptions, prove mathematically that

a) insulation level of HVDC transmission is lesser than AC transmission.

b) Power transfer capability of HVDC transmission is greater than AC transmission.

9. a) Determine the converter transformer rating of a rectifier system. Draw & describe different types of DC transmission system briefly. 5 + 5

b) A DC link has a loop resistance of 10Ω and is connected to transformers giving secondary voltage of 120 kV at each end. The bridge connected converters operate as follows :

Rectifier : $\alpha = 15^\circ$, $X_c = 15 \Omega$

Inverter : $\delta_0 = 10^\circ$, $\gamma = 15^\circ$, $X_c = 15 \Omega$

Allow 5° margin on δ_0 for δ .

Calculate the direct current delivered if the inverter operates on constant β control. 5

10. A three phase, 12-pulse rectifier is fed from a transformer with nominal voltage ratings of 220 kV/110 kV.

a) If the primary voltage is 230 kV and the effective turns ratio T is 0.48, determine the dc output voltage when the ignition delay angle α is 20° and the commutation angle is 18° .

b) If the direct current delivered by the rectifier is 2000 A, calculate effective commutating reactance X_c , RMS fundamental component of alternating current, power factor $\cos \phi$, and reactive power at the primary side of the transformer. 5 + 10

11. Write short notes on any *three* of the following : 3×5

a) Principle of HVDC system operation

- b) Series & parallel connection of Thyristor
- c) DC circuit breaker
- d) Parallel operation of DC link with an AC network
- e) Graphical representation of cost comparison between AC & DC transmissions.

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