Code No: A4902 **NR**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH I SEMESTER EXAMINATIONS, APRIL/MAY 2012
HVDC TRANSMISSION
(ELECTRICAL POWER ENGINEERING)

Time: 3hours **Max.Marks:60**

Answer any five questions
All questions carry equal marks

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1. State the advantages of HVDC transmission over EHVAC transmission for bulk power transmission.

2.a) Sketch the waveforms of the output voltage and the transformer secondary current in the case of 3-phase, 6-pulse bridge circuit (Graetz's circuit).

b) An HVDC converter rated 100 MW at 100 kV on the DC side has a commutation reactance of 0.2 p.u. The delay is varied between 5^0 and 20^0. Determine the converter transformer rating and percentage of tap-changing required. Determine the rating of the condenser to make the p.f. on the primary side of the converter 1.0.

3.a) Explain the necessity of compounding both rectifier and inverter stations with constant current control.

b) The constants of a 3-phase line are $A=0.9\angle 2^0$ and $B=0.9\angle 70^0\ \Omega$/ph. The line delivers 60 MVA at 132 kV and 0.8 p.f. lag. Find the sending end voltage and the maximum receiving end power of the V_R are held constant. If the above line is converted into a DC line, find the receiving end power of the line.

4.a) Explain the operation of pulse frequency control and state why it is preferred in modern HVDC systems?

b) An HVDC link delivers DC power with AC line voltage to the rectifier being 400 kV and that at the inverter being 392 kV. Taking $\alpha = 10^0$, $\gamma = 15^0$ and the DC resistance of the line as 20Ω; calculate
(i) The DC voltage at both the ends,
(ii) The current in the DC link,
(iii) The power delivered, and losses in the link.

5.a) What is the effect of different control modes on harmonics and their relative magnitudes?

b) Obtain relative magnitude of sixth harmonic voltage of a 6-pulse converter when $\alpha = 10^0$ and $\mu = 10^0$.

6.a) Why are filters not needed on the DC side with HVDC voltage source converter schemes?

b) Determine the cost of a 5^{th} harmonic filter for a bipolar 4-bridge 12-pulse converter rated 1000A, ± 300 kV. The filter is connected to 400 kV, 3-ph. 50 Hz supply. Filter is to be designed for operation with one bridge out of service.
Cost: Capacitors 20 lakhs/MVAR
Inductors 45 lakhs/MVAR
Take $\alpha=15^0$, p.f = 0.866 and network impedance angle limited to 75^0.

7.a) Give the principle of different types of DC circuit breaker schemes. Why is a surge diverter needed across the DC Circuit Breaker?

b) What are the different sub harmonic oscillations that occur due to disturbances in DC systems? Explain.

8. Define and explain the following terms
   a) Two terminal HVDC system
   b) HVDC pole
   c) Multiterminal system
   d) Converter substation

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