1. Each conductor of a 33KV, 3-phase system is suspended by a string of three similar insulators, the capacitance of each disc is nine times the capacitance to ground. Calculate the voltage across each insulator. Determine the string efficiency also. (20%)

2. The apparent power delivered by a cylindrical rotor synchronous machine to an infinite bus is 1.2 p.u. The excitation voltage is 1.3 p.u. and the power angle is 20°. Compute the synchronous reactance of the machine, given that the infinite bus voltage is 1 p.u. (14%)

3. What are the equalizers? Why are they needed on a lap-wound machine but not on a wave-wound machine? (10%)

4. (a) Draw the connections for opposition test on two transformers. (b) describe the advantages of opposition test in temperature test for transformers. (13%)

5. What is a damper winding in a synchronous machine? What is its function, and where is it located? (10%)

6. A completely transposed three-phase transmission line has a total length of 360 km. The line parameters for this line are:

$r = 81.4 \times 10^{-3}$ Ω/km, $l = 1.333 \times 10^{-3}$ H/km
$g = 0$ $\mho$/km. $c = 8.706 \times 10^{-3}$ F/km.

It is being operated at a receiving-end voltage of 380 kV (line-to-line) and delivers a three-phase power of $150 + j50$ MW and MVar. Find

(a) characteristic impedance and propagation constant (5%)
(b) equivalent-π circuit (5%)
(c) sending-end voltage and current (6%)
(d) voltage regulation (5%)

of the line. f=60Hz.

$[\cosh(a+jb) = \cosh(a)\cos(b) + j\sinh(a)\sin(b)]$
$[\sinh(a+jb) = \sinh(a)\cos(b) + j\cosh(a)\sin(b)]$

7. Give the reasons for the following phenomina of a cylindrical-rotor synchronous machine

(a) $x_d' < x_d$ (3%)
(b) $x_d'' < x_d'$ (3%)
(c) x_- (negative-sequence reactance) $= x_d''$ (3%)
(d) x_0 (zero-sequence reactance) $< x_d''$ (3%)