Benha University | **Jan. 2011**
High Institute of Technology | **Mechanical Department**
Electrical Power Technology | **3rd year (تخلفات)**
Dr.Wael Abdel-Rahman Mohamed | **Time: 3 Hrs**

Exam with model answer

Answer the following questions.

Question (1): **[15 Marks]**

a) What are the kinds of electrical power generation and the kinds of power stations?

Hydroelectric, Coal fired , Nuclear, Wind power, Diesel electric, Solar, Gasoline engine, Ocean currents

b) Explain the difference between passive and active elements.

Passive elements don't require a power from the supply to produce its effect on a signal. They derive the power of the input signal to perform its action. e.g. Resistor- it doesn't require a separate supply to provide its action of resistance in a circuit. (Also inductors and capacitors.)

In active elements there should be a power source for its working. They require a supply for there working. e.g. transistor - Only after biasing the transistor in required region of operation, its characteristics are applied on the signal. ie, for amplification, transistor require a source from where it can work in. (Also diodes, thyristors and ICs.)

c) The field winding of a DC electromagnet is wound with 960 turns and has a resistance of 30Ω when exciting voltage is 330V, the coil magnetic flux linking is 0.005wb. This winding is connected in series with a capacitor having C=0.0001F. Calculate the self-inductance of the coil, the resistance power loss and the energy stored in the magnetic field and the capacitor.

$N\Phi = I\,L$

$I = V / R = 11$ A

➔ $L = 0.436$ H

$P = I^2 R = 3630$ Watt

$W_L = .5\,L\,I^2 = 26.378$ J

$W_C = .5\,C\,V^2 = 5.445$ J

Question (2): **[15 Marks]**

a) Give proof of the impedance and admittance of long transmission line π connected by parameters from comparison between the general equations and π connection equations.

See in the book

b) State:

1- The corona and the corona critical voltage.

Corona is a phenomenon that has the capability for degrading insulators, and causing systems to fail. Corona critical voltage is the maximum voltage after that the corona happens.

2- The regulation factor.

See in the book

3- The feeder line and distribution line.

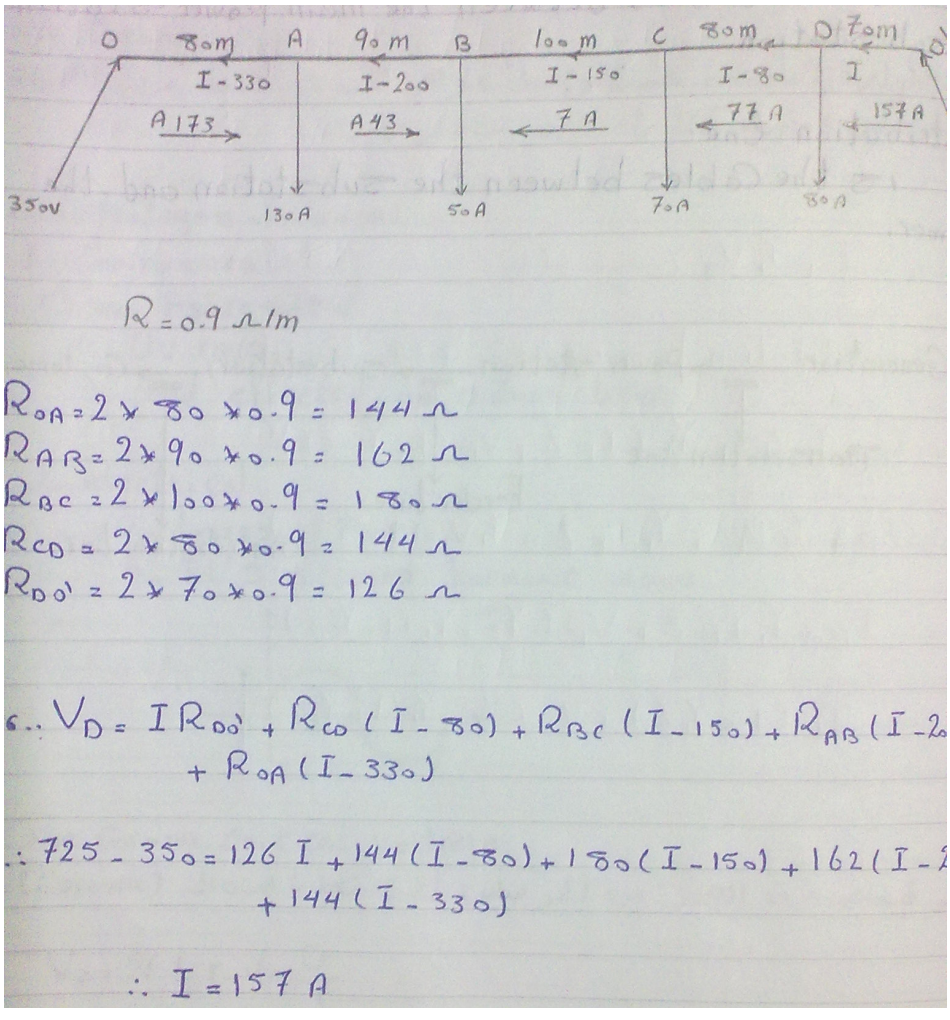
The feeder line is the cables between the main power station and substation. Distribution line is the cables between the substation and the customer.

4- The annual cost function.

See in the book

Question (3): **[15 Marks]**

DC distribution line is fed from two ends. The feeder voltages are 350V and 725V. The resistance per meter is 0.9Ω. The current at each load is I_1=130A, I_2=50A, I_3=70A and I_4=80A. The length of each part is L_1=80m, L_2=90m, L_3=100m, L_4=80m and L_5=70m. Calculate the distribution voltage of each point and their efficiency.



$R = 0.9\ \Omega/m$

$R_{OA} = 2 * 80 * 0.9 = 144\ \Omega$

$R_{AB} = 2 * 90 * 0.9 = 162\ \Omega$

$R_{BC} = 2 * 100 * 0.9 = 180\ \Omega$

$R_{CD} = 2 * 80 * 0.9 = 144\ \Omega$

$R_{DO'} = 2 * 70 * 0.9 = 126\ \Omega$

$\therefore V_D = I R_{DO'} + R_{CD}(I - 80) + R_{BC}(I - 150) + R_{AB}(I - 2$
$+ R_{OA}(I - 330)$

$\therefore 725 - 350 = 126\ I + 144(I - 80) + 180(I - 150) + 162(I -$
$+ 144(I - 330)$

$\therefore I = 157\ A$

$V_{D_{DD'}} = R_{DD'} * I_{DD'} = 126 * 157 = 19782\ V$

$V_{D_{CD}} = R_{CD} * I_{CD} = 144 * 77 = 11088\ V$

$V_{D_{BC}} = R_{BC} * I_{BC} = 180 * 7 = 1260\ V$

$V_{D_{AB}} = R_{AB} * I_{AB} = 162 * -43 = -6966\ V$

$V_{D_{OA}} = R_{OA} * I_{OA} = 144 * -173 = -24912\ V$

$\therefore V_D = V_{O'} - V_{DD'} = 725 - 19782 = -19057\ V$

$V_C = V_D - V_{D_{CD}} = -19057 - 11088 = -30145\ V$

$V_B = V_C - V_{D_{BC}} = -30145 - 1260 = -31405\ V$

$V_A = V_B - V_{D_{AB}} = -31405 - (-6966) = -24439\ V$

$\therefore \eta = \frac{P_{OLP}}{P_{ILP}}$

$P_{ILP} = (725 * 157) + (350 * -173) = 53275\ W$

$P_{OLP} = P_{ILP} - P_{Losses}$

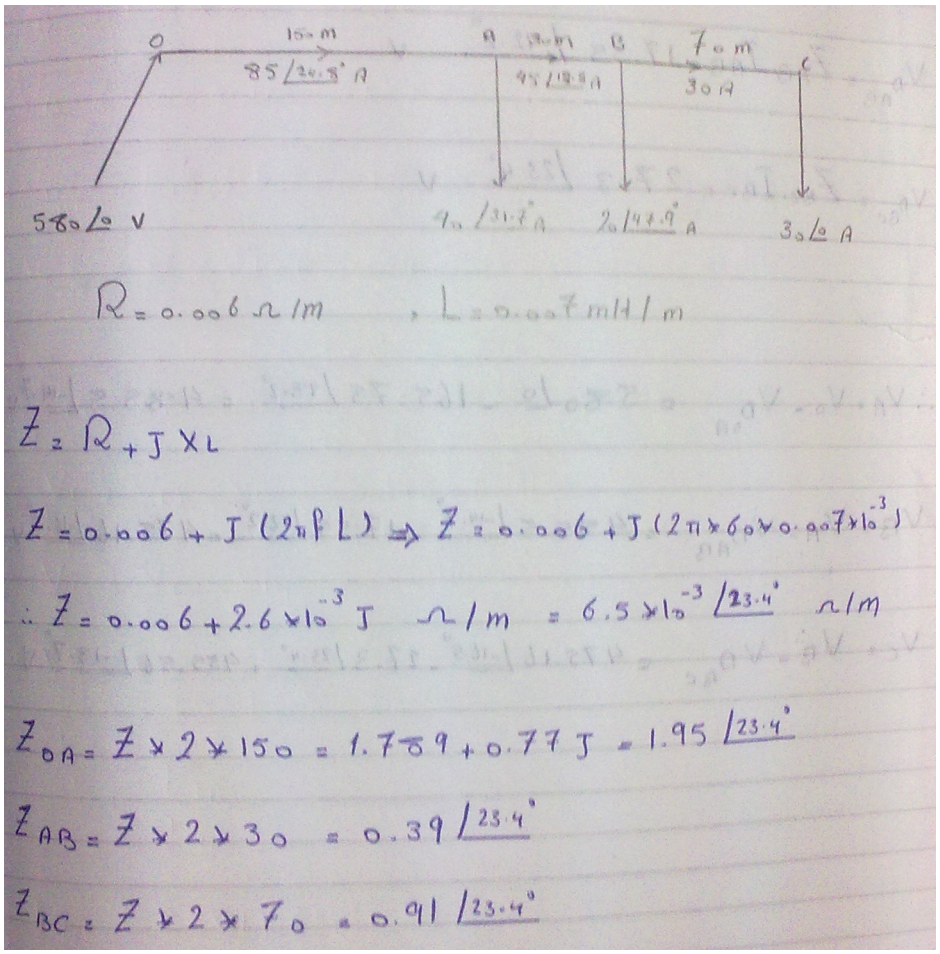
$P_L = I_{OA}^2 R_{OA} + I_{AB}^2 R_{AB} + I_{BC}^2 R_{BC} + I_{CD}^2 R_{CD} + I_{DD'}^2 R_{DD'}$

$P_L = 5577684$

$\therefore \eta = 66.2\ \%$

Question (4): **[15 Marks]**

AC distribution line, single phase, is fed from one end. The feeder voltage is 580 /0 V. The resistance per meter is 0.006Ω, the inductance per meter is 0.007mH and the frequency is 60Hz. The current at each load is I_1=40A at 0.85 power factor lag, I_2=20A at 0.67 power factor lag and I_3=30A at unity power factor. The length of each part is L_1=150m, L_2=30m and L_3=70m. Calculate the distribution voltage of each point.



$R = 0.006\ \Omega/m$, $L = 0.007\ mH/m$

$Z = R + J X_L$

$Z = 0.006 + J(2\pi f L) \Rightarrow Z = 0.006 + J(2\pi \times 60 \times 0.007 \times 10^{-3})$

$\therefore Z = 0.006 + 2.6 \times 10^{-3} J\ \Omega/m = 6.5 \times 10^{-3} \angle 23.4^\circ\ \Omega/m$

$Z_{OA} = Z \times 2 \times 150 = 1.789 + 0.77 J = 1.95 \angle 23.4^\circ$

$Z_{AB} = Z \times 2 \times 30 = 0.39 \angle 23.4^\circ$

$Z_{BC} = Z \times 2 \times 70 = 0.91 \angle 23.4^\circ$

$V_{D_{OA}} = Z_{OA} \cdot I_{OA} = 165.75 \angle 48.2^\circ$ V

$V_{D_{AB}} = Z_{AB} \cdot I_{AB} = 17.55 \angle 42.2^\circ$ V

$V_{D_{BC}} = Z_{BC} \cdot I_{BC} = 27.3 \angle 23.4^\circ$ V

$\therefore V_A = V_O - V_{D_{OA}} = 580 \angle 0 - 165.75 \angle 48.2^\circ = 485.5 \angle -14.7^\circ$ V

$V_B = V_A - V_{D_{AB}} = 485.5 \angle -14.7^\circ - 17.55 \angle 42.2^\circ = 475.16 \angle -16.5^\circ$ V

$V_C = V_B - V_{D_{BC}} = 475.16 \angle -16.5^\circ - 27.3 \angle 23.4^\circ = 455.56 \angle -18.7^\circ$ V