UE21EE141B – JULY 2022 ESA ANSWER KEY

1a) R_{AB} = 29.77Ω

1b) With only 12A source active, $I' = 8A$

With only 30V source active, $I'' = 1.67A$

With only 6A source active, $I''' = -4A$

By Superposition Theorem, current through 2Ω resistor = $I' + I'' + I''' = 5.67A$

1c) $V_{TH} = -5V$; $R_{TH} = 0.67\Omega$

Load current varies between 49.66mA and 0.468A

2a) i) It is a series RC network with R = 10Ω & C = 183.78μF

ii) P = 500W ; Q = -866VAR ; S = 1000VA

iii) Power factor = 0.5 Lead

2b) i) P_T = 77KW ; Q_T = 57.33KVAR ; S_T = 96KVA

ii) Overall Power factor = 0.802 Lag

iii) New value of Power factor = 0.899 Lag

2c) i) $Z_2 = (10 + j13.33)\Omega$

ii) Current in Z_1 = 4A ; Current in Z_2 = 6A

iii) Q_1 = 320VAR ; Q_2 = 480VAR

3b) New readings of Wattmeters: W_1 = 1.42KW ; W_2 = 3.58KW

3c) i) Z = 23.094Ω

ii) R = 11.55Ω & L = 63.66mH

iii) P_T = 3.465KW ; Q_T = 6KVAR

4b) i) f = 50Hz

ii) P = 4

iii) Slip under Full Load = 0.04 pu (or) 4%

iv) f_r (Full load) = 2 Hz

v) No Load speed = 1485 rpm

4c) i) Constant Losses = 796W

ii) Efficiency (Motor) = 73.5 %

iii) Efficiency (Generator) = 76.63 %

5b) C = 255.4µF

5c) i) Total number of Units consumed = 224

ii) Monthly Bill = Rs. 2065.237/-