UE21EE141A – MARCH 2022 ESA ANSWER KEY

1a) R_{AB} = 21.94Ω

1b) With only 5A source active, $I' = 3A$

With only 10V source active, $I'' = -2A$

With only 20V source active, $I''' = 4A$

By Superposition Theorem, current through 2Ω resistor = $I' + I'' + I''' = 5A$

1c) V_{TH} = 12.5V ; R_{TH} = 10Ω

2a) It is a parallel RL network with R = 16.67Ω & L = 39.79mH

2b) i) Power factor = 0.5 Lead

ii) Reactive Power = -3.464 KVAR

iii) C = 269.71µF

Extra inductance to be added in series for resonance condition is 27.56mH

2c) i) $Z_A = (80 + j60)\Omega$; $Z_B = (59.54 – j6.037)\Omega$

ii) P_A = 320W ; P_B = 665W

3b) i) Line current = 28.87A

ii) Z = 24Ω

iii) Power factor = 0.8 Lag

iv) R = 19.2Ω ; L = 45.84mH

3c) i) Line current = 69.28A

ii) W_1 = 3.315KW ; W_2 = 25.484KW

When reconnected as star load & supply voltage reduced to 200V,

New Line current = 11.55A

New Wattmeter Readings are W_1 = 276.31W ; W_2 = 2.124KW

4a) i) N_s = 750 rpm

ii) Slip under No Load = 0.0133 pu (or) 1.33%

iii) Full load speed = 712.5 rpm

iv) f_r (Full load) = 2.5 Hz

v) f_r at Standstill = f = 50 Hz

4b) i) Under Half-load condition, I_1 = 5A ; I_2 = 50A

ii) N_1 = 750 turns

iii) Under Half-load condition, I_1 = 2.5A ; I_2 = 25A

iv) B_m = 1.2T

v) EMF/turn = 2.67 Volts/turn

5b) i) P_T = 12KW ; Q_T = 7KVAR

ii) S_T = 13.89KVA

iii) Overall Power factor = 0.863 Lag

A capacitor with KVAR rating = 7 KVAR must be connected in parallel.

5c) i) Total number of Units consumed = 202

ii) Monthly Bill = Rs. 1810.87/-