Total No. of Questions – [3] Total No. of Printed Pages: 4

Paper Code - U119 - 102 (T1)

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F. Y. B.TECH. (COMMON) (SEMESTER - I)

COURSE NAME: BASIC ELECTRICAL ENGINEERING

COURSE CODE: ET 10182A

MODEL ANSWER AND MARKING SCHEME

(PATTERN 2018)

Time: [1 Hour] [Max. Marks: 20]

(*) Instructions to candidates:

1) **All questions are compulsory.**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed.**
4) **Use suitable data where ever required.**
5) **Assume suitable data, if required.**

Q 1) Attempt any **two**.

a) Current throgh 3Ω resistance can be found using Superposition theorem

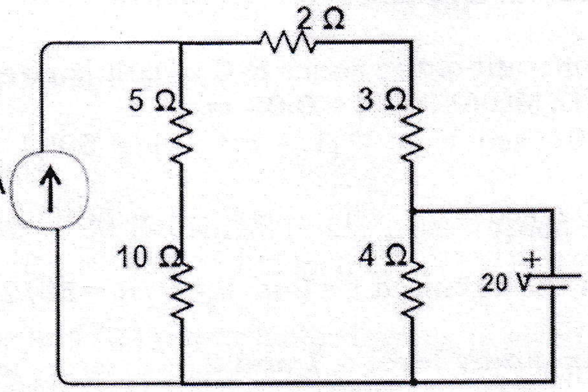


Fig.1

Considering 5A current source acting alone. 20 V voltage source is shorted.
Applying current divison rule,
$I_{3\Omega}'$ (5 A current source alone) = (5*15)/(15+2+3) = **3.75 A** downwards **1M**

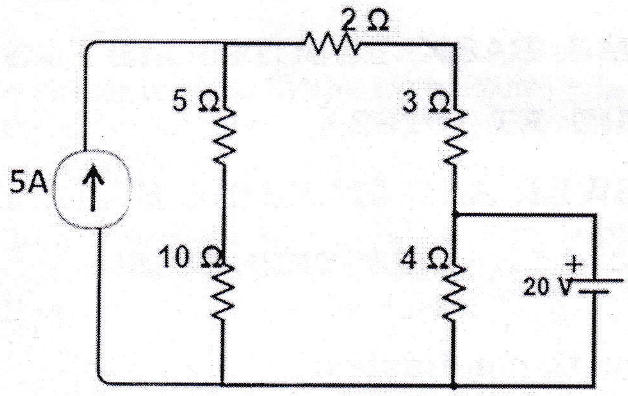
Considering 20 V voltage source acting alone. 5A current source is open circuited.
Total current deivered by 20 V voltage source is
I_T = (20)/[(10+5+2+3)II(4)] = 20*24/80 = 6 A
Applying current divison rule,
$I_{3\Omega}'$ (20 V voltage source alone) = (6*4)/(10+5+2+3+4) = **1 A** upwards **2M**

Total current throgh 3Ω resistance is given as

$I_{3\Omega} = I_{3\Omega}'$ (5 A current source alone) + $I_{3\Omega}''$ (20 V voltage source alone)
= 3.75 – 1 = **2.75 A** **1M**

Bloom's Taxonomy level :- 3 **CO:- 1**

b) Removing the load branch of 3Ω resistance



Applying KVL to loop
– 20 + 4I = 0 4I = 20
Therefore, I = 5 A **1M**
$V_{Th} = V_{oc}$ = 2(0) + (5+10)*(5) – 4(5) = **55 V** **1M**
R_{eq} = 2 + 5 + 10 + (4 II 0) =17 + 0 = **17 Ω** **1M**
Drawing Thevenin's equivalent circuit with correct V_{Th} and R_{eq}. **1M**

Bloom's Taxonomy level :- 3 **CO;- 1**

c) The time constant of the series R-C circuit is given by
ζ = RC = (2 MΩ)(0.01μF) = **0.02 sec** **1M**
At t = 0.01 sec $V_c = V*[1 - e^{(-t/\zeta)}]$ = $50*[1 - e^{(-0.01/0.02)}]$ = **30.32 V** **1M**
At t = 0.02 sec $V_c = V*[1 - e^{(-t/\zeta)}]$ = $50*[1 - e^{(-0.02/0.02)}]$ = **31.606 V** **1M**
Current in the circuit at t = 0 is I_o = V/R = 50/2 MΩ = **25 μA** **1M**

Bloom's Taxonomy level :- 1 and 2 **CO;- 1**

Q 2) Attempt any **two.**
a) v = V_m sin ωt Volt and i = I_m sin(ωt+Φ) Amp
Instantaneous power, p = v*i = (V_m sin ωt) * [I_m sin(ωt+Φ)]
= $V_m I_m$sin ωt sin(ωt+Φ)
Using cos(A – B) – cos(A +B) = 2 sin A sin B
p = ($V_m I_m$/2)*[cos(ωt–ωt+Φ) – cos(2ωt+Φ)]
p = ($V_m I_m$/2)*[cos Φ – cos(2ωt+Φ)]
Integrating this instantaneous power over a cycle, the average power in the circuit is given by,
P_{av} = ($V_m I_m$/2)cos Φ = V I cos Φ W **4M**

Bloom's Taxonomy level :- 2 and 3 **CO;- 2**

b) Apparent power S = 10 KVA Q = 8 KVAR
Power consumed, P = $\sqrt{[(S)^2 - (Q)^2]}$ = $\sqrt{(100 - 64)}$ = **6 KW**
1M
sin Φ = 8/10 = 0.8 cos Φ = 0.6
Power consumed, P = V I cos Φ
6000 = 230*I*0.6
I = 6000/(230*0.6) = **43.47 A** **1M**
Z = V/I = 230/43.47 = 5.2910 Ω
R = Zcos Φ = 5.2910*0.6 = **3.1746 Ω** **1M**
X_L = Zsin Φ = 5.2910*0.8 = 4.2328 Ω
L = X_L /2*∏*f = 4.2328 /2*∏*50 = **0.01347 H = 13.47 mH** **1M**

Bloom's Taxonomy level :- 4 **CO;- 2**

c) R = 10 Ω L = 0.1H C = 150μF V = 200 V f = 50 Hz
X_L = ωL = 2*∏*f*L = 2*∏*50*0.1 = 31.41Ω
X_C =1/ωC = 1/ 2*∏*f*C = 1/2*∏*50*150X10^{-6} = 21.22Ω
Z = R + j X_L – jX_C = 10 + j(X_L – X_C) = 10 + j(31.41– 21.22) = 10 +j10.19
= **14.27<45.53^0 Ω** **1M**
I = V/Z = 200/14.27<45.53^0 = **14.01 A** **1M**
cos Φ = cos 45.53^0 = 0.7 lag
P = V I cos Φ = 200* 14.01* 0.7 = **1.96 kW** **1M**
Frequency at which circuit will undergo resonance is given by,
f = 1/2*∏*√(L*C) =1/2*∏*√(0.1*150X10^{-6}) = **41.09 Hz** **1M**

Bloom's Taxonomy level :- 2 and 3 **CO;- 2**

Q 3) Attempt any **one.**

a) A 1.5 KVA, 220/110 V, 50 Hz, single phase transformer
P_{core} = 32 W P_{cu} = 44 W at full load

efficiency at full load and 0.8 power factor lagging is given as,
η =[(KVA*1000*cos Φ) /(KVA*1000*cos Φ) + P_{core} + P_{cu}]*100
= [1500*0.8/1500*0.8 + 32 + 44] = **94.04 %** **2M**

efficiency at half load and unity power factor is given as,
η =[(KVA*1000*cos Φ) /(KVA*1000*cos Φ) + P_{core} + ¼ *P_{cu}]*100
=[1500*1/1500*1 + 32 + 11] * 100
= **97.21 %** **2M**

Bloom's Taxonomy level :- 1 and 2 **CO;- 3**

b) Let N_1 = No. of turns on primary winding
N_2 = No. of turns on secondary winding
E_1 = rms value of emf induced in primary winding
E_2 = rms value of emf induced in secondary winding

Φ_m = maximum flux in the core
f = frequency of the supply
Let $\Phi = \Phi m \sin \omega t$ be flux in the core
According to Faraday's laws of electromagnetic induction emf induced in primary winding is,
$e_1 = -N_1 d\Phi/dt = -N_1 d/dt \{\Phi m \sin \omega t\} = -N_1 \omega \Phi_m \cos \omega t$
$= -N_1 d\Phi/dt = -N_1 d/dt \{\Phi m \sin \omega t\} = N_1 \omega \Phi_m \sin(\omega t - \prod /2)$
rms value of emf induced in primary winding is given by,
$E_1 = N_1 \omega \Phi_m / \sqrt{2} = N_1{*}2{*}\prod {*}f{*}\Phi_m/\sqrt{2} = \mathbf{4.44 f \Phi_m N_1}$ **Volts** **2M**
emf induced in secondary winding is,
$e_2 = -N_2 d\Phi/dt = -N_2 d/dt \{\Phi m \sin \omega t\} = -N_2 \omega \Phi_m \cos \omega t$
$= -N_2 d\Phi/dt = -N_2 d/dt \{\Phi m \sin \omega t\} = N_2 \omega \Phi_m \sin(\omega t - \prod /2)$
Similarly rms value of emf induced in secondary winding by Faraday's laws is given by,
$E_2 = N_2 \omega \Phi_m / \sqrt{2} = N_2{*}2{*}\prod {*}f{*}\Phi_m/\sqrt{2} = \mathbf{4.44 f \Phi_m N_2}$ **Volts** **2M**

OR

Let N_1 = No. of turns on primary winding
N_2 = No. of turns on secondary winding
E_1 = rms value of emf induced in primary winding
E_2 = rms value of emf induced in secondary winding
Φ_m = maximum flux in the core
f = frequency of the supply
Let $\Phi = \Phi m \sin \omega t$ be flux in the core
According to Faraday's laws of electromagnetic induction average value of emf induced per turn considering first quarter cycle is,
$e = d\Phi/dt = (\Phi_m - 0)/ (T/4) = 4\Phi_m f$
For sinusoidal waveform, form factor which is equal to rms value/average value is 1.11 Hence, rms value of emf induced per turn is,
$E = 1.11{*}4\Phi_m f = 4.44 f\Phi_m$ **2M**
rms value of emf induced in primary winding is given by,
$E_1 = \mathbf{4.44 f \Phi_m N_1}$ **Volts** **1M**
rms value of emf induced in secondary winding is given by,
$E_2 = \mathbf{4.44 f \Phi_m N_2}$ **Volts** **1M**

Bloom's Taxonomy level :- 3 **CO;- 3**