**Quiz 3 – Sections 1, 3 and 4**

**Closed Book – One Hour**

10%



1. If *M* = 5 mH, determine the ratio *v*1/*v*.

**Solution:** *Leq* = *L*1 + *L*2 – 2*M*; ; ; hence,  

**Version 1**: *M* = 5 mH, 

**Version 2**: *M* = 10 mH, 

**Version 3**: *M* = 15 mH, 

**Version 4**: *M* = 20 mH, 

**Version 5**: *M* = 25 mH, 

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2. Determine **VO**, given that **I** *=* 1∠0° A and *ω* = 10 rad/s.



**Solution:** H; secondary voltage is *jωM***I**, with the dotted terminal positive with respect to the undotted terminal. Hence, **VO** = -*jωM***I** = -*j*10×0.5**I** = -*j*5**I**.

**Version 1**: **I** = 1∠0° A, **VO** = -*j*5×1∠0° = 5∠-90° V

**Version 2**: **I** = 1.5∠0° A, **VO** = -*j*5×1.5∠0° = 7.5∠-90° V

**Version 3**: **I** = 2∠0° A, **VO** = -*j*5×2∠0° = 10∠-90° V

**Version 4**: **I** = 2.5∠0° A, **VO** = -*j*5×2.5∠0° = 12.5∠-90° V

**Version 5**: **I** = 3∠0° A, **VO** = -*j*5×3∠0° = 15∠-90° V



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3. The lamp glows brighter when the dots are at coil terminals

**Solution:** The lamp glows brighter when the voltage across it is largest. This occurs when the voltages across the windings are additive, that is, when the dots are at terminals 1 and 2 or 1′ and 2′.

**Version 1**: 1 and 2

**Version 2**: 1 and 2

**Version 3**: 1 and 2

**Version 4**: 1′ and 2 (dimmer)

**Version 5**: 1′ and 2 (dimmer)

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4. Determine the reactive power absorbed in the circuit, given that **I** *=* 1∠0° A rms.

**Solution:** The equivalent series impedance is . The reactive power is 5|*I*|2 VAR. As a check, the current in the capacitive branch is **I** = *j***I**; the reactive power absorbed by the capacitor is -5|*j***I**|2 = -5|*I*|2 VAR. The current in the inductive branch is **I** = (1 – *j*)**I** = ∠-45°**I**; the reactive power absorbed by the inductor is 5|*I*|2 = 10|*I*|2 VAR. The total reactive power absorbed is 10|*I*|2 – 5|*I*|2 = 5|*I*|2 VAR.

**Version 1**: **I** = 1∠0° A, *Q* = 5×(1)2 = 5 VAR

**Version 2**: **I** = 1.5∠0° A, *Q* = 5×(1.5)2 = 11.25 VAR

**Version 3**: **I** = 2∠0° A, *Q* = 5×(2)2 = 20 VAR

**Version 4**: **I** = 2.5∠0° A, *Q* = 5×(2.5)2 = 31.25 VAR

**Version 5**: **I** = 3∠0° A, *Q* = 5×(3)2 = 45 VAR

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5. In the circuit shown, *L*1 consumes 160 W at 0.8 p.f. lagging and *L*2 consumes 320 VAR at 0.6 p.f. lagging. Determine **I** when *XC* is chosen for unity power factor, assuming **VSRC** = 200∠0° V rms.



**Solution:** Ay unity p.f. the total reactance seen by the source is zero and the source applies only real power. The real power consumed by *L*2 is  W. The total real

power supplied by the load is 160 + 240 = 400 W. The current is  A rms.

**Version 1**: **VSRC** = 200∠0° V rms, **I**  A rms = 2∠0° A rms

**Version 2**: **VSRC** = 250∠0° V rms, **I**  A rms = 1.6∠0° A rms

**Version 3**: **VSRC** = 300∠0° V rms, **I**  A rms = 1.33∠0° A rms

**Version 4**: **VSRC** = 350∠0° V rms, **I**  A rms = 1.14∠0° A rms

**Version 5**: **VSRC** = 4000∠0° V rms, **I**  A rms = 1∠0° A rms

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1. Derive the time-domain expression for *vC*, given that *vSRC* = 10sin(2,000*t*) V.

**Solution:** *ωL* = 2×103×2×10-3 = 4 Ω;  Ω; **VSRC** = 10∠0°.

The node-voltage method can be applied, the circuit being as shown. At the middle node:



**VC**/-*j*5 + (**VC** – **Vx**)/*j*4 + (**VC** – 10)/*j*4 = 0

At the right-hand node:

(**Vx** – **VC**)/*j*4 + (**Vx** – 10)/3 = 5**Ix** = 5(10 – **VC**)/*j*4

Solving, **VC** = 11.98 + *j*1.44 = 12.1∠6.86°, so that *vC* = 12.1sin(2,000*t +* 6.86°) V.

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1. Derive **VTh** and *ZTh* as seen between terminals ab, given that *vSRC* = 10cos(1,000*t +* 45°) V.

**Solution:** *ωL*1 = 103×30×10-3 = 30 Ω; *ωL*2 = *ωM* =103×20×10-3 = 20 Ω;  = 20 Ω; **VSRC** = 10∠45°. The circuit in the frequency domain will be as shown, where *ω*(*L*1 – *M*) = 10 Ω; *ω*(*L*2 – *M*) = 0 Ω and is omitted. The *j*20 Ω in parallel with -*j*20 Ω is effectively an open circuit. The current in the (5 + *j*10) Ω impedance is zero, **Vcd** = 10∠45°, and **Vab** = **VTh** = 20∠45°.



If the independent voltage source is replaced by a short circuit, the impedance on the primary side is (5 + *j*10) Ω and *ZTh* = 4(5 + *j*10) = 20 + *j*40 Ω.