INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Mid-Spring Semester Examination 2023-24

Date of Examination: 22 February 2024 Session: FN Duration: 2 hrs. Full marks: 60

Subject Number: EE11003 Subject: Electrical Technology

Department/Centre/School: Electrical Engineering

Specific charts, graph papers, log book, etc. required: No

Special instructions if any: **Refer to the special answer booklet provided.**

Answer any FOUR questions. All answers must be written in the special answer booklet provided. Read the instructions carefully given in the answer booklet.

Q1(a). For the circuit shown in Fig. Q1, using **superposition theorem** determine the value of the voltage source $V_x(\neq 0)$ such that no power is absorbed/delivered by this source. [9]

Q1(b). For the same circuit shown in Fig. Q1, applying Thevenin's theorem determine the value of V_x such that the maximum power is delivered to this source. Also calculate the value of the maximum power. [6]

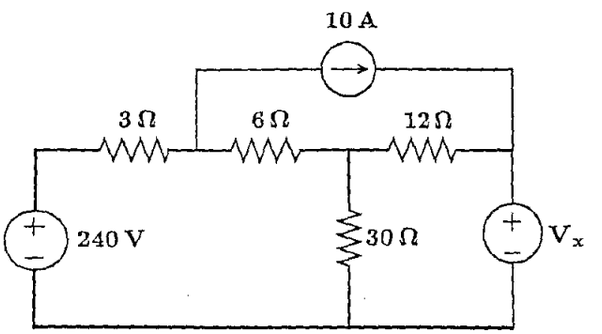

Fig. Q1

Q2(a). Consider the circuit shown in Fig. Q2. Find $v(t)$ if $i(t) = 10\sin(10t) + 5\,A$. [5]

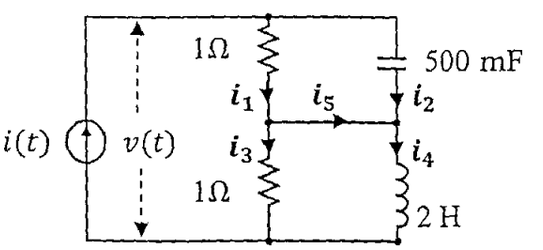

Fig. Q2

Q2(b). In the circuit shown in Fig. Q2, now **if $i(t) = 10\sqrt{2}\sin(t)$ A**, find phasors $\bar{I}_1$, $\bar{I}_2$, $\bar{I}_5$, $\bar{I}_3$, $\bar{I}_4$ and $\bar{V}$ by considering $\bar{I}(10\angle 0^0 A)$ as the reference phasor. [7]

Draw the phasor diagram in the space provided in the answer booklet (i.e. Fig. A2) by considering $\bar{I}\,(10\angle 0^0 A)$ as the reference phasor as indicated. In the diagram, show $\bar{I}_1$, $\bar{I}_2$, $\bar{I}_5$, $\bar{I}_3$, $\bar{I}_4$ and $\bar{V}$. Proper scaling is not necessary. [3]

Q3(a). Using **Nodal method,** find $\bar{V}_1$ and $\bar{V}_2$ for the circuit shown in Fig. Q3a. Find also the complex power delivered by each source. Determine the value of the reactance to be connected across the voltage source so that no reactive power is supplied/received by this source. [5+3+3]

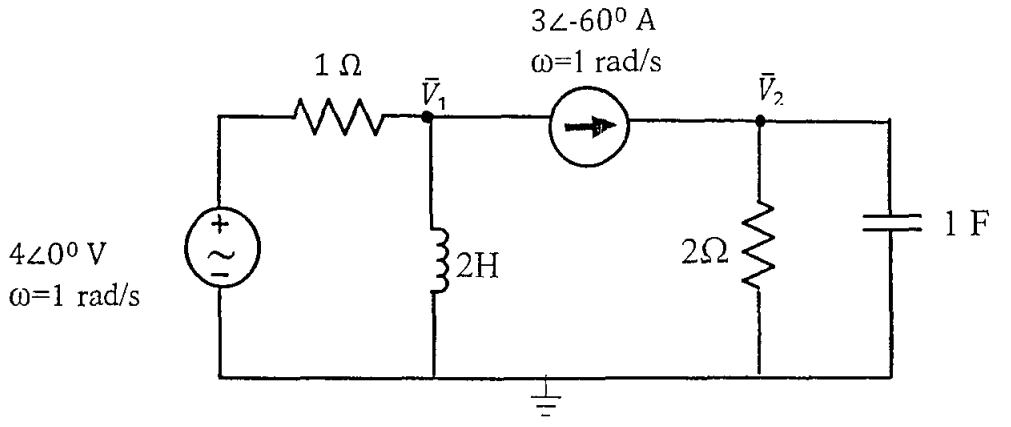

Fig. Q3a

Q3(b). Find the value of the reactance X in the circuit shown in Fig. Q3b for which the current through X becomes maximum. [4]

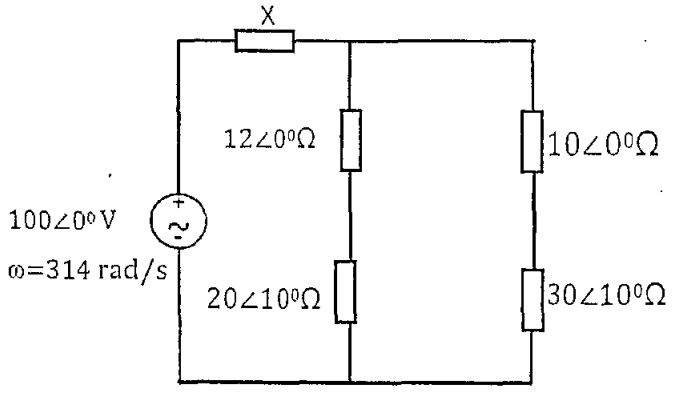

Fig. Q3b

Q4(a). For the circuit shown in Fig. Q4a, find the Thevenin equivalent ($\bar{V}_{th}$ and Z_{th}) as seen from terminals A-B. Find the value of Z_L (in R+jX form, both R and X being non-zero) to be connected across terminals A and B such that the active power transferred to Z_L will be maximum. Calculate the value of this maximum active power transferred to Z_L. [4+3+1+1]

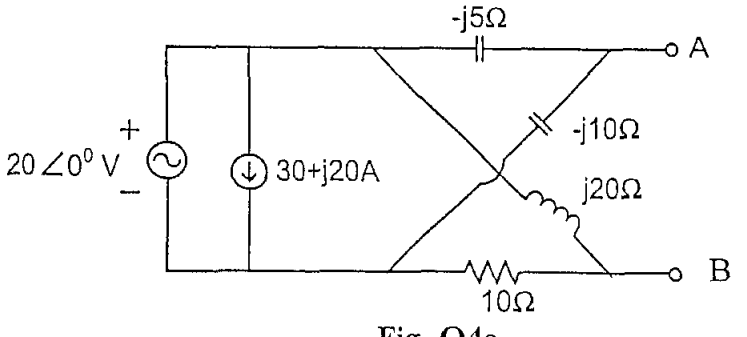

Fig. Q4a

Q4(b). Find the value of impedance Z (in R+jX form) in the circuit shown in Fig. Q4b such that $\bar{V}_1 = 140 + j30\ V$. [6]

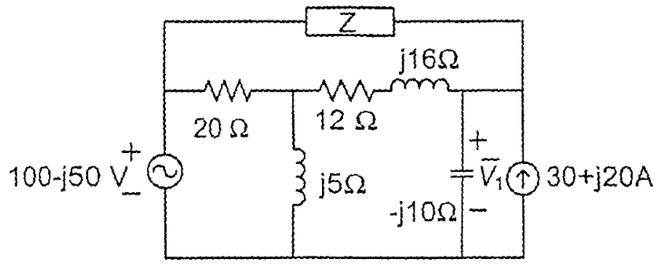

Fig. Q4b

Q5(a). The circuit shown in Fig. Q5a is initially at steady state with S1 and S2 closed. At time t=0 s, both the switches are opened. Find $v_c(t)$ at t=1 s. [7]

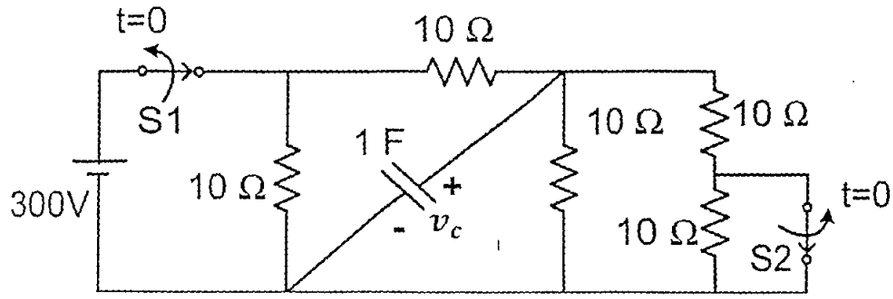

Fig. Q5a

Q5(b). The circuit shown in Fig. Q5b is initially at steady state with S1 closed and S2 open. At t=0 s, S1 is opened and S2 is closed simultaneously. Find $i(t)$ at t=0.01 s. [8]

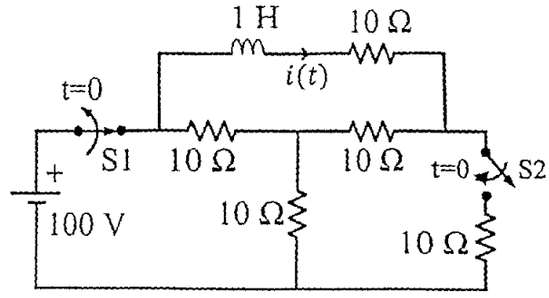

Fig. Q5b

End of question paper.