上 海 交 通 大 学 试 卷

（ 2024~ 2025~1 Academic Year/Fall Semester ）

Class No._____ Name in English or Pinyin: _____

Student ID No._____ Name in Hanzi(if applicable): _____

ECE2150J and Intro to Circuits

Final Exam

19th December 10:00 – 11:40 am

The exam paper has 13 pages in total.

You are to abide by the University of Michigan-Shanghai Jiao Tong University Joint Institute (UM-SJTU JI) honor code. Please sign below to signify that you have kept the honor code pledge.

THE UM-SJTU JI HONOR CODE

I accept the letter and spirit of the honor code:

I have neither given nor received unauthorized aid on this examination, nor have I concealed any violations of the Honor Code by myself or others.

Signature:_____

Please enter grades here:

Exercises No. 题号	**Points** 得分	**Grader's Signature** 流水批阅人签名
1		
2		
3		
4		
5		
Total 总分		

Q1. Discrete small questions. For multiple choice questions, there is only one correct answer. [24 points]

1.1 Suppose two equal-frequency AC voltages $\mathbf{V_1} = \mathbf{1\angle 0°}$ and $\mathbf{V_2} = \mathbf{1\angle 60°}$, which statement is correct? [4 points]

(A) $\mathbf{V_1}$ and $\mathbf{V_2}$ are in phase.

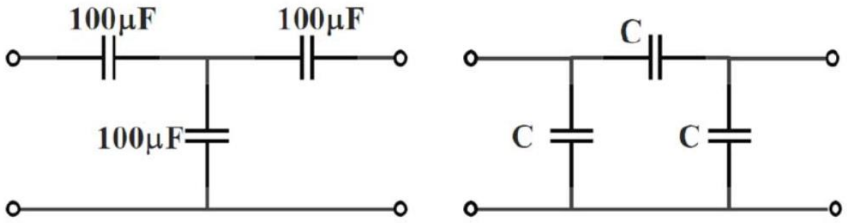
(B) $\mathbf{V_2}$ lags $\mathbf{V_1}$ by 60°

(C) $\mathbf{V_1}$ leads $\mathbf{V_2}$ by 60°.

(D) $\mathbf{V_2}$ leads $\mathbf{V_1}$ by 60°.

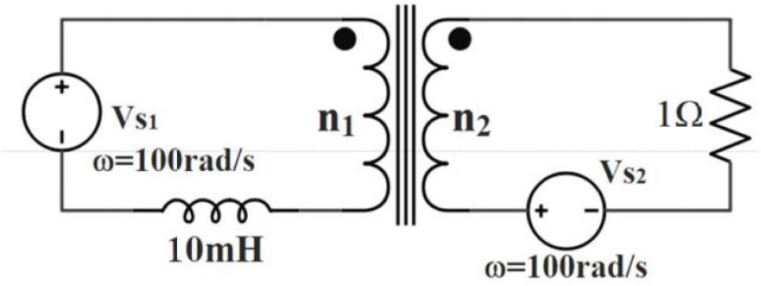
(e) No correct answer.

1.2 Suppose the following two circuit structures are equivalent under the same source frequency. What is the value of C? [4 points]



1.3 The primary current to an ideal transformer rated at 1100/220 V is 10 A. Find the secondary current. Assume turns ratio is all positive. [4 points]

1.4 Suppose $V_{S1} = V_{S2}$, if the real power in the following circuit reaches its maximum, which statement about n_1 and n_2 is correct? Please note that n_1 and n_2 are the number of turns for the primary and secondary stages in the ideal transformer, respectively. [6 points]



(a) $n_1 = n_2$

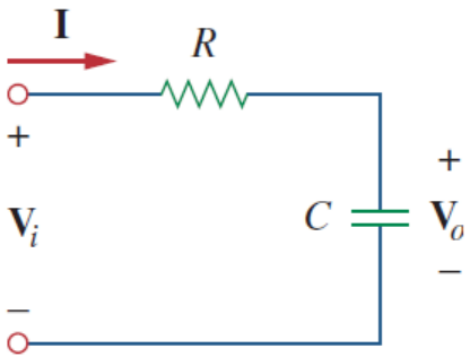
(b) $n_1 < n_2$

(c) $n_1 > n_2$

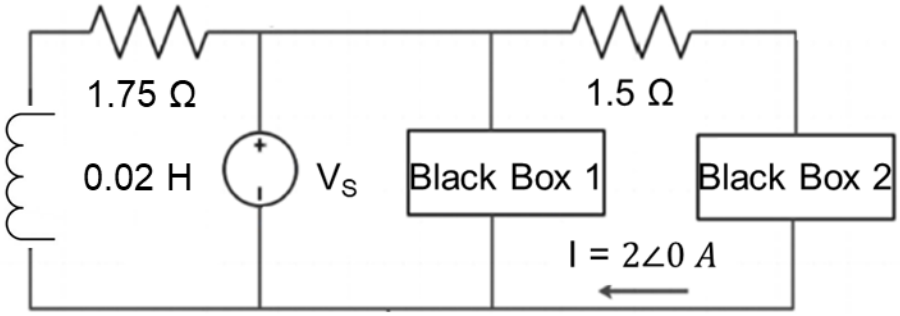
(d) The relationship between n_1 and n_2 cannot be determined in the circuit.

Please provide brief reasoning/processes:

1.5 For the phase shifter circuit below, prove that 90° phase shift is not achievable due to zero output voltage. [6 points]



Q2. The two black boxes are composed of *RLC* (resistor, inductors, and capacitors) without a power source. The frequency of the source voltage is adjusted so that the circuit transfers the maximum average power to the Black Box 1. All values are **rms**. [20 points]



Black Box 1
14 W – j4 VAR

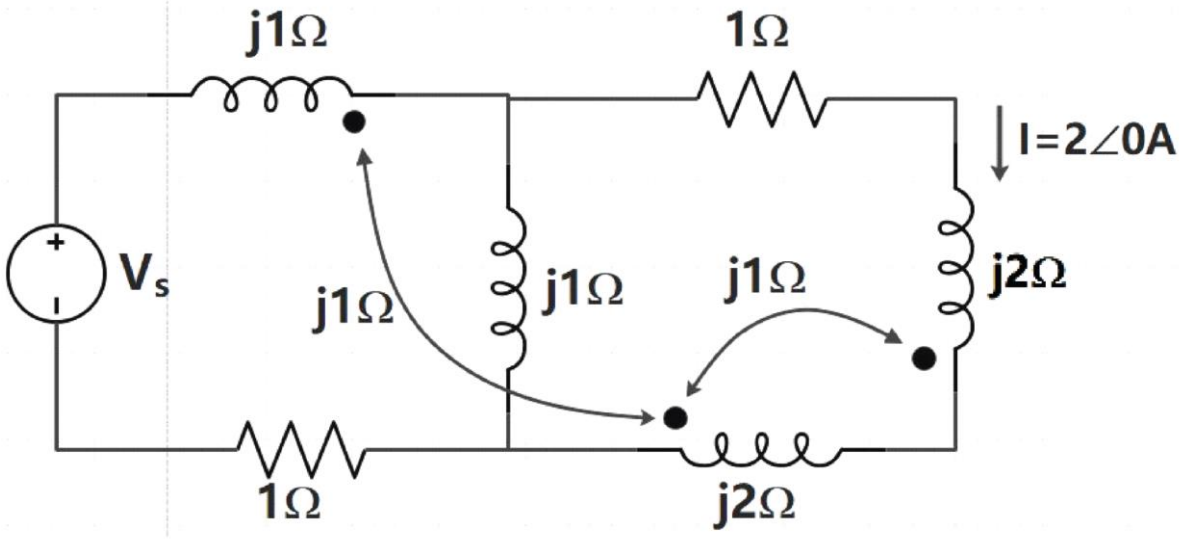
Black Box 2
1 + j2 VA

(a) Please calculate the phasor representation of the source voltage V_S. [6 points]

(b) What is the frequency of the source voltage. [10 points]

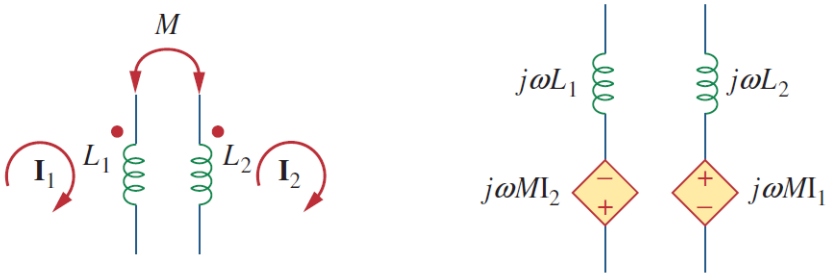
(c) Suppose you want to correct the overall power factor by connecting pure reactive loads in parallel with the source. Please calculate possible value of such additional capacitance (or inductance) that will change the overall power factor to 0.9. [4 points]

Q3. For the magnetically coupled circuit below, please answer the following questions. [22 points]



(a) Please draw the equivalent circuit using the dependent voltage sources (example below). [8 points]

Example: Magnetically coupled circuit and its equivalent circuit with dependent voltage sources.



(b) Derive KVL equations. All currents flow **clockwise**. [6 points]

(c) Find $\mathbf{V_S}$. Use the **phasor** form. [8 points]

Q4. For **Δ-Y** three phase circuit, please answer the following questions. The load impedance (Y) in each phase is $Z_L = 4 + j3\ \Omega$. The phase voltages (**rms**) for three sources are $8.66\angle 0°$, $8.66\angle -120°$, $8.66\angle 120°$ V. [12 points]

(a) Please find line voltages and line currents. [6 points]

(b) Please calculate the complex power per phase and total complex power consumed. [3 points]

(c) What is power factor of the total complex power consumed in the circuit? [3 points]

Q5. The variable load resistor R_L in the circuit below is adjusted for maximum average power transfer to R_L. Please answer the following questions. All currents flow **clockwise**. [22 points]

(a) Find V_{TH} and I_{SC}. [10 points]

(b) Find R_{TH}. [2 points]

(c) Find the maximum average power. [4 points]

(d) Average power developed by the ideal voltage source when R_L is absorbing maximum average power? [6 points]