Technology for Development

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE:

COURSE TITLE: ELECTRIC CIRCUIT THEORY AND ANALYSIS II

DATE: FRIDAY, APRIL 19TH 2024 **TIME:** 8:00 AM - 10:00 AM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

MMUST observes ZERO tolerance to examination cheating

Question 1 **[30marks]**

(a) A coil of 2Ω resistance and 0.01H inductance is connected in series with a capacitor across 200V mains. Determine the capacitance in order that maximum current occurs at a frequency of 50Hz. [2marks]

(b) A voltage v(t)= 10 sin ωt is applied to a series RLC circuit. At the resonant frequency of the circuit, the voltage across the capacitor is found to be 500V. The bandwidth of the circuit is known to be 400 rad/s and the impedance of the circuit at resonance is 100Ω. Determine,

(i) inductance and capacitance [2marks]

(ii) resonant frequency [2marks]

(iii) upper and lower cut-off frequencies. [2marks]

(c) Two impedances given by $Z_1 = (10 + j15)\Omega$ and $Z_2 = (6 - j8)\Omega$, are connected in parallel across an ac supply. If the total current supplied is 15A, determine the power taken by each branch. [3marks]

(d) (i) State any TWO merits of polyphase systems over single phase. [2marks]

(ii) Three coils, each having a resistance of 8Ω and an inductance of 0.02H, are connected in delta to a three-phase, 400V, 50 Hz supply. Calculate the power absorbed. [3marks]

(e) A capacitor is charged to 100V and then discharged through a 50 kΩ resistor. If the time constant of the circuit is 0.8s, determine:

(i) the value of the capacitor. [2marks]

(ii) the time for the capacitor voltage to fall to 20 V, [2marks]

(iii) the current flowing when the capacitor has been discharging for 0.5s, [2marks]

(iv) the voltage drop across the resistor when the capacitor has been discharging for one second. [2marks]

(f) (i) Two mutually coupled coils X and Y are connected in series to a 240V d.c supply. Coil X has a resistance of 5Ω and inductance of 1H. Coil Y has a resistance of 10Ω and an inductance of 5H. At a certain instant after the circuit is connected, the current is 8A and increasing at a rate of 15A/s. Determine mutual inductance and coefficient of coupling between the coils. [3marks]

(ii) A three-phase, star-connected source feeds 1500 kW at 0.85 power factor lag to a balanced mesh-connected load. Calculate the current, its active and reactive components in each phase of the source and the load. The line voltage is 2.2 kV [3marks]

[15marks]

Question 2

(a) A 415V, 50 Hz, three-phase voltage is applied to three star-connected identical impedances. Each impedance consists of a resistance of 15Ω , a capacitance of 177 μF and an inductance of 0.1H in series. Determine;

(i) line current, [4marks]
(ii) active power, [2marks]
(e) reactive power [2marks]

(b) A three-phase, 200kW, 50Hz, delta-connected induction motor is supplied from a three-phase, 440V, 50Hz supply system. The efficiency and power factor of the three-phase induction motor are 91% and 0.86 respectively. Determine;

(i) line currents [2marks]
(ii) active and reactive component of phase current [2marks]

(c) Three identical impedances of $10\angle 30^\circ\ \Omega$ each are connected in star and another set of three identical impedances of $18\angle 60^\circ\ \Omega$ are connected in delta. If both the sets of impedances are connected across a balanced, three-phase 400V, supply, determine the line current. [3marks]

Question 3 **[15marks]**

(a) A coil of 400Ω resistance and 318 μH inductance is connected in parallel with a capacitor and the circuit resonates at 1 MHz. If a second capacitor of 23.5 pF capacitance is connected in parallel with the first capacitor, find the frequency at which the circuit resonates. [4marks]

(b) The winding of an electromagnet has an inductance of 3H and a resistance of 15Ω. When it is connected to a 120V, d.c. supply, determine;

(i) the steady state value of current flowing in the winding, [1mark]
(ii) the value of the induced e.m.f. after 0.1s, [2marks]
(iii) the time for the current to rise to 85% of its final value, [2marks]
(iv) the value of the current after 0.3s [2marks]

(c) Determine the current in the circuit of Figure Q3(c). Hence, find the power consumed as well as p.f. [4marks]

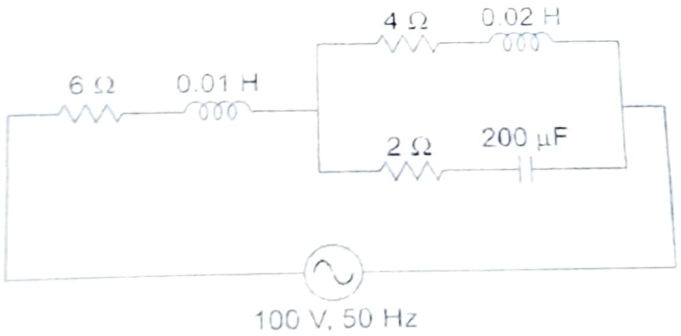

Figure Q3(c)

Question 4 **[15marks]**

(a)(i) Two coils have self-inductances of 250mH and 400mH respectively. Determine the magnetic coupling coefficient of the pair of coils if their mutual inductance is 80mH. [2marks]

(ii) Two coils connected in series have self-inductance of 40mH and 10mH respectively. The total inductance of the circuit is found to be 60mH. Determine the mutual inductance. [3marks]

(b) For the coupled circuit shown in Figure Q4(b), calculate;

(i) the self-impedance of the primary circuit [1mark]
(ii) the self-impedance of the secondary circuit [1mark]
(iii) the impedance reflected into the primary circuit [2marks]
(iv) the effective primary impedance [2marks]
(v) the primary current [2marks]
(vi) the secondary current [2marks]

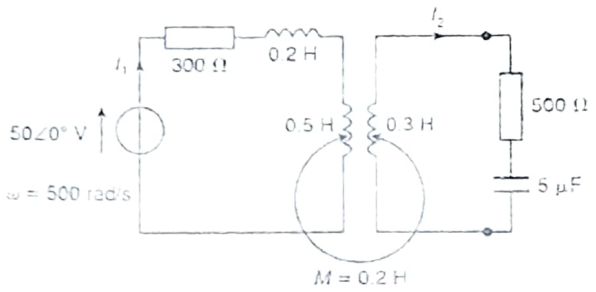

Figure Q4(b)

Question 5 **[15marks]**

(a) Three star-connected impedances Z_Y = 20+ j37.7 Ω per phase are connected in parallel with three delta-connected impedances Z_Δ =(30-j159.3)Ω per phase. The line voltage is 398V. Find the line current and power dissipated by the combination. [4marks]

(b) A voltage v(t) = 177 sin (314t + 10°) is applied to a circuit. It causes a steady-state current to flow, which is described by i(t) = 14.14 sin (314t – 20°). Determine the power factor and average power delivered to the circuit. [4marks]

(c) A coil of 10Ω resistance and 0.2H inductance is connected in parallel with a variable capacitor across a 220 V, 50 Hz supply. Calculate;

(i) the capacitance of the capacitor for resonance [3marks]
(ii) the dynamic impedance of the circuit [2marks]
(iii) supply current. [2marks]