University of KwaZulu-Natal

Electrical, Electronic & Computer Engineering

Examinations: June 2026

Subject, Course & Code: Electrical & Electronic Engineering ENEL2EE

Duration: 3 Hours **Total Marks: 100**

Examiner/s:

S Rezenom (Internal)
P Kumar (Internal)
R Khuboni (Moderator)

Instructions:

1. This paper consists of **electrical section** and **electronic section.** Use **separate answer sheets** for each section.

2. Clearly label the answer sheets as "**EC Section**" or "**EL Section**" to provide clarity.

3. The electronic section consists of **two questions.** All questions must be answered in full. All relevant assumptions must be documented clearly.

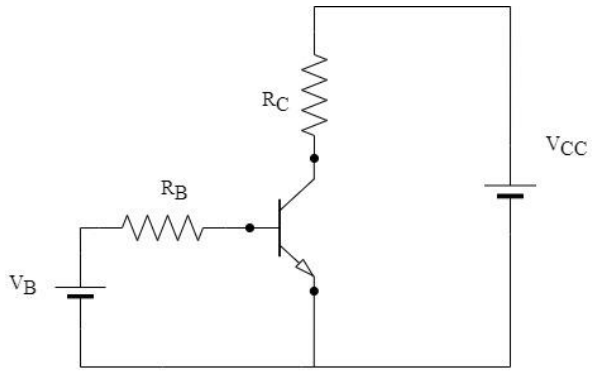
4. The electrical section consists of **two questions**. All questions must be answered in full. All relevant assumptions must be documented clearly.

5. A dark pencil may be used.

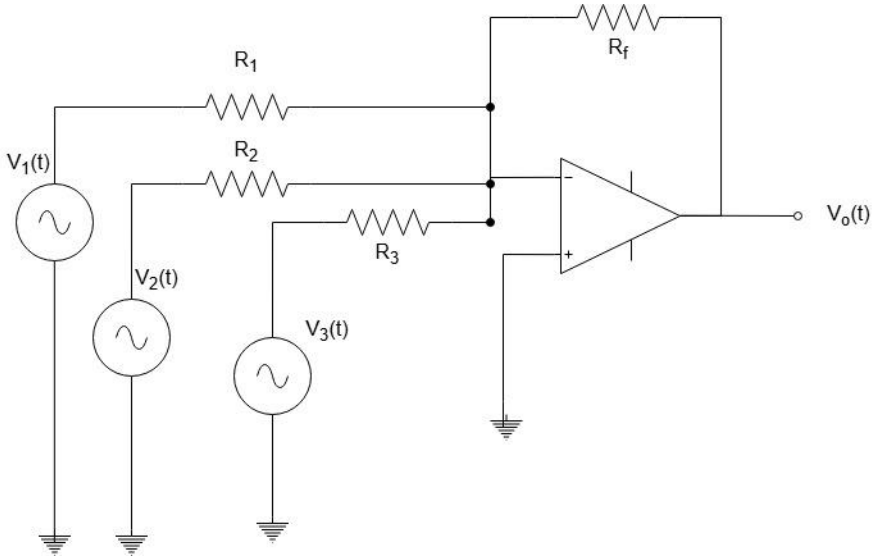
Electronic Section

EC Question 1 [25 marks]

a) Consider the circuit shown below and determine the operation region of the transistor. The relevant values are V_B = 5.0 V, Vcc = 10 V, V_{BE} = 0.7 V, R_B = 20 k Ohm, R_C = 10 k Ohm and β = 300. [5]



b) Consider the ideal operational amplifier shown below.

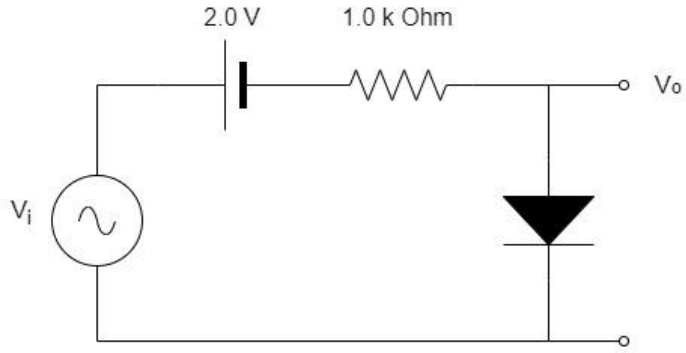


i. Obtain an expression for the output voltage $V_o(t)$ using first principles. [3]

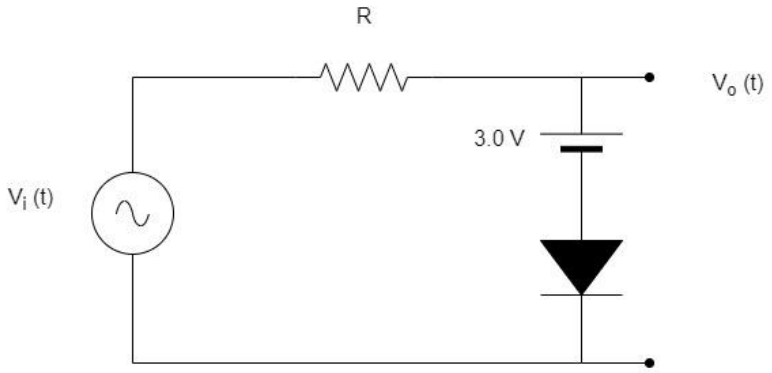
ii. Assume the input voltages are $V_1(t) = 10 \sin(1000\pi t)$, mV, $V_2(t) = 20 \sin(1000\pi t)$, mV and $V_3(t) = 10 \sin(1000\pi t)$, mV. The resistor values are R_1 = 10 k Ohm, R_2 = 10 k Ohm, R_3 = 20 k Ohm, R_f = 50 k Ohm. Plot the output voltage $V_o(t)$. [2]

c) Briefly show the equivalent circuit diagram of the non-ideal operational amplifier and explain the relevant parameters. [5]

d) Consider the circuit shown below. The input voltage is Vi(t) = 12 sin(5000πt),Volts. Assume the threshold voltage of the diode is 1.0 V. Plot the output voltage Vo versus the input voltage Vi. [5]



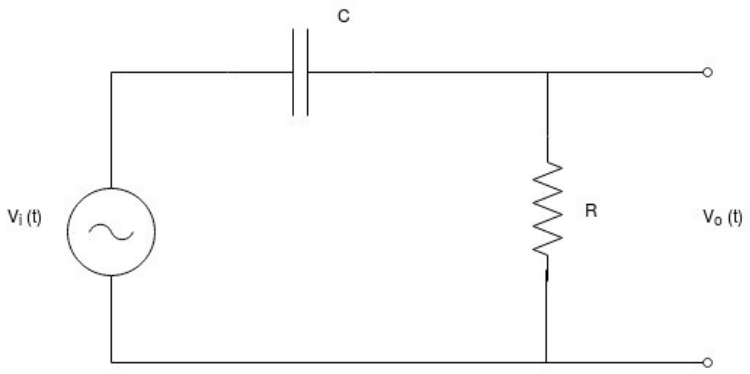
e) The input voltage Vi(t) of the circuit shown below varies from -10 V to 10 V. Plot the current in the resistor. Assume ideal diodes and R = 1 k Ohm. [5]



EC Question 2 [25 marks]

a) Design an operational amplifier that has a gain -20 ± 10 %. Assume 2 % tolerance resistors are available. Clearly document any assumptions. [5]

b) Consider the circuit shown below.



i) Derive the transfer function. [5]

ii) Sketch the approximate plot of the magnitude and phase response. [5]

c) Consider the Boolean expression $Y = ABC + (AC + \bar{C})(A\bar{B} + BC)$.

i) Simplify the expression. [5]
ii) Show the logical circuit of the simplified expression using NAND gates. [5]

Electrical (EL) Section

Question EL1 [30 marks]:

(a) Using nodal voltage analysis, determine the voltages V1, V2 and V3 in the circuit of Fig. QEL1(a). [6]

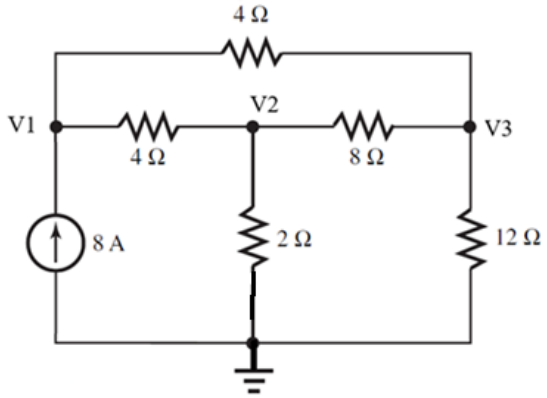


Fig. QEL1(a)

(b) In Fig QEL1(b), the switch was closed for a long time. The switch is opened at t=0 as shown in figure. Determine the voltage across capacitor (v_C) at t=2 s. [6]

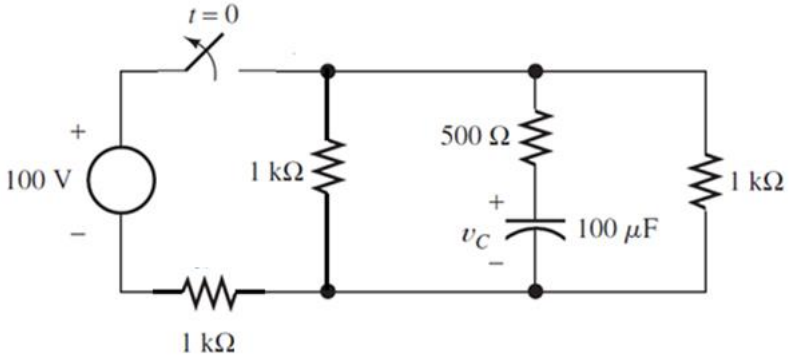


Fig. QEL1(b)

(c) In the circuit of Fig. QEL1(c), determine the following:

(i) The mesh current equations for I_1 and I_2. [2]

(ii) The Norton's equivalent circuit across the $50\angle -10^o\ \Omega$ impedance. [5]

(iii) The current (in polar form) in the $50\angle -10^o\ \Omega$ impedance using Norton's equivalent circuit. [2]

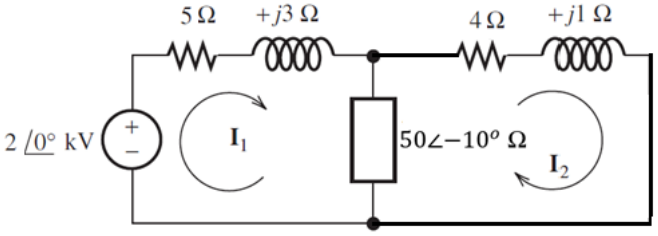


Fig. QEL1(c)

(d) A balanced three-phase star connected load is connected to a balanced three-phase star connected 50 Hz supply with 400 V between the lines. Each phase of the load consists of a resistance of 20 Ω and an inductance of 0.05 H connected in series. Determine the following:
(i) The phase voltages (in polar form). [2]
(ii) The magnitude and phase of the load impedance. [3]
(iii) The total power supplied to the load. [4]

Question EL2 [20 marks]:

(a) A 5 kVA, 200/800 V, 50 Hz transformer gave the following test results:
Open Circuit Test: 2000 V, 1.2 A, 90 W
Short Circuit Test: 50 V, 5 A, 110 W
For the open circuit test, the high voltage side was open and for the short circuit test the low voltage side was shorted.
(i) Calculate the equivalent circuit parameters referred to the low voltage side. [9]
(ii) Determine the voltage regulation at full load with 0.7 power factor lagging. [5]

(b) A self-excited series dc motor takes 40 A at 220 V and runs at 700 rpm. If the armature resistance and field resistance are 0.2 Ω and 0.1 Ω, respectively, and the rotational losses are 0.4 kW, find:
(i) The torque developed in the armature, [3]
(ii) The output power of the motor. [3]