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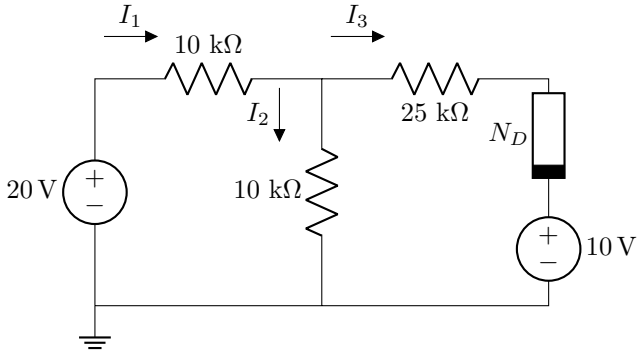
Brac University

Semester: Summer 2022
Course No: CSE251
Course Title: Electronic Devices and Circuits
Section: 2 to 14

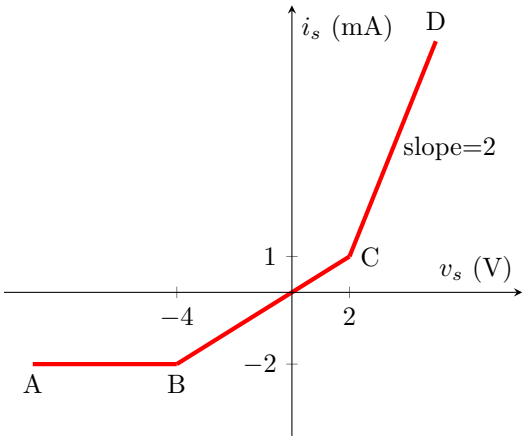
Midterm
Full Marks: 40
Time: 2 hours
Date: July 27, 2022

Answer **any 4 questions**. All the questions carry equal marks.

Question 1 [CO1] **10**



(a) A circuit with a non-linear device N_D



(b) IV Characteristics of the non-linear device N_D

(a) **Identify** the equivalent linear circuit models for the 3 linear regions (AB, BC, CD) shown in the IV characteristics of the non-linear device N_D (Figure (b)) and **calculate** the model parameters. [3]

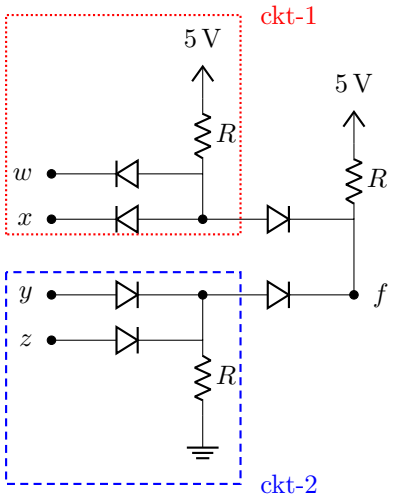
(b) **Detect** the operating region for the device when $v_s = 3$ V and **calculate** the current through the device, i_s, for this voltage (hint: use Figure (b) and answers from previous part). [1+1]

(c) **Show** the alternative representation of the circuit in Figure (a). [1.5]

(d) Assume that the non-linear device N_D has been replaced with its equivalent linear device of segment BC. **Draw** the alternative representation of the circuit again by replacing N_D. [0.5]

(e) **Apply** KVL and KCL on the circuit of part (d) to calculate the values of I_1, I_2, and I_3. [3]

Question 2 [CO2] **10**



Part a: Analyze of the circuit on the left. Assume all the diodes are ideal diodes.

(a) Assuming w, x, y, z are boolean variables, **analyze** the circuit to find an expression of ckt-1 (the dotted ... rectangle) in terms of w and x, and an expression of ckt-2 (the dashed - - - rectangle) in terms of y and z. [2+2]

(b) **Analyze** the circuit again to find an expression of f in terms of w, x, y, z. Use results from (a). [2]

Part b: Jawad has created a new ride sharing app - *Juber*. When you request a Juber ride, Juber's algorithm generates 4 signals to determine whether it will be forwarded to a rider. (1) Signal F determines if the rider is free. (2) Signal R determines if the rider is within close proximity. (3) Signal G determines if

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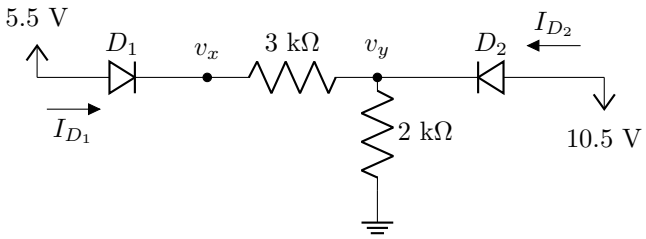
the rider has good rating. (4) Signal N determines if the rider is new. If both conditions 1 and 2 are satisfied, **and** either condition 3 or condition 4 are satisfied, the request will be connected

(c) **Deduce** the logic function using boolean signals F, R, G and N to implement Juber's algorithm. [2]

(d) **Design** a circuit using ideal diode logic gates to implement this function. [2]

Question 3 [CO1] **7+3**

Analyze the circuit to find the values of I_{D_1}, I_{D_2}, v_x, and v_y [$V_{D_0} = 0.5$ V]. You must **validate** your assumptions.



Question 4 [CO2] **10**

The input of a full-wave rectifier is a sinusoidal voltage with peak $V_M = 10$ V and frequency 60 Hz, and output load resistance is $R = 2$ kΩ. Silicon diodes are used in this circuit for which the forward drop is $V_{D_0} = 0.7$ V.

(a) Briefly **explain** the purpose of a rectifier and **describe** its operation. [2]

(b) **Show** the input and output waveforms. [2]

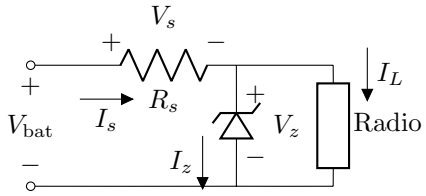
(c) **Calculate** the DC value of the output voltage. [1]

Now after connecting a capacitor in parallel with the load, the output becomes a ripple voltage $V_{\text{out}} = V_{\text{DC}} \pm 0.2$ V.

(d) **Calculate** the peak-to-peak ripple voltage, and from that, the value of the capacitor. [1+2]

(e) **Calculate** the average of the output voltage V_{DC} after connecting the capacitor. [2]

Question 5 [CO1, CO2] **10**



The circuit above is a voltage regulator used to power a car radio (which requires ≈ 9 V) from the car battery, V_{bat} whose voltage may vary between 11 and 13.6 V. The current in the radio, I_L, will vary between 0 (off) to 9 mA (full volume). The Zener diode in the circuit is specified with parameter $V_{z_0} = 9$ V, $r_z = 0.05$ kΩ, and $I_{\text{zk}} = 1$ mA.

(a) **Identify** the worst-case conditions and **calculate** the Zener current (I_z), Zener voltage (V_z), the input voltage (V_{bat}), and the load current (I_L) in this worst-case scenario. [1+1+1+1+1]

(b) **Calculate** the current (I_s) and the voltage (V_s) the input resistor R_s in the worst-case scenario. [2]

(c) **Design** the circuit, i.e., find the value of R_s, such that even in the worst-case scenario voltage regulation is maintained. Calculate the load regulation for this circuit. [2+1]