FULL NAME (Printed): ____

Program: _____________

You have the entire period to complete this examination. You are allowed your Sharp EL-516 calculator and the DC Formula Sheet from the text (provided). All of the questions are equally weighted

- **M/C Questions**
    - o Circle the correct answer
    - o NO partial credit will be awarded
- **Work the Problem Questions**
    - o SHOW ALL your work in the space provided
    - o BOX-IN your final answer
    - o Partial credit may be awarded

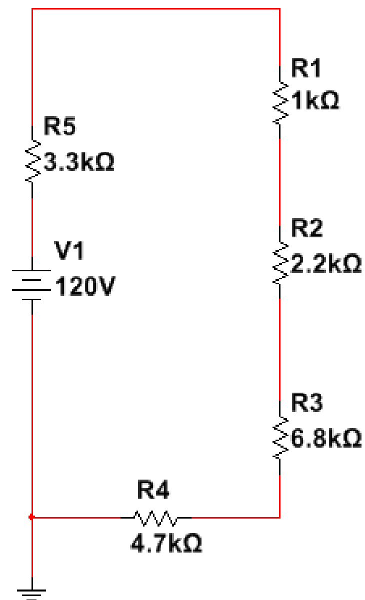

Figure 1- Schematic for Problems 1 through 3

1. See Figure 1. How much power is dissipated by R_5?
   a. 146.7 mW
   b. 132.2 mW
   c. 36.4 mW
   d. 6.67 mW

2. See Figure 1. <u>If R_3 is open circuited</u>, how much power is dissipated by R_5?
   a. 36.4 mW
   b. 6.76 mW
   c. 1.76 mW
   d. 0 W

3. See Figure 1. Which *one* of the following statements is true *if the 120V source is replaced by a 60V source*?
   a. The voltage across R3 will decrease by 25%
   b. The power dissipated by R5 will decrease by 25%
   c. The current in the circuit will reduce to half its original value
   d. The power dissipated by R5 will decrease to half of its original value

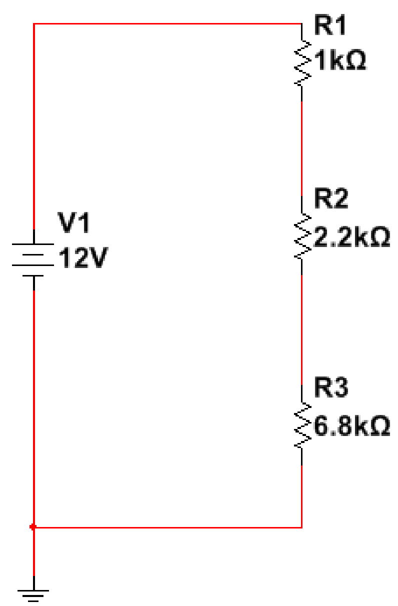

Figure 2- Schematic for Problems 4 - 6

4. See Figure 2. The total resistance in this circuit is (as seen by the source):

   a. 12 kΩ
   b. 10 kΩ
   c. 1 kΩ
   d. 0.624 kΩ

5. See Figure 2. The total current flowing from the battery is

   a. 12 mA
   b. 1.8 mA
   c. 1.2 mA
   d. 1.0 mA

6. See Figure 2. The total power dissipated by the 2.2 kΩ resistor is

   a. 144 mW
   b. 23.2 mW
   c. 14.4 mW
   d. 3.17 mW

7. The total *resistance* of a 10 Ω resistor and a 100 Ω resistor in parallel is

   a. 1010 Ω
   b. 9.09 Ω
   c. 7.07 Ω
   d. 0.110 Ω

8. A 10 Ω resistor and an 8 Ω resistor are connected in parallel across a 15 V battery. What is the total current drawn from the battery?

   a. 3.38 A
   b. 1.88 A
   c. 1.50 A
   d. 0.830 A

9. What is the total conductance of a parallel circuit with three resistors with values of 80, 120 and 220 Ω?

   a. 39.4 S
   b. 53.8 mS
   c. 39.4 mS
   d. 25.4 mS

10. As additional resistors are added (in parallel) to a parallel circuit, what will happen to the total conductance of the circuit?

   a. It depends on the number of resistors added whether the conductance will increase or decrease
   b. The total conductance will remain the same
   c. The total conductance will increase
   d. The total conductance will decrease

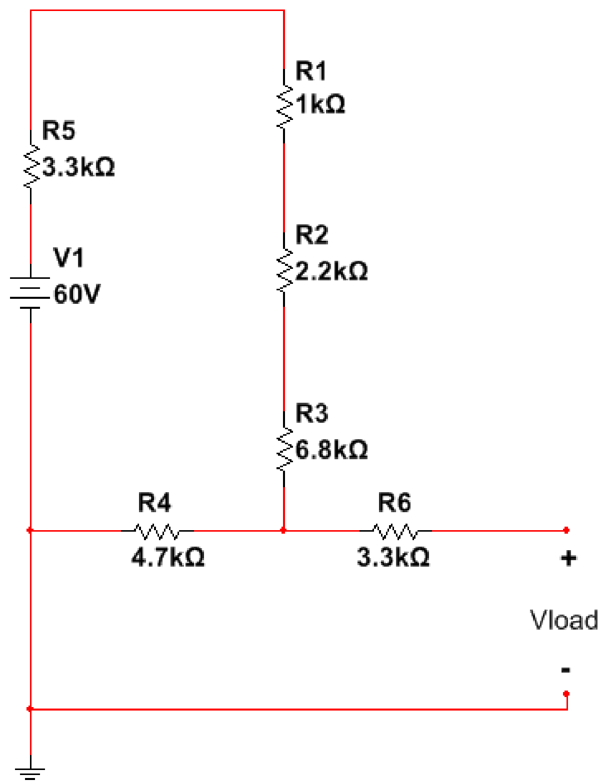

Figure 3 - Schematic for Questions 11, 12 and 13

11. See Figure 3. What is the open circuit output voltage Vload?

    a. 60 V
    b. 21.2 V
    c. 15.7 V
    d. 0 V

12. See Figure 3. What is the new voltage Vload *if R4 is shorted*?

    a. 60 V
    b. 21.2 V
    c. 14.9 V
    d. 0 V

13. See Figure 3. What is the new voltage V_{load} *if R4 is open-circuited*?

    a. 60 V
    b. 21.2 V
    c. 14.9 V
    d. 0 V

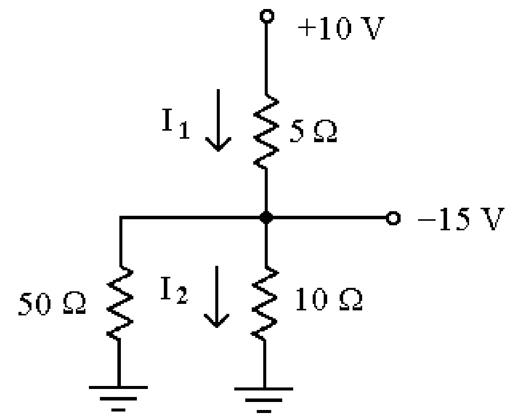

Figure 7.6

14. See Figure 7.6. What is the current I_2?

a. 5.0 A
b. 1.5 A
c. -1.5 A
d. -2.0 A

15. See Figure 7.6. What is the power dissipated by the 50 Ω resistor?

a. 22.5 W
b. 4.5 W
c. 2.0 W
d. 1.5 W

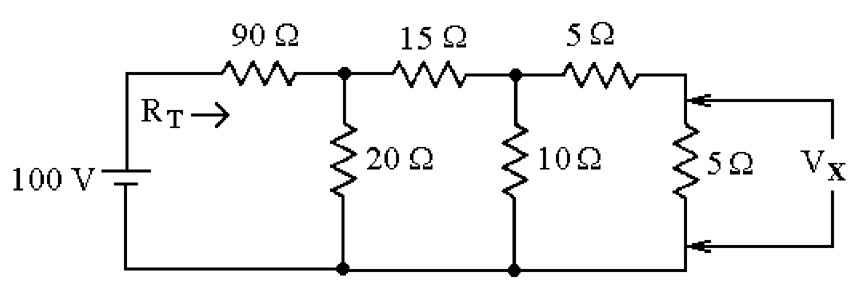

Figure 7.5

16. See Figure 7.5. What is R_T *if the 5 Ω resistor on the far right is short-circuited*?

a. 110 Ω
b. 99.6 Ω
c. 90.0 Ω
d. 18.7 Ω

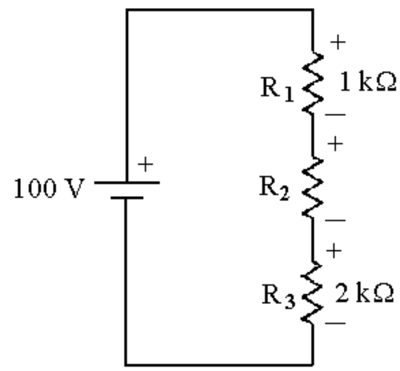

Figure 5.6

17. See Figure 5.6. Use voltage divider to *choose* R_2 *such that* $V_{R3} = 30$ *V (polarity as shown)*

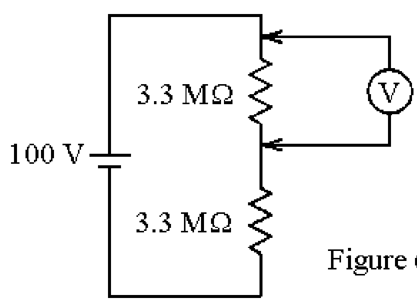

Figure 6.6

18. See Figure 6.6. Compute the voltage reading if a digital multimeter with 1 MΩ of internal resistance is used.

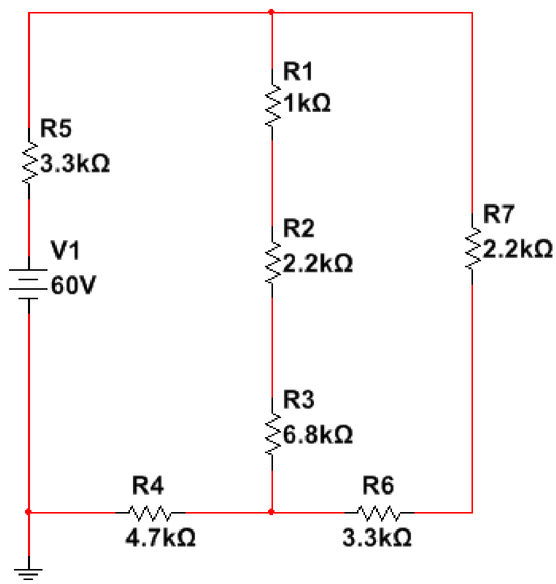

Figure 4 - Schematic for Questions 19 and 20

19. See Figure 4. What is the total resistance seen by the source?

20. See Figure 4. If R6 is replaced by an open-circuit, what is the total resistance seen by the source?

Summary of Equations to Accompany

INTRODUCTORY CIRCUIT ANALYSIS, Thirteenth Edition, by Robert L. Boylestad

dc

Introduction

Conversions 1 meter = 100 cm = 39.37 in., 1 in. = 2.54 cm, 1 yd = 0.914 m = 3 ft, 1 mile = 5280 ft, °F = 9/5°C + 32, °C = 5/9(°F − 32), K = 273.15 + °C **Scientific notation** 10^{12} = tera = T, 10^9 = giga = G, 10^6 = mega = M, 10^3 = kilo = k, 10^{-3} = milli = m, 10^{-6} = micro = μ, 10^{-9} = nano = n, 10^{-12} = pico = p **Powers of ten** $1/10^n = 10^{-n}$, $1/10^{-n} = 10^n$, $(10^n)(10^m) = 10^{n+m}$, $10^n/10^m = 10^{n-m}$, $(10^n)^m = 10^{nm}$

Voltage and Current

Coulomb's law $F = kQ_1Q_2/r^2$, $k = 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$, Q = coulombs (C), r = meters (m) **Current** $I = Q/t$ (amperes), t = seconds (s), $Q_e = 1.6 \times 10^{-19}$ C **Voltage** $V = W/Q$ (volts), W = joules (J)

Resistance

Circular wire $R = \rho l/A$ (ohms), ρ = resistivity, l = feet, $A_{CM} = (d_{\text{mils}})^2$, $\rho(\text{Cu}) = 10.37$ **Metric units** l = cm, $A = \text{cm}^2$, $\rho(\text{Cu}) = 1.724 \times 10^{-6}$ ohm-cm **Temperature** $(|T_i| + T_1)/R_1 = (|T_i| + T_2)/R_2$, $R_1 = R_{20}[1 + \alpha_{20}(T_1 - 20°\text{C})]$, $\alpha_{20}(\text{Cu}) = 0.00393$ **Color code** Bands 1–3: 0 = black, 1 = brown, 2 = red, 3 = orange, 4 = yellow, 5 = green, 6 = blue, 7 = violet, 8 = gray, 9 = white, Band 3: 0.1 = gold, 0.01 = silver, Band 4: 5% = gold, 10% = silver, 20% = no band, Band 5: 1% = brown, 0.1% = red, 0.01% = orange, 0.001% = yellow **Conductance** $G = 1/R$ siemens (S)

Ohm's Law, Power, and Energy

Ohm's law $I = E/R$, $E = IR$, $R = E/I$ **Power** $P = W/t = VI = I^2R = V^2/R$ (watts), 1 hp = 746 W
Efficiency $\eta\% = (P_o/P_i) \times 100\%$, $\eta_T = \eta_1 \cdot \eta_2 \cdot \eta_3 \cdots \eta_n$
Energy $W = Pt$, $W\text{(kWh)} = [P(\text{W}) \cdot t(\text{h})]/1000$

Series Circuits

$R_T = R_1 + R_2 + R_3 + \cdots + R_N$, $R_T = NR$, $I = E/R_T$, $V = IR$
Kirchhoff's voltage law $\Sigma_{\circlearrowright} V = 0$, $\Sigma_{\circlearrowright} V_{\text{rises}} = \Sigma_{\circlearrowright} V_{\text{drops}}$
Voltage divider rule $V_x = R_x E/R_T$

Parallel dc Circuits

$R_T = 1/(1/R_1 + 1/R_2 + 1/R_3 + \cdots + 1/R_N)$, $R_T = R/N$, $R_T = R_1R_2/(R_1 + R_2)$, $I = EG_T = E/R_T$
Kirchhoff's current law $\Sigma I_{\text{entering}} = \Sigma I_{\text{leaving}}$
Current divider rule $I_x = (R_T/R_x)I$, (Two parallel elements): $I_1 = R_2I/(R_1 + R_2)$, $I_2 = R_1I/(R_1 + R_2)$

Series-Parallel Circuits

Potentiometer loading $R_L >> R_T$
Ammeter $R_{\text{shunt}} = R_mI_{CS}/(I_{\max} - I_{CS})$
Voltmeter $R_{\text{series}} = (V_{\max} - V_{VS})/I_{CS}$
Ohmmeter $R_s = (E/I_{CS}) - R_m - \text{zero-adjust}/2$

Methods of Analysis and Selected Topics (dc)

Source conversions $E = IR_p$, $R_s = R_p$, $I = E/R_s$

Determinants $D = \begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix} = a_1b_2 - a_2b_1$

Bridge networks $R_1/R_3 = R_2/R_4$ **Δ-Y conversions** $R' = R_A + R_B + R_C$, $R_3 = R_AR_B/R'$, $R_2 = R_AR_C/R'$, $R_1 = R_BR_C/R'$, $R_Y = R_\Delta/3$
Y-Δ conversions $R'' = R_1R_2 + R_1R_3 + R_2R_3$, $R_C = R''/R_3$, $R_B = R''/R_2$, $R_A = R''/R_1$, $R_\Delta = 3R_Y$

Network Theorems

Superposition Voltage sources (short-circuit equivalent), current sources (open-circuit equivalent)
Thévenin's Theorem R_{Th}: (all sources to zero), E_{Th}: (open-circuit terminal voltage)
Maximum power transfer theorem $R_L = R_{Th} = R_N$, $P_{\max} = E^2_{Th}/4R_{Th} = I^2_NR_N/4$

Capacitors

Capacitance $C = Q/V = \epsilon A/d = 8.85 \times 10^{-12}\epsilon_r A/d$ farads (F), $C = \epsilon_r C_o$ **Electric field strength** $\mathscr{E} = V/d = Q/\epsilon A$ (volts/meter) **Transients** (charging) $i_C = (E/R)e^{-t/\tau}$, $\tau = RC$, $v_C = E(1 - e^{-t/\tau})$, (discharge) $v_C = Ee^{-t/\tau}$, $i_C = (E/R)e^{-t/RC}$ i_C $i_{C_{\text{av}}} = C(\Delta v_C/\Delta t)$
Series $Q_T = Q_1 = Q_2 = Q_3$, $1/C_T = (1/C_1) + (1/C_2) + (1/C_3) + \cdots + (1/C_N)$, $C_T = C_1C_2/(C_1 + C_2)$ **Parallel** $Q_T = Q_1 + Q_2 + Q_3$, $C_T = C_1 + C_2 + C_3$ **Energy** $W_C = (1/2)CV^2$

Inductors

Self-inductance $L = N^2\mu A/l$ (henries), $L = \mu_r L_o$
Induced voltage $e_{L_{\text{av}}} = L(\Delta i/\Delta t)$ **Transients** (storage) $i_L = I_m(1 - e^{-t/\tau})$, $I_m = E/R$, $\tau = L/R$, $v_L = Ee^{-t/\tau}$ (decay), $v_L = [1 + (R_2/R_1)]Ee^{-t/\tau'}$, $\tau' = L/(R_1 + R_2)$, $i_L = I_me^{-t/\tau'}$, $I_m = E/R_1$
Series $L_T = L_1 + L_2 + L_3 + \cdots + L_N$ **Parallel** $1/L_T = (1/L_1) + (1/L_2) + (1/L_3) + \cdots + (1/L_N)$, $L_T = L_1L_2/(L_1 + L_2)$
Energy $W_L = 1/2(LI^2)$

Magnetic Circuits

Flux density $B = \Phi/A$ (webers/m^2) **Permeability** $\mu = \mu_r\mu_o$ (Wb/A · m)
Reluctance $\mathscr{R} = l/\mu A$ (rels) **Ohm's law** $\Phi = \mathscr{F}/\mathscr{R}$ (webers)
Magnetomotive force $\mathscr{F} = NI$ (ampere-turns) **Magnetizing force** $H = \mathscr{F}/l = NI/l$ **Ampère's circuital law** $\Sigma_{\circlearrowright}\mathscr{F} = 0$
Flux $\Sigma\, \Phi_{\text{entering}} = \Sigma\, \Phi_{\text{leaving}}$ **Air gap** $H_g = 7.96 \times 10^5 B_g$

Greek Alphabet

Letter	Capital	Lowercase	Letter	Capital	Lowercase
Alpha	A	α	Nu	N	ν
Beta	B	β	Xi	Ξ	ξ
Gamma	Γ	γ	Omicron	O	o
Delta	Δ	δ	Pi	Π	π
Epsilon	E	ϵ	Rho	P	ρ
Zeta	Z	ζ	Sigma	Σ	σ
Eta	H	η	Tau	T	τ
Theta	Θ	θ	Upsilon	Υ	υ
Iota	I	ι	Phi	Φ	ϕ
Kappa	K	κ	Chi	X	χ
Lambda	Λ	λ	Psi	Ψ	ψ
Mu	M	μ	Omega	Ω	ω

Prefixes

Multiplication Factors	SI Prefix	SI Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^9	giga	G
1 000 000 = 10^6	mega	M
1 000 = 10^3	kilo	k
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a