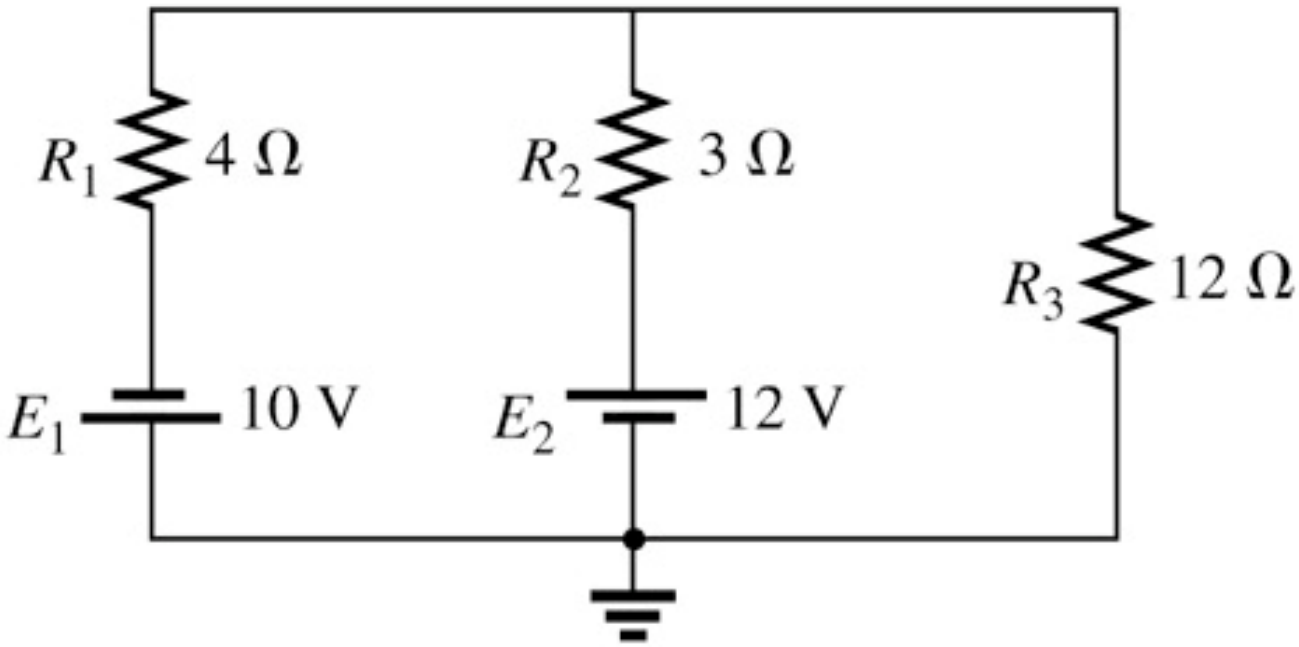
Electrical Engineering Technology

Mesh Analysis Introduction

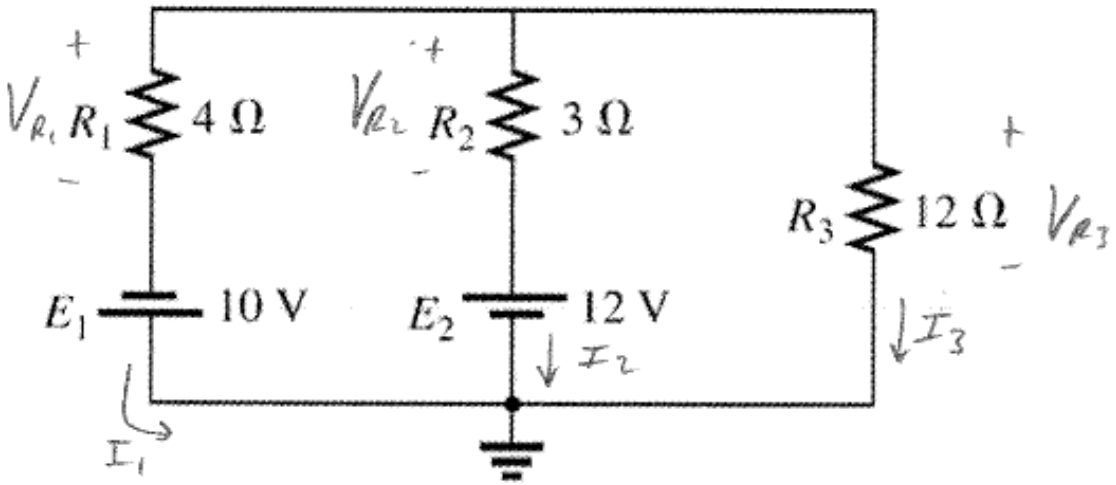
Fall 2018 (2181)

Breakout #1 (from Friday)

- Find P_{E1}, P_{R2} and the current through R_3



Breakout #1



$$4I_1 - 3I_2 + 0I_3 = 22$$
$$0I_1 + 3I_2 - 12I_3 = -12$$
$$I_1 + I_2 + I_3 = 0$$

Solving yields

$I_1 = 3.063\ A$
$I_2 = -3.25\ A$
$I_3 = 187.5\ mA$

KVL $\quad -10 + V_{R_1} - V_{R_2} - 12 = 0$

$$4I_1 - 3I_2 = 22 \quad (1)$$

KVL $\quad +12 + V_{R_2} - V_{R_3} = 0$

$$3I_2 - 12I_3 = -12 \quad (2)$$

KCL $\quad -I_1 - I_2 - I_3 = 0$

or $\quad I_1 + I_2 + I_3 = 0 \quad (3)$

$P_{E_1} = (E_1)(I_1) = (10V)(3.063A) = \boxed{30.63W}$

$P_{R_2} = (I_2)^2 R_2 = (-3.25A)^2(3\Omega) = \boxed{31.69W}$

$I_3 = 187.5\ mA$ DOWN

8.4 MESH ANALYSIS (GENERAL APPROACH)

- AN ORGANIZED MANNER OF APPLYING BRANCH CURRENT ANALYSIS

- UTILIZES K.V.L. TO SOLVE SIMPLE OR MORE COMPLICATED CIRCUIT ANALYSIS PROBLEMS.

PROCEDURE (ABBREVIATED, SEE PG. 310,311 FOR MORE DETAILS):

(1) DRAW THE PLANAR (NO CROSSOVER) NETWORK WITH CLOCKWISE CURRENTS IN EACH "WINDOW."

(2) WRITE KVL EQUATIONS FOR EACH LOOP
- INCREASE VOLTAGE ⇒ PLUS
- VOLTAGE DROP ⇒ MINUS
- TAKE ALL CURRENTS THROUGH EACH COMPONENT INTO ACCOUNT.

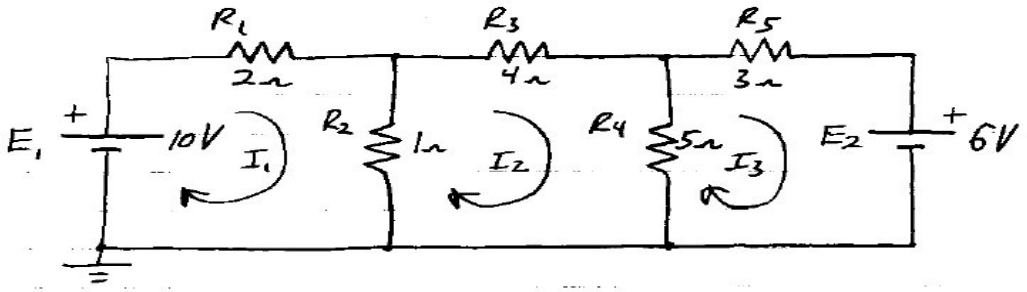
(3) SIMPLIFY YOUR EQUATIONS & FORMAT
- COLLECT TERMS
- PUT INTO PROPER FORM ($AI_1 + BI_2 + CI_3 + \ldots = \#$)
  ↑ ↑ ↑
  UNKNOWNS

(4) SOLVE THE SIMULTANEOUS EQUATIONS
- SUBSTITUTION (O.K. FOR 2 EQ.'S, DIFFICULT FOR 3 OR MORE)
- DETERMINANTS METHOD
  > (SHOULD BE REVIEW, SEE APPENDIX D

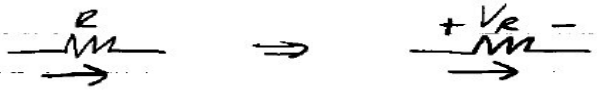
See Appendix B

- We'll use the Sharp Equation Solver (will handle up to 3x3)
- You should learn the method of determinants for HW and lab work

(EXAMPLE)



- NOTE LOOP (MESH) CURRENTS I_1, I_2 & I_3
- RECALL PASSIVE SIGN CONVENTION:



LOOP 1: $+E1 - R_1 I_1 - R_2 I_1 + R_2 I_2 = 0$

$10 = I_1(R_1 + R_2) - R_2 I_2$

$10 = 3I_1 - 1I_2 \rightarrow 3I_1 - I_2 = 10 \quad (1)$

LOOP 2: $-R_2 I_2 + I_1 R_2 - R_3 I_2 - I_2 R_4 + I_3 R_4 = 0$

$I_1 R_2 + I_2(-R_2 - R_3 - R_4) + I_3 R_4 = 0$

$I_1 - 10 I_2 + 5 I_3 = 0 \rightarrow -I_1 + 10 I_2 - 5 I_3 = 0 \quad (2)$

LOOP 3: $-R_4 I_3 + R_4 I_2 - I_3 R_5 - E2 = 0$

$I_2 R_4 - I_3(R_4 + R_5) = 6$

$5 I_2 - 8 I_3 = 6 \rightarrow -5 I_2 + 8 I_3 = -6 \quad (3)$

3 SIMULTANEOUS EQUATIONS:

$$\left.\begin{aligned} 3I_1 - I_2 + 0I_3 &= 10 \\ -I_1 + 10I_2 - 5I_3 &= 0 \\ 0I_1 - 5I_2 + 8I_3 &= -6 \end{aligned}\right\} \quad AI_1 + BI_2 + CI_3 = K \text{ FORM}$$

(UNKNOWNS: I_1, I_2, I_3; CONSTANT: K)

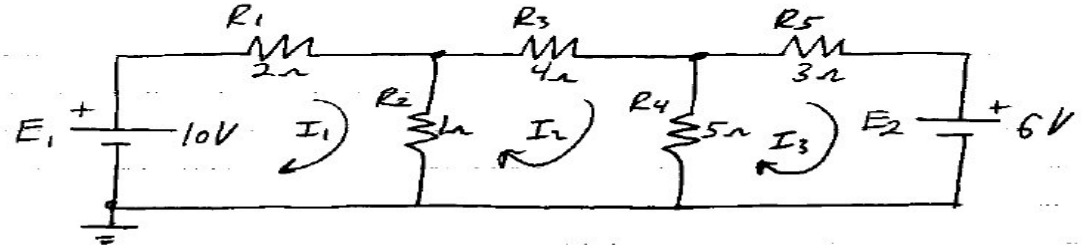
$I_1 = 3.312\,A$

$I_2 = -63.69\,mA$

$I_3 = -789.8\,mA$

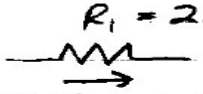
NOW, USE THE MESH CURRENTS TO SOLVE FOR THE REQUIRED UNKNOWNS:

ORIGINAL CIRCUIT:

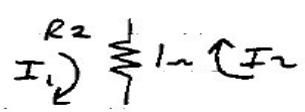


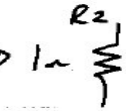
$I_1 = 3.312A$
$I_2 = -63.69mA$
$I_3 = -789.8mA$

→FIND THE CURRENT THROUGH R_1 & R_2:



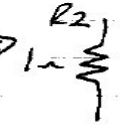
$\therefore I_{R_1} = I_1 = \boxed{3.312A}$



$\Rightarrow$ 

$= \boxed{3.38A}$

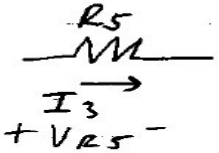
OR

$\Rightarrow$ 

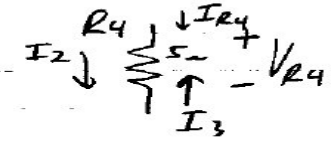
$= \boxed{-3.38A}$

} EQUIVALENT

→FIND V_{R5} & V_{R4}:



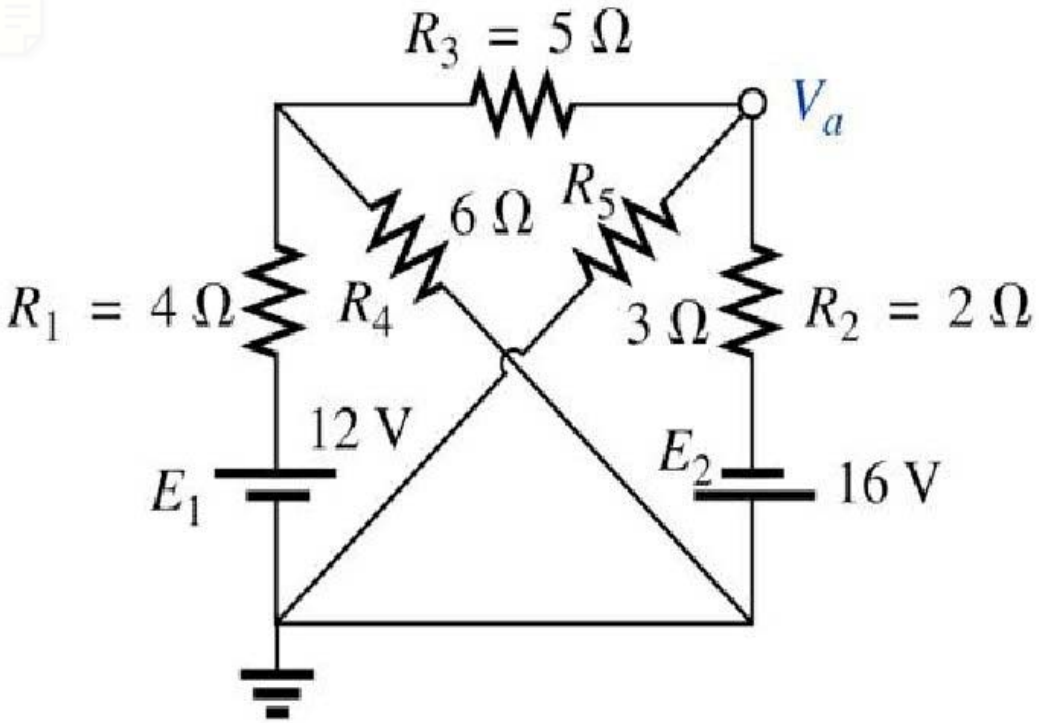
$V_{R5} = (I_3)(R_5) = (-789.8mA)(3\Omega) = \boxed{-2.37V}$



$V_{R4} = (I_{R4})(R_4) = (I_2 - I_3)5 = [-63.69mA - (-789.8mA)](5\Omega)$
$= \boxed{3.63V}$

CHECK: (KVL) $V_{R4} - V_{R5} - 6 = 0$ $\therefore$ $3.63 - (-2.37) = 6$ ✓

Breakout Problem 1

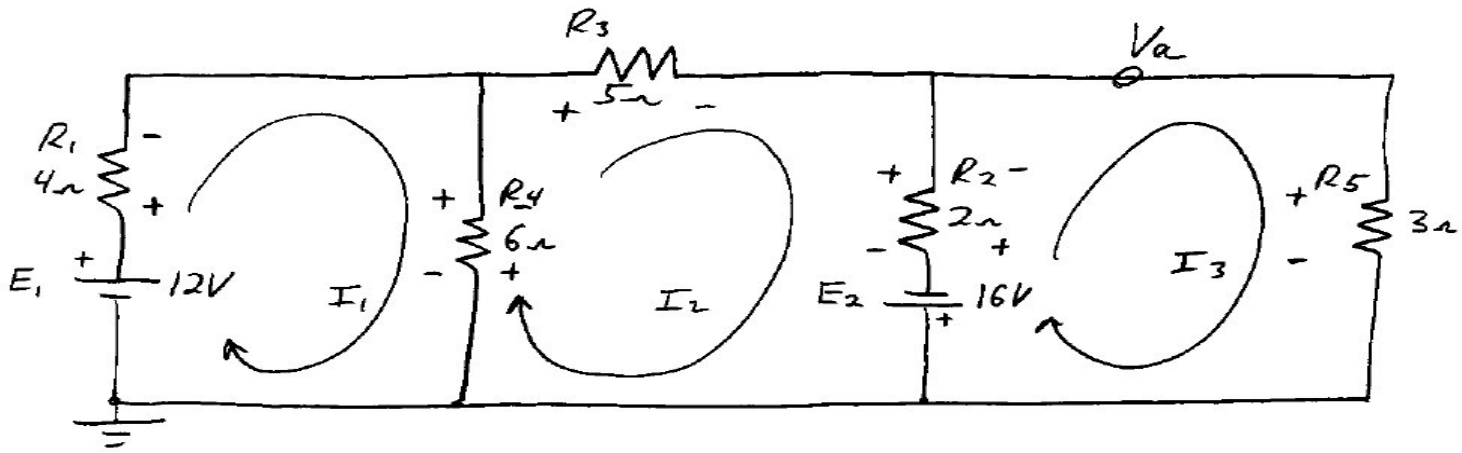


Find:

1) The MESH currents I1, I2, I3
2) Va

Use MESH Analysis…

REDRAWN (PLANAR NETWORK)



Loop 1 : $E_1 - I_1 R_1 - I_1 R_4 + I_2 R_4 = 0$

NP