1. For the circuit below, assume that the current $i_g$ is known. The resistors $R_1 - R_5$ are also known.
   a) How many unknown currents are there?
   b) How many independent equations can be written using Kirchhoff’s current law (KCL)?
   c) Write an independent set of KCL equations.
   d) How many independent equations can be derived from Kirchhoff’s voltage law (KVL)?
   e) Write a set of independent KVL equations.

2. (a) Formulate mesh-current equation for the circuit in figure below.
   (b) Solve for $v_x$ and $i_x$ when $R_1 = R_2 = 10 \, \Omega$ $R_3 = 2 \, \Omega$ $R_4 = 1 \, \Omega$ $i_s = 2.5$ mA, $v_{s1} = 12$ V, and $v_{s2} = 0.5$ V
   (c) Find the power supplied by $v_{s1}$. 
3. Find (a) the node voltages \(v_1\), \(v_2\) and \(v_3\) in the circuit below. (b) Total power dissipated in circuit.

![Circuit Diagram](image)

4. (a) Use the node-voltage method to find the power dissipated in the \(2\Omega\) resistor in the following circuit. (b) Find the power supplied by the 230V source.

![Circuit Diagram](image)

5. Assume you are a project engineer and one of your staff is assigned to analyze the circuit shown below. The reference node and node numbers given on the figure were assigned by the analyst. Her solution gives the values of \(v_3\) and \(v_4\) as 108V and 81.6V respectively. Test these values by checking the total power developed in the circuit against the total power dissipated. Do you agree with the solution submitted by the analyst?

![Circuit Diagram](image)
6. (a) Use series of source transformations to find the current $i_0$ in the circuit shown below.
(b) Verify your solution by using the node-voltage method to find $i_0$.

![Circuit Diagram](image)

7. (a) Use source transformations to find $v_0$ in the circuit in fig below
(b) Find the power developed by 520 V source.
(c) Find the power developed by the 1 A current source.

![Circuit Diagram](image)
8. The variable dc voltage source in the circuit shown below is adjusted so that $i_o$ is zero.
   (a) Find the value of $V_{dc}$.
   (b) Check your solution by showing the power developed equals the power dissipated.

\[\text{Diagram of circuit with voltage sources and resistors.}\]

9. Find the Norton equivalent with respect to the terminals a, b in the circuit below.

\[\text{Diagram of circuit with resistors and currents.}\]

10. The variable resistor in the circuit below is adjusted for maximum power transfer to $R_o$.

   (a) Find the numerical value of $R_o$.

   (b) Find the maximum power delivered to $R_o$.

   (c) How much power does the 280V source deliver to the circuit when $R_o$ is adjusted to the value found in (a)?
11. (a) Search for LM 741 Data Sheet on internet and draw pin diagram of LM 741. What is use of each pin?
   (b) Find out typical values of following parameters:
       1. Input offset voltage
       2. Bandwidth
       3. Input resistance
   What are these values for an Ideal Op-Amp? Write significance of these parameters. (Write down proper references for this question)

12. A voltmeter with a full-scale reading of 10V is used to measure the output voltage in the following circuit. What is the reading of the voltmeter? Assume the op amp is ideal.

13. (a) The op amp in the circuit shown below is ideal. The adjustable resistor $R_\Delta$ has a maximum value of 100kΩ, and $\alpha$ is restricted to the range of $0.2 \leq \alpha \leq 1.0$. Calculate the range of $v_o$ if $v_g = 40mV$.
   (b) If $\alpha$ is no restricted, at what value of $\alpha$ will the op amp saturate?