

**Name of Institute: ITE**  
**Name of Faculty: Prof. Kaushal Patel**

**Course code:**

**Course name:** Basics of DC Circuit

Pre-requisites: Physics (12<sup>th</sup>)

Credit points: 3

Offered Semester: 1<sup>st</sup>

**Course Coordinator**

Full Name: Prof. Kaushal Patel

Department with siting location: 5<sup>th</sup> floor, Electrical Design Lab

Telephone: 9426028096

Email: kaushalpatel.el@indusuni.ac.in

Consultation times: 4:30 PM to 5 PM

**Course Lecturer**

Full Name: Prof. Kaushal Patel

Department with siting location: 5<sup>th</sup> floor, Electrical Design Lab

Telephone: 9426028096

Email: kaushalpatel.el@indusuni.ac.in

Consultation times: 4:30 PM to 5 PM

Students will be contacted throughout the Session via Mail with important information relating to this Course.

**Course Objectives**

By participating in and understanding all facets of this Course a student will able:

1. To understand the basic concepts of work and energy
2. To understand the working of magnetic circuits, electro magnetism and electrostatics.
3. To have knowledge of basic DC theorems applied in electrical circuits.
4. To understand and analyses DC circuits.
5. To understand about electromagnetic induction
6. To solve basic DC circuits

**Course Outcomes (CO)**

After completion of this course, student will have,

CO-1 Knowledge of the basic concepts of work and energy

CO-2 Knowledge of the working of magnetic circuits, electro magnetism and electrostatics.

CO-3 Knowledge of basic DC theorems applied in electrical circuits.

CO-4 The capability to understand and analyses DC circuits.

CO-5 Knowledge of electromagnetic induction

CO-6 capability to solve basic DC circuits

### Course Outline

Proposed course mainly deal with Work, Power and Energy, Magnetic Circuits and Electromagnetic induction.

### Method of delivery

Face to face lectures

### Study time

3 lectures

### CO-PO Mapping (PO: Program Outcomes)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | 1   | 2   | 3   | 1   | 1   | 3   | 2   | 3   | 1   | 1    | 2    | 3    |
| CO2 | 2   | 3   | 1   | 2   | 3   | 3   | 1   | 2   | 3   | 3    | 1    | 2    |
| CO3 | 3   | 1   | 1   | 2   | 2   | -   | 3   | 1   | 1   | 3    | 3    | 3    |
| CO4 | 1   | 3   | 2   | 3   | 1   | 1   | 2   | -   | 1   | -    | -    | 1    |
| CO5 | 3   | 3   | 1   | 2   | 3   | 3   | 1   | 2   | 2   | 1    | -    | 2    |
| CO6 | 2   | -   | 3   | 1   | 1   | 3   | 3   | 2   | 1   | 2    | 2    | 1    |

### Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

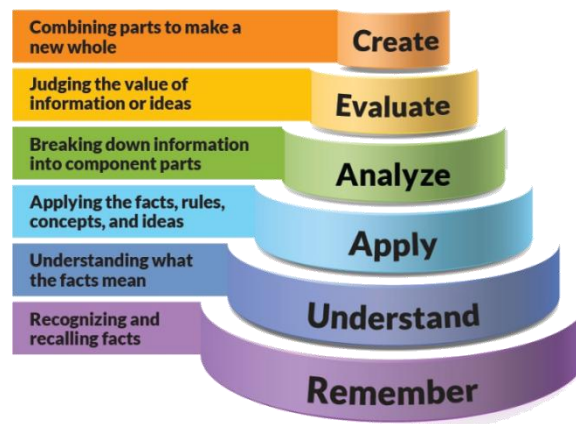


Figure 1: Blooms Taxonomy

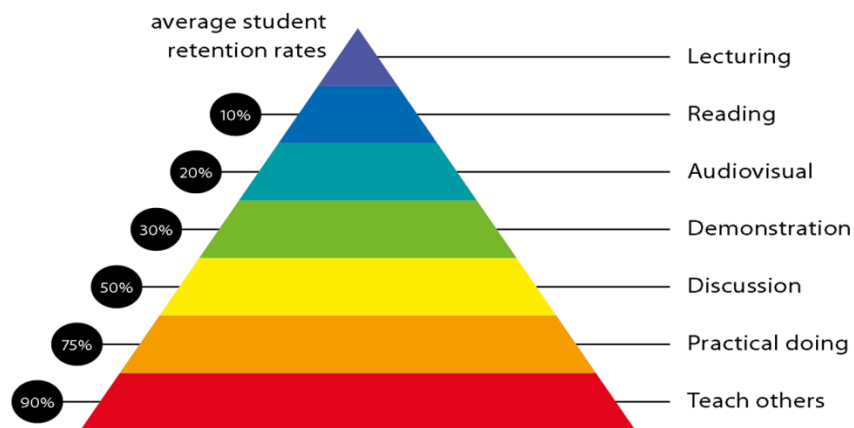


Figure 2: Knowledge retention

**Graduate Qualities and Capabilities covered**  
 (Qualities graduates harness crediting this Course)

| General Graduate Qualities   | Specific Department of _____ Graduate Capabilities                |
|--|---|
| <p><b>Informed</b><br/>                     Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.</p>  | <p><b>1 Professional knowledge, grounding &amp; awareness</b></p> |
| <p><b>Independent learners</b><br/>                     Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.</p> | <p><b>2 Information literacy, gathering &amp; processing</b></p>  |
| <p><b>Problem solvers</b></p>  | <p><b>4 Problem solving skills</b></p>                            |

|   |   |
|---|---|
| Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.              |   |
| <b>Effective communicators</b><br>Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.    | <b>5 Written communication</b>                                |
|   | <b>6 Oral communication</b>                                   |
|   | <b>7 Teamwork</b>   |
| <b>Responsible</b><br>Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities. | <b>10 Sustainability, societal &amp; environmental impact</b> |

### Practical work:

NA

### Lecture/tutorial times

(Give lecture times in the format below)

Lectures: Monday – 7<sup>th</sup>  
 Tuesday – 6<sup>th</sup>  
 Friday – 3<sup>rd</sup>

### Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

### Details of referencing system to be used in written work

### Text books

1. Elements of Electrical Engineering, J N Swamy, Mahajan Publication House.
2. Basic Electrical Engineering, S K Sahdev, Pearson
3. Basic Electrical Engineering, K N Srinivas, I K International

## Additional Materials

1. Basic Electrical Engineering, U A Bakshi, Technical Publications
2. Basic Electrical Engineering, T P Tewari, New Age International Publishers

## ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

|                       |
|-----------------------|
| Class Test (20 marks) |
| Quiz (10 marks)       |
| Assignment (20 marks) |
| Attendance (10 marks) |

## SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

### Practical Work Report/Laboratory Report:

NA.

### Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -1% of the maximum mark per calendar day

### Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

### Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

### **University and Faculty Policies**

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

**Plagiarism** - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

*Do not copy the work of other students.*

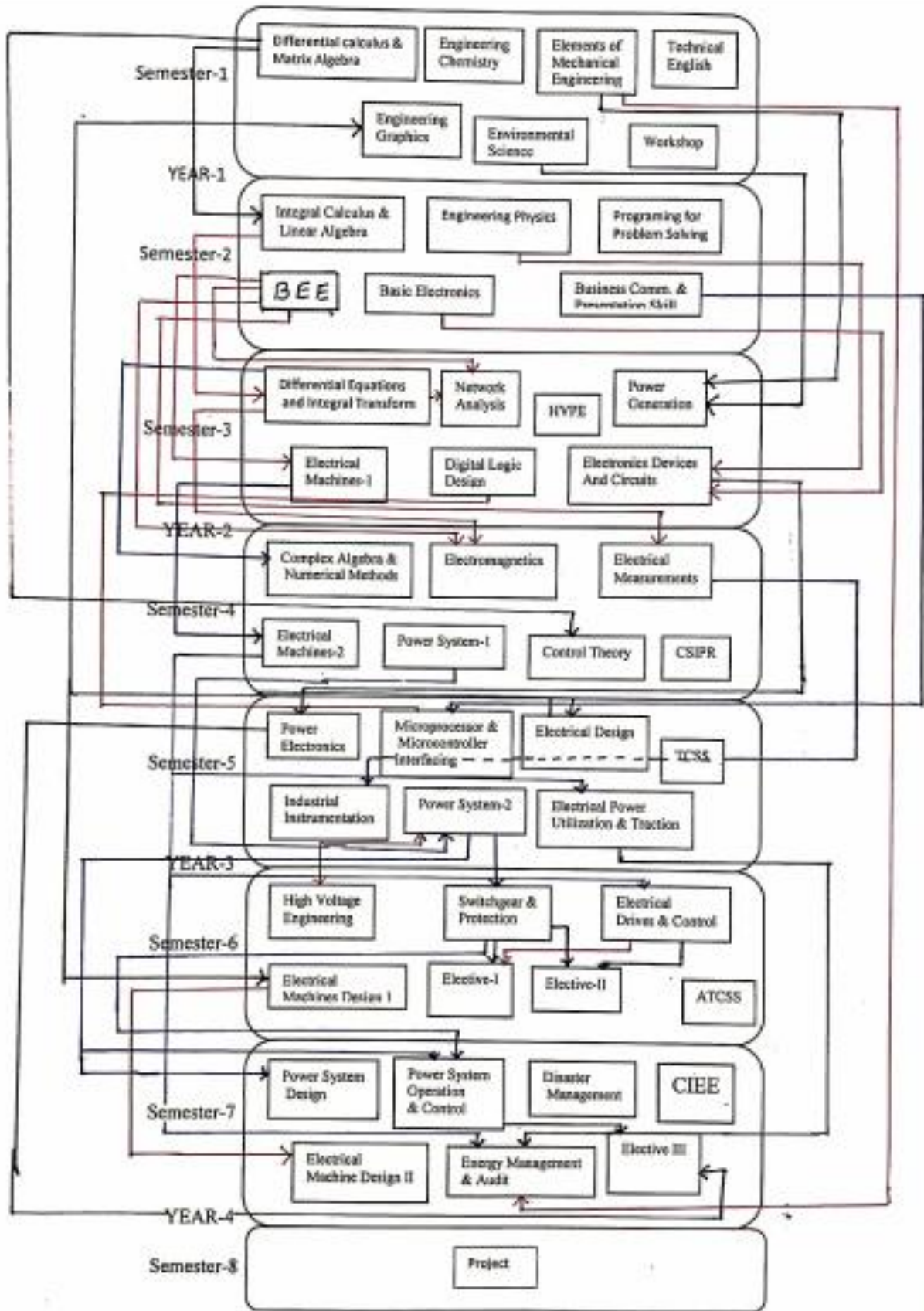
*Do not share your work with other students (except where required for a group activity or assessment)*

### Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

| Week #  | Topic & contents  | CO Addressed | Teaching Learning Activity (TLA) |
|---------|---|--------------|----------------------------------|
| Weeks 1 | Introduction, Heating effect of electric current, Joules Law, Unit of Heat, Thermal Efficiency  |              | BB                               |
| Weeks 2 | Quantity of electricity, Electric Power, Electric Energy, Units in SI system, Ohm's law, Conductor, Insulator, Semi-conductors, classification of resistance                            |              | BB                               |
| Week 3  | temperature coefficient of resistance, Combination of resistances, Resistance in series-parallel, KCL, KVL, Bridge circuit.   |              | BB                               |
| Week 4  | Ideal and practical voltage and current sources, Cramer's Rule, Mesh and Nodal analysis   |              | BB                               |
| Week 5  | Source transformation. Star delta transformation.   |              | BB                               |
| Week 6  | Superposition theorem   |              | BB                               |
| Week 7  | Thevenin's theorem, Norton's theorem  |              | BB                               |
| Week 8  | maximum power transfer theorem, Fundamental laws of electrostatics, absolute and relative permittivity, electric field, electric flux, electric field intensity, electric flux density, |              | BB                               |
| Week 9  | electric potential, potential difference, potential gradient, dielectric strength and breakdown potential, capacitor and capacitance  |              | BB                               |
| Week 10 | permittivity, capacitance of parallel plate capacitor, variable capacitor, capacitors in series, capacitor in parallel  |              | BB                               |
| Week 11 | energy storage in capacitor, charging and discharging of capacitor, types of capacitors   |              | BB                               |
| Week 12 | Magnetic field, Coulomb's law, magnetic field due to current carrying conductor   |              | BB                               |

|         |  |  |    |
|---------|--|--|----|
| Week 13 | magnetic circuit, composite magnetic circuit, leakage flux, comparison between electric and magnetic circuit |  | BB |
| Week 14 | B-H curve. Magnetic hysteresis, Laws of electromagnetic induction  |  | BB |
| Week 15 | types of induced emf, coefficient of coupling, inductor in series and parallel.                              |  | BB |



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing  
 Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOCC  
 Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOCC

**INSTITUTE OF TECHNOLOGY & ENGINEERING**  
**DEPARTMENT OF ELECTRICAL ENGINEERING**  
**ASSIGNMENT – 1**  
**SUBJECT – BASICS OF DC CIRCUIT**

1. Define the following:
  1. Resistance
  2. Inductance
  3. Capacitance
  4. Conductance
  5. Power
  6. Resistivity
  7. Conductivity
  8. Electric potential
  9. Electric current
2. State and explain ohm's law with its limitation.
3. Derive voltage divider equation when only two resistances are connected in series.
4. Derive current divider equation when only two resistances are connected in parallel.
5. State and explain KCL and KVL with proper examples.
6. Explain the effect of temperature on resistance.
7. Discuss the heating effect of electric current.
8. Discuss Joule's law of electric heating.
9. Explain thermal efficiency.
10. An electric kettle is required to raise the temperature of 1 kg of water from 25<sup>0</sup>C to 100<sup>0</sup>C in 20 minutes. Calculate the resistance of the heating element if the kettle is to be used on a 240 V supply. Assume the efficiency of the kettle to be 75%.

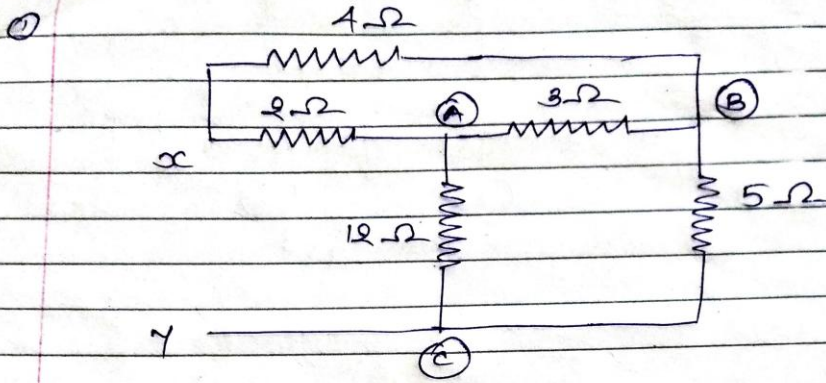
**Last date of submission: 20-09-2019 (Friday)**

**Prepared By-**  
**Kaushal R. Patel**  
**Electrical Engg. Department,**  
**ITE, Indus University**

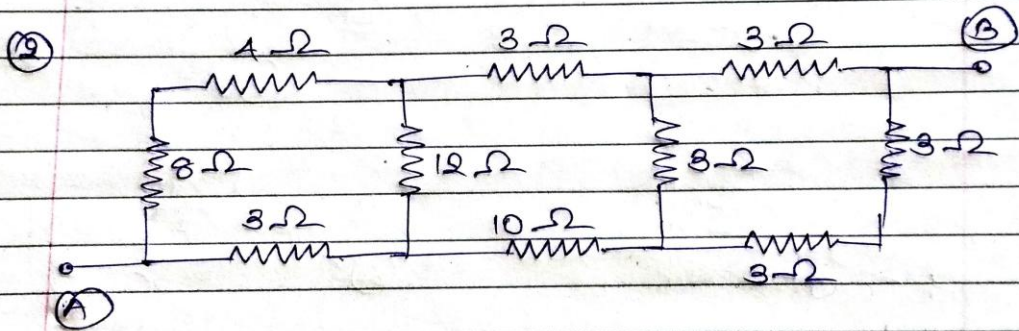
ASSIGNMENT : 2

stars - delta

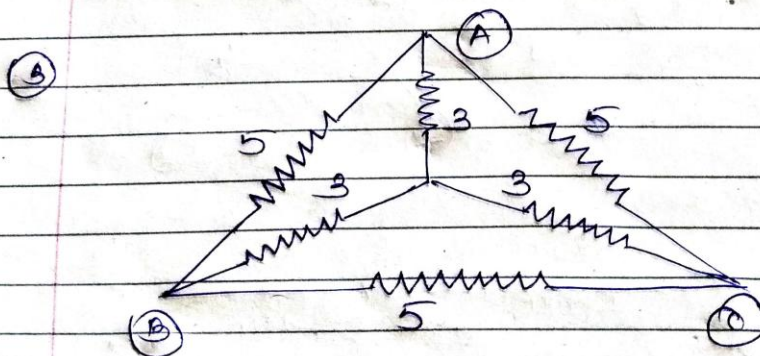
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Find equivalent resistances between x and y.



Find equivalent resistances b/w A & B.

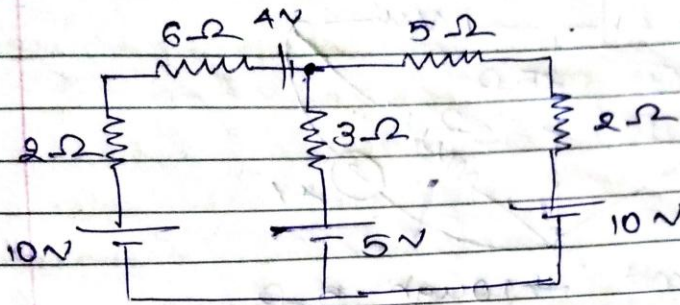


Find, (1)  $R_{AB}$  (2)  $R_{BC}$

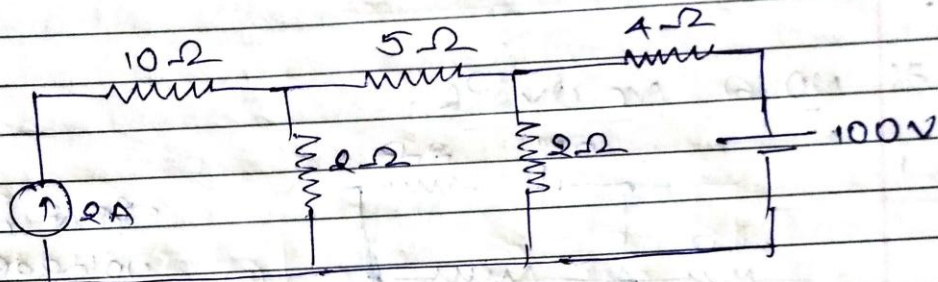
## Mesh Analysis

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ex.1

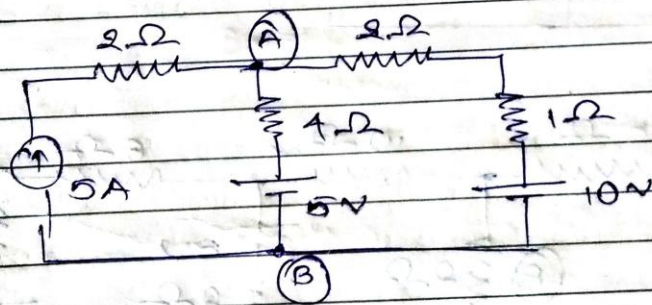


ex.2



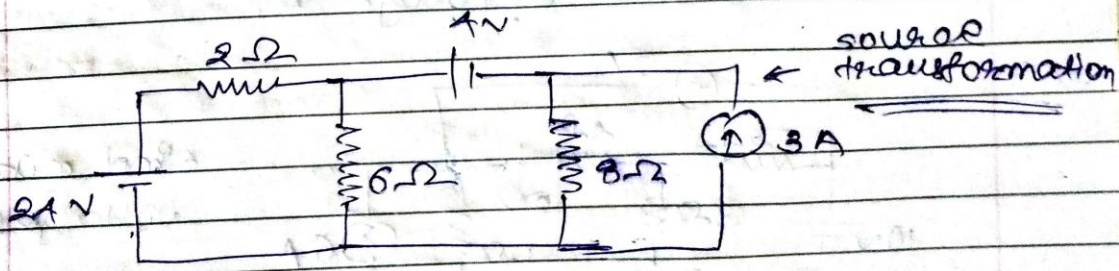
Find all branch currents.

ex.3



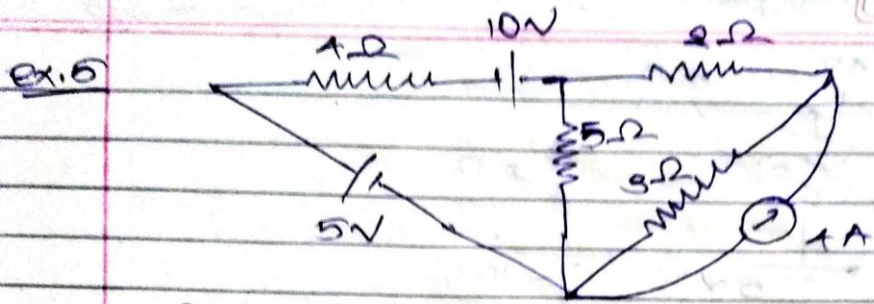
Find the current through AB.

ex.4



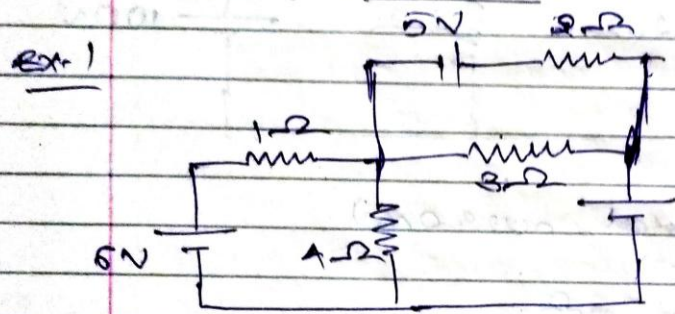
Find current through 4V.

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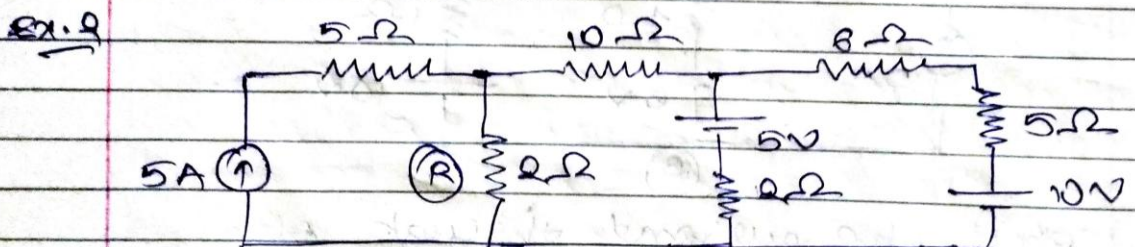
Find current through  $3\Omega$ .

\* Node Analysis.

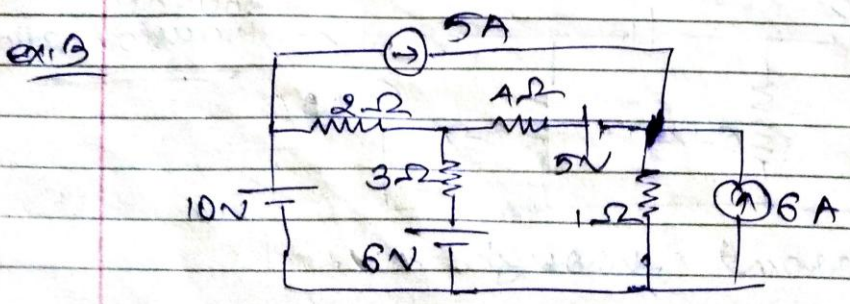


Find node voltages

It will be  $V_B$ .



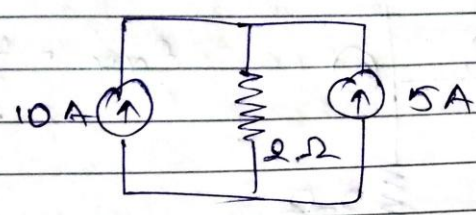
Find current through R.



Find node voltages.

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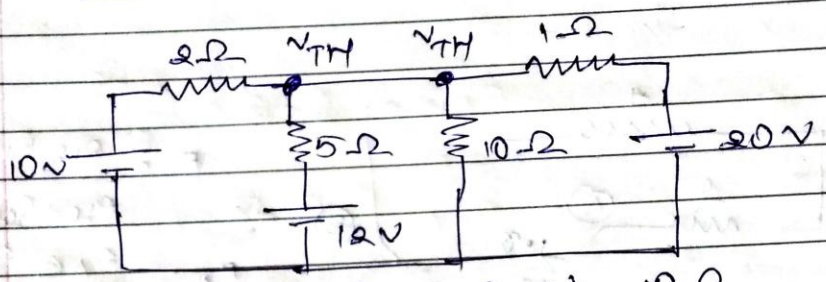
Ex. 1



Find the current through  $2\Omega$ .

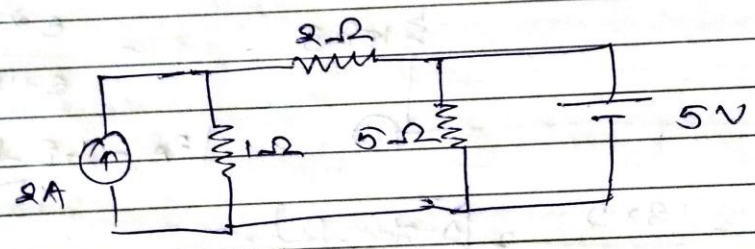
\* Thevenin Theorem:

Ex. 1



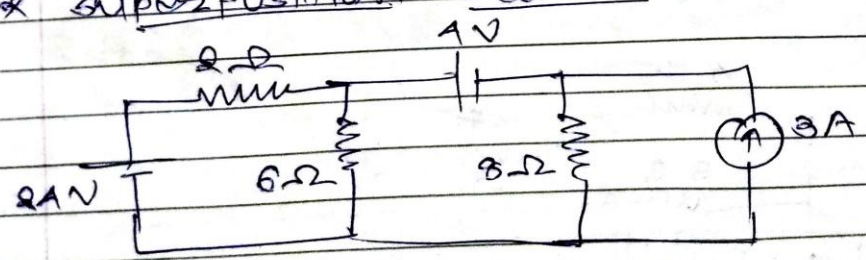
Find current through  $10\Omega$ .

Ex. 2



Find the current through  $2\Omega$ .

\* Superposition Theorem:



Find current through  $8\Omega$ .

**INSTITUTE OF TECHNOLOGY & ENGINEERING  
DEPARTMENT OF ELECTRICAL ENGINEERING  
ASSIGNMENT – 3  
SUBJECT – BASICS OF DC CIRCUIT**

1. Define following:
  - Electrostatics
  - Electric charge
  - Permittivity
  - Absolute permittivity
  - Relative permittivity
  - Electric field
  - Electric flux
  - Electric flux density
  - Electric field intensity
  - Capacitance
  - Dielectric
2. Explain Coulomb's laws of electrostatics.
3. Derive the expression of a capacitance of parallel plate capacitor.
4. Derive the equation of capacitance for a parallel plate capacitor with composite dielectric.
5. What is capacitor action? Explain the capacitor action in detail.
6. Derive the equation of an energy stored in a charged capacitor.
7. Explain the charging of a capacitor through resistor.
8. Explain the discharging of a capacitor through resistor.
9. A capacitor consists of two parallel square plates each of 120 mm side generated by 1 mm in air. When a voltage is applied between the plates, an average current of 12 mA flows for 5 sec. calculate,
  - The charge on the capacitor
  - The electric flux
  - The electric flux density
  - The electric field strength in the dielectric
10. A parallel plate capacitor has plates of area of 1.5 m<sup>2</sup>. It has three dielectric 1 mm, 1.6 mm and 2 mm thick. The relative permittivity of these dielectrics are 2, 4 and 5 respectively. Calculate the electric field strength in the dielectric if a voltage of 2.5 kV is applied between the plates.

**INSTITUTE OF TECHNOLOGY & ENGINEERING  
DEPARTMENT OF ELECTRICAL ENGINEERING  
ASSIGNMENT – 4  
SUBJECT – BASICS OF DC CIRCUIT**

11. Define following:
  - Magnetic Flux
  - Magnetic Flux Density
  - Magnetomotive Force
  - Magnetic Field Intensity
  - Permeability
  - Reluctance
  - Permeance
  - Reluctivity
12. Give the comparison between magnetic circuit and electric circuit.
13. Discuss the concept of composite magnetic circuit. Also derive the equation of MMF for the same.
14. Explain leakage flux with neat sketch.
15. Explain statically induced EMF and dynamically induced EMF with neat sketch.
16. Derive the expression of self inductance.
17. Derive the expression of mutual inductance.
18. Derive the equation of inductance for following coupled circuits.
  - Series-aiding
  - Series-opposition
  - Parallel-aiding
  - Parallel-opposition
19. Derive the equation of energy stored in magnetic circuit.
20. Explain Magnetic Hysteresis with full hysteresis loop diagram.
21. A toroidal air cored coil with 2000 turns has a mean radius of 25 cm and diameter of each turn being 6 cm. if the current in the coil is 10 A, than find,  
(1) MMF (2) Flux (3) Flux Density

| Quiz and Class Test 2019 |                             |                |                              |
|--------------------------|-----------------------------|----------------|------------------------------|
| <b>Subject Name:</b>     | <b>Basics of DC Circuit</b> | <b>Marks :</b> | <b>30 (Combined)</b>         |
| <b>Date:</b>             | <b>30-09-2019 (Monday)</b>  | <b>Time:</b>   | <b>45 minutes (Combined)</b> |

### Multiple Choice Questions

- (1) Which element will oppose the change in flow of current? [1]  
 (A) Resistor (B) Inductor (C) Capacitor (D) All of them
- (2) Which of the following does not represent limitation of Ohm's law? [1]  
 (A) It is not applicable to all non-metallic materials  
 (B) It is not applicable to AC Circuits  
 (C) It is true for only metal conductors at constant temperature  
 (D) It is applicable to DC Circuit at variable temperature
- (3) According to maximum power transfer theorem, the power will be maximum when, [1]  
 (A) Source resistance is greater than load resistance. (B) Load resistance is zero.  
 (C) Source resistance is less than load resistance (D) Source resistance is equal to load resistance
- (4) Thermal efficiency is the ratio of [1]  
 (A) heat loss to heat utilized (B) heat utilized to heat produced  
 (C) heat loss to heat produced (D) heat produced to heat utilized
- (5) 1 kWh = \_\_\_\_\_ joules [1]  
 (A)  $36 \times 10^5$  joules (B)  $36 \times 10^6$  joules (C)  $36 \times 10^8$  joules (D)  $36 \times 10^4$  joules
- (6) Two resistor  $R_1$  and  $R_2$  give combine resistance of  $4.5 \Omega$  when in series and  $1 \Omega$  when in parallel. The resistance are [1]  
 (A)  $1 \Omega$  and  $3.5 \Omega$  (B)  $1.5 \Omega$  and  $3 \Omega$  (C)  $2 \Omega$  and  $2.5 \Omega$  (D)  $4 \Omega$  and  $0.5 \Omega$
- (7) Nodal analysis mainly depends on [1]  
 (A) KCL (B) KVL (C) KCL & KVL both (D) None of the above
- (8) Which of the following will be the equivalent zero to current source? [1]  
 (A) Short Circuit (B) Closed loop (C) Open Circuit (D) All above are possible
- (9) The ability of the charged body to do work is known as [1]  
 (A) Current (B) Power (C) Output (D) Potential
- (10) Which of the following have positive temperature co-efficient? [1]  
 (A) Pure Metals (B) Semi-conductors (C) Insulators (D) All of the above

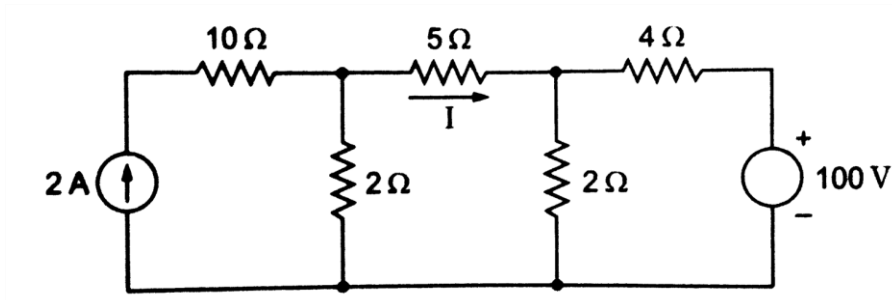
### Class Test

#### Question : 1 (Attempt any TWO)

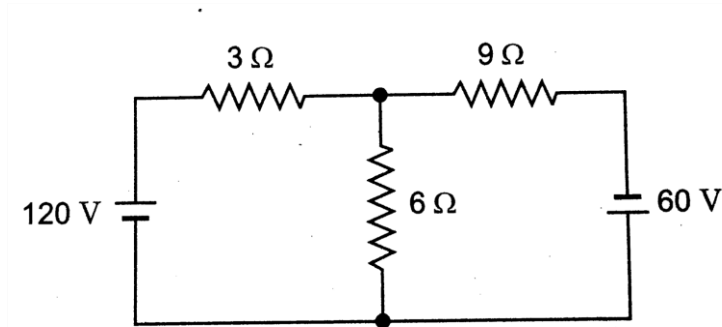
- (A) Derive the expression for converting delta connection to star connection with neat sketch. [05]
- (B) What do you mean by temperature coefficient of resistance? Derive the expression for the same. [05]
- (C) Define following: [05]  
 (1) Power (2) Electric Current (3) Conductivity (4) Resistivity (5) Capacitance

#### Question : 2 (Attempt any TWO)

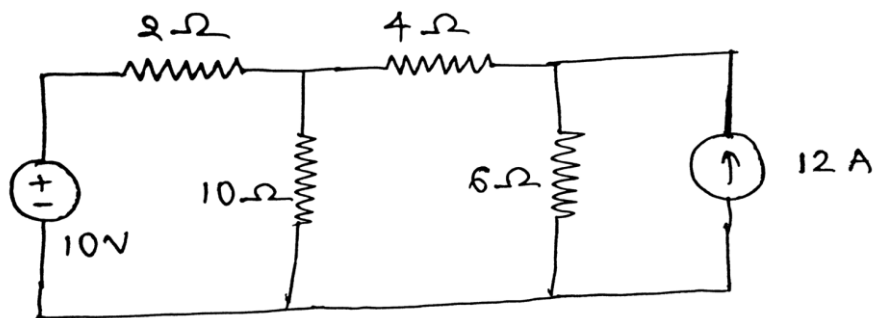
(A) Applying mesh analysis, obtain the current through  $5\ \Omega$  resistance in the following circuit. [05]



(B) In the circuit shown in fig., find the current through  $6\ \Omega$  resistor using superposition theorem. [05]



(C) Find the current through  $4\ \Omega$  using Thevenin theorem. [05]



| <b>Quiz and Class Test 2019</b> |                             |                |                              |
|---------------------------------|-----------------------------|----------------|------------------------------|
| <b>Subject Name:</b>            | <b>Basics of DC Circuit</b> | <b>Marks :</b> | <b>30 (Combined)</b>         |
| <b>Date:</b>                    | <b>15–11-2019 (Friday)</b>  | <b>Time:</b>   | <b>45 minutes (Combined)</b> |

### Multiple Choice Questions

- (1) The value of Absolute Permittivity is [1]  
 (A)  $8.85 \times 10^{-10}$  F/m (B)  $8.85 \times 10^{-12}$  F/m (C)  $8.85 \times 10^{-10}$  H/m (D)  $8.85 \times 10^{-12}$  H/m
- (2) Which of the following is not a dielectric material? [1]  
 (A) Paper (B) Mica (C) Air (D) Iron
- (3) Which of the following is not a characteristic of magnetic flux? [1]  
 (A) Flux lines are imaginary in nature. (B) Flux lines forms closed loop by itself.  
 (C) Flux lines can intersect each other. (D) Closer flux lines in same direction can repel each other.
- (4) The ability of a material to establish and allow magnetic flux in material is known as [1]  
 (A) Permeability (B) Permittivity (C) Conductivity (D) Resistivity
- (5) Which of the following pairs is not correct? (Magnetic Circuit – Electric Circuit) [1]  
 (A) Flux - Current (B) Reluctance - Resistance  
 (C) Permeance - Conductance (D) Magnetic Flux Density – Electric Field Intensity
- (6) In statically induced EMF, which of the following component is stationary? [1]  
 (A) Magnet (B) Conductor or Coil (C) Both (A) & (B) (D) None of the above
- (7) Magnetic Hysteresis Curve is drawn between which parameters? [1]  
 (A) Density v/s Intensity (B) Intensity v/s Conductivity  
 (C) Conductivity v/s Reluctivity (D) Reluctivity v/s Density
- (8) 1 Weber = (?) Maxwells [1]  
 (A)  $10^6$  (B)  $10^7$  (C)  $10^8$  (D)  $10^9$
- (9) A fully charged capacitor discharges some charge in atmosphere due to [1]  
 (A) Electrostatic force between charges of plates (B) Leakage flux flowing through it  
 (C) Low supply voltage (D) Uneven number of charges on plates
- (10) In Fleming's left hand rule, the thumb represents direction of [1]  
 (A) Motion of conductor (B) Flux (C) Current (D) None of the above

### Class Test

#### Question : 1 (Attempt any TWO)

- (A) Derive the expression of capacitor voltage when capacitor is discharging through resistor. [05]
- (B) Give the comparison between magnetic circuit and electric circuit. [05]
- (C) Explain the principle of statically induced EMF and dynamically induced EMF with neat sketch. [05]

#### Question : 2 (Attempt any TWO)

- (A) Two capacitors having capacitances of  $6 \mu\text{F}$  and  $10 \mu\text{F}$  respectively are connected in parallel. [05]  
 A  $16 \mu\text{F}$  capacitor is connected in series with the parallel combination and the complete circuit is connected across a 400 V DC supply. Calculate,
  1. Total capacitance of the circuit
  2. Voltage across each capacitor

3. Total charge in the circuit

4. Charge on each capacitor

**(B)** A toroidal air-cored coil with 2000 turns has a mean radius of 25 cm and diameter of each turn being 6 cm. If the current in the coil is 10 A than find, [05]

1. MMF      2. Flux      3. Flux Density

**(C)** A capacitor consists of two parallel square plates each of 120 mm side separated by 1 mm in air. When a voltage of 1000 V is applied between the plates, an average current of 12 mA flows for 5 sec. Calculate, [05]

1. Charge on the capacitor

2. Electric Flux

3. Electric Flux Density

4. Electric Field Strength in dielectric