TED (15) – 2031

(REVISION — 2015)

Reg. No. ....

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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — APRIL, 2019

BASIC ELECTRICAL ENGINEERING

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. Define the resistance and write its unit.
2. Mention type of energy conversion occur in battery.
3. Notate the Thevenins equivalent of an electric circuit.
4. Define mmf.
5. Define capacitance. (5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Draw the atomic structure of silicon atom neatly. Atomic number of silicon is 14.
2. State the ohms law. Write laws of resistance.
3. Derive the equation for effective resistance when the resistance R1, R2, R3 are connected in parallel.
4. State voltage divide rule in series circuit of resistance with neat fig.
5. State the Coulombs laws of electrostatics.
6. Explain electrical potential.
7. State Faradays laws of electromagnetic induction. (5×6 = 30)

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

III (a) What are the factors effecting resistance ? 8

(b) A coil has a resistance 18Ω at $20°C$ and 22Ω at $50°C$. Find the rise in the temperature when resistance becomes 24Ω. The room temperature is $18°C$. 7

OR

Marks

IV (a) Write the short note on short circuit, open circuit with figure. 8

(b) Calculate the cost of electrical energy for a month of April of a residential. 100W bulb-3 nos. working 12 hours per day, 25W- 4 nos. fluorescent lamp working 10 hours per day, 40W fluorescent lamp-5 nos. working 10 hours per day. Cost of energy is Rs. 4 per unit. 7

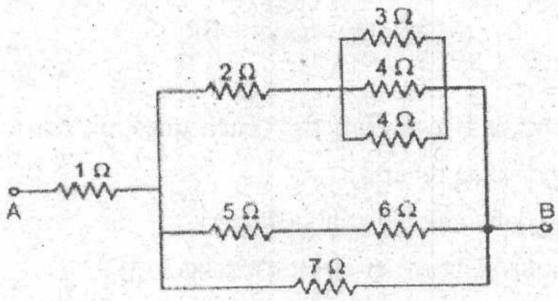
UNIT — II

V (a) State and explain the charging and discharging of lead acid battery with neat diagram. 10

(b) State and explain Norton's theorem. 5

OR

VI (a) Find the equivalent resistance between A and B (show the each step of reduction).



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(b) State Super position theorem. 5

UNIT — III

VII (a) Derive the equation for equivalent capacitance when capacitors C1, C2, C3 are connected in series. 7

(b) A parallel plate capacitor has an area of 10 cm^2, distance between the plate is 2mm, relative permittivity of dielectric medium of capacitor is 3. The potential gradient between the plates of a capacitor is 12kV/cm. Determine the capacitance of the parallel plate capacitor, voltage across the plate, charge, electric flux density and electric flux between the plate. 8

OR

VIII (a) Define relative permittivity, absolute permittivity. 8

(b) Four capacitors are connected in parallel across 250V supply. The charges are taken by them are 750, 1000, 1500, 2000 μC each. What is the equivalent capacitance ? 7

UNIT — IV

IX (a) Explain self induced emf, mutual induced emf with figure. 8

(b) A solenoid of a 100cm is wound on a brass tube. If the current flow through the coil is 0.5A, calculate the number of turns necessary over the solenoid produce a field strength of 500AT/m at the centre of the coil. 7

OR

X (a) Derive the equation for energy stored in magnetic field. 6

(b) A coil carries 200 turns of gives rise a flux of 500μWb when carrying a certain current. If this current is reversed in 1/10th of a second, find the average emf induced in the coil. 6

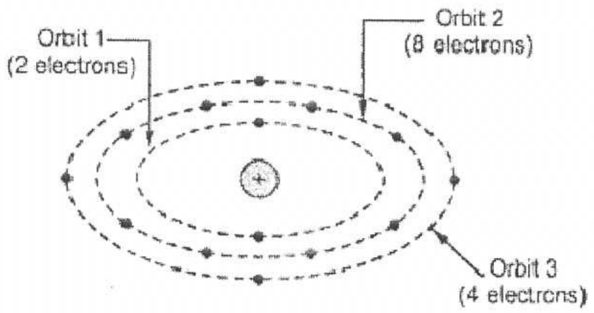
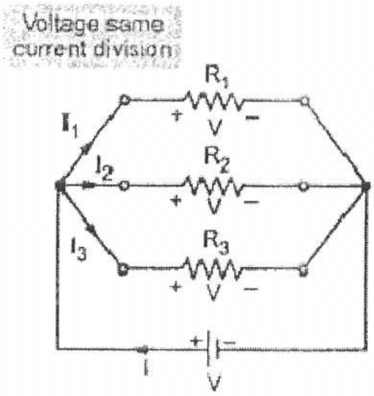
(c) List any three application of electromagnet. 3

Q1
A

14

1

QN NO.	SCORING INDICATORS	SPLIT SCORE	TOTAL SCORE
I.	**PART – A**		
1	This is the property of electric circuit tending to prevent the flow of current and the same time cause electrical energy to be converted in to heat is called resistance. unit ohm(Ω)	1+1	2
2	In battery-chemical energy converted to electrical energy		
3	$\boxed{I_L = \frac{V_{TH}}{R_L + R_{eq}}}$ V_{TH}- Theveninsvoltage ,R_L-load resistance. R_{eq}- thevenins equivalent resistance	2	2
4	The force behind the flow of flux or production of flux in the magnetic circuit is called magnetic motive force(mmf) Its unit is ampere turns (AT)	2 2	2 2
5	A capacitor is nothing but the two conducting surfaces, separated by an insulating medium called **dielectric.** These conducting surfaces could be in the form of rectangular, circular, spherical or cylindrical in shape. A capacitor is also called **condenser.** The commonly used dielectrics in capacitors are paper, mica, air etc. Capacitance is the property of a capacitor to store electricity. Unit is farad	2	2

QN NO	SCORING INDICATORS	SPLIT SCORE	TOTAL SCORE
II	**PART-B**		
1	**2) Silicon :** This atom consists of 14 electrons. These revolve around the nucleus in three orbits. The first orbit has maximum 2 electrons, the second has maximum 8 electrons and the third orbit has remaining 4 electrons. This is shown in the Fig. 1.1 (b). 	3 3	6
2	The Ohm's law can be defined as, The ratio of potential difference (V) between any two points of a conductor to current (I) flowing between them is constant, provided that the temperature of conductor remains constant. R directly promotional to l R inversely proportional to l/A R depends on material and temperature	3 3	6
3	In the parallel connection shown, the three resistances R_1, R_2 and R_3 are connected in parallel and combination is connected across a source of voltage 'V '. Let total current drawn is say ' I '  Now let us study current distribution. Apply Ohm's law to each resistance. $V = I_1 R_1$, $V = I_2 R_2$, $V = I_3 R_3$	3	6

$$I_1 = \frac{V}{R_1},\ I_2 = \frac{V}{R_2},\ I_3 = \frac{V}{R_3}$$

$$I = I_1 + I_2 + I_3 = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$= V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

3

For overall circuit if Ohm's law is applied,

$$V = I R_{eq}$$

and $$I = \frac{V}{R_{eq}}$$

where R_{eq} = Total or **equivalent resistance** of the

Comparing the two equations,

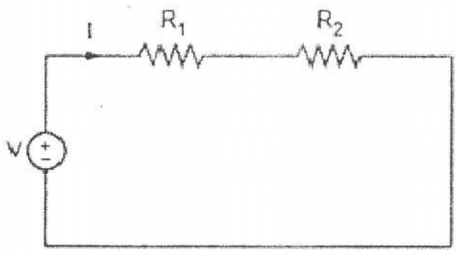
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

where R is the equivalent resistance of the parallel combinatic

In general if 'n' resistances are connected in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... + \frac{1}{R_n}$$

4



3

Consider a series circuit of two resistors R_1 and R_2 connected to source of V volts.

As two resistors are connected in series, the current flowing through both the resistors is same, i.e. I. Then applying KVL, we get,

$$V = I R_1 + I R_2$$

$$\therefore\ I = \frac{V}{R_1 + R_2}$$

6

Total voltage applied is equal to the sum of voltage drops V_{R1} and V_{R2} across R_1 R_2 respectively.

$$\therefore \quad V_{R1} = I \cdot R_1$$

$$\therefore \quad \boxed{V_{R1} = \frac{V}{R_1 + R_2} \cdot R_1 = \left[\frac{R_1}{R_1 + R_2}\right] V}$$

Similarly, $V_{R2} = I \cdot R_2$ 3

$$\therefore \quad \boxed{V_{R2} = \frac{V}{R_1 + R_2} \cdot R_2 = \left[\frac{R_2}{R_1 + R_2}\right] V}$$

So this circuit is a voltage divider circuit.

5

The law states that the mechanical force, attraction or repulsion, between the two sm charged bodies is

i) directly proportional to the product of the charges present on the bodies.

ii) inversely proportional to the square of the distance between the bodies an 3

iii) depends upon the nature of the medium surrounding the bodies.

$$F \propto \frac{Q_1 Q_2}{d^2}$$ 6

$$\boxed{F = \frac{K Q_1 Q_2}{d^2} \quad \text{Newtons}}$$ 3

6 **It can be defined as the work done in joules, in moving a unit positive charge fro infinity (position of zero potential) to the point against the electric field.** 3

It is denoted by symbol V and is measured in joule per coulomb or volt. 6

Thus, $\boxed{\text{Electric Potential } V = \frac{\text{Workdone (W)}}{\text{Charge (Q)}}}$ ... volt 3

7 First law

Whenever the number of magnetic lines of force (flux) linking with a coil or circuit change e.m.f. gets induced in that coil or circuit. 3

Second law

The magnitude of the induced e.m.f. is directly proportional to the rate of change of flux linkages (flux × turns of coil). 6 3

$\boxed{\textbf{Flux linkages} = \text{Flux} \times \text{Number of turns of coil}}$

Thus such an induced e.m.f. is mathematically expressed alongwith its sign as,

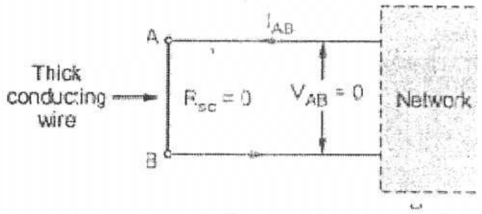
$$\therefore \quad \boxed{e = -N\frac{d\phi}{dt} \quad \text{volts}}$$

III	## PART –C UNIT-1		
(a)	**1. Length of the material :** The resistance of a material is directly proportional to the length. The resistance of longer wire is more. Length is denoted by 'l'. **2. Cross-sectional area :** The resistance of a material is inversely proportional to the cross-sectional area of the material. More cross-sectional area allowed the passage of more number of free electrons, offering less resistance. The cross sectional area is denoted by 'a'. **3. The type and nature of the material :** As discussed earlier whether it consists more number of free electrons or not, affects the value of the resistance. So material which is conductor has less resistance while an insulator has very high resistance. **4. Temperature :** The temperature of the material affects the value of the resistance. Generally the resistance of the material increases as its temperature increases. Generally effect of small changes in temperature on the resistance is not considered as it is negligibly small. So for a certain material at a certain temperature we can write a mathematical expression as, $$R \propto \frac{l}{a}$$ and effect of nature of material is considered through the constant of proportionality denoted by ρ (rho) called **resistivity or specific resistance** of the material. So finally, $$\boxed{R = \frac{\rho l}{a}}$$ Where l = length in metres a = cross-sectional area in square metres ρ = resistivity in ohms-metres R = resistance in ohms	4 2 2	8
(b)	Solution : $R_1 = 18\ \Omega,\ t_1 = 20\ ^\circ C,\ R_2 = 22\ \Omega$ and $t_2 = 50\ ^\circ C$ Now, $R_2 = R_1[1 + \alpha_1(t_2 - t_1)]$ i.e. $22 = 18\ [1 + \alpha_1(50-20)]$ Solving, $\alpha_1 = 0.007407\ /^\circ C$ Now $R_3 = 24\ \Omega$ and $R_3 = R_1\ [1 + \alpha_1\ (t_3 - t_1)]$ $\therefore\ 24 = 18\ [1 + 0.007407\ (t_3 - 20)]$ $\therefore\ 0.3333 = 0.007407\ (t_3 - 20)$ $\therefore\ t_3 - 20 = 45$ $\therefore\ t_3 = 65\ ^\circ C$ So room temperature is 18 °C given $\therefore$ Temperature rise = 65 − 18 = 47 °C	3 2 2	7

OR

IV (a Short circuit — 2

When any two points in a network are joined directly to each other with a thick metalic conducting wire, the two points are said to be short circuited. **The resistance of such short circuit is zero.**



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The points A and B are short circuited. The resistance of the branch AB is $R_{sc} = 0\ \Omega$.

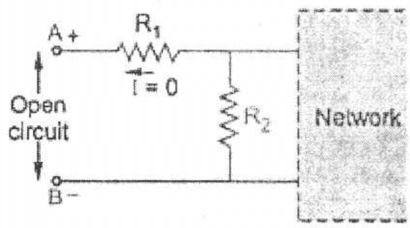
According to Ohm's law,

$$V_{AB} = R_{sc} \times I_{AB} = 0 \times I_{AB} = 0 \text{ V}$$

Open circuit

When there is no connection between the two points of a network, having some voltage across the two points then the two points are said to be open circuited.

As there is no direct connection in an open circuit, **the resistance of the open circuit is ∞.** — 2



There exists a voltage across the points AB called open circuit voltage, V_{AB} but $R_{oc} = \infty\,\Omega$. — 2

According to Ohm's law,

$$I_{oc} = \frac{V_{AB}}{R_{oc}} = \frac{V_{AB}}{\infty} = 0 \text{ A}$$

(b) Solution :

Energy consumed per day

bulb 100x3x12=3600Wh

Fluorescent lamp 25x4x10=1000Wh
CFL 40x5x10=2000Wh 2
Total energy consumed=6600Wh 7
Total energy consumed =6.6kWh
Energy consumed a month of April is 30 days
That is 6.6 x 30=198kWh 2
Cost of one unit energy is 4
Cost of energy consumed April = 198x4=Rs 792 3

UNIT-II

VI a.

1. First charging : When the current is passed for the first time through electrolyte, the H_2O in the electrolyte is electrolysed as,

$$H_2O \rightarrow 2H^+ + O^-$$

The hydrogen ions as positively charged get attracted towards one of the electrodes which acts as cathode (negative). The hydrogen does not combine with lead and hence cathode retains its original state and colour.

The oxygen ion as negatively charged gets attracted towards the other lead plate which acts as anode (positive). But this oxygen chemically combines with the lead (Pb) to form lead peroxide (PbO_2). Due to the formation of lead peroxide the anode becomes dark brown in colour.

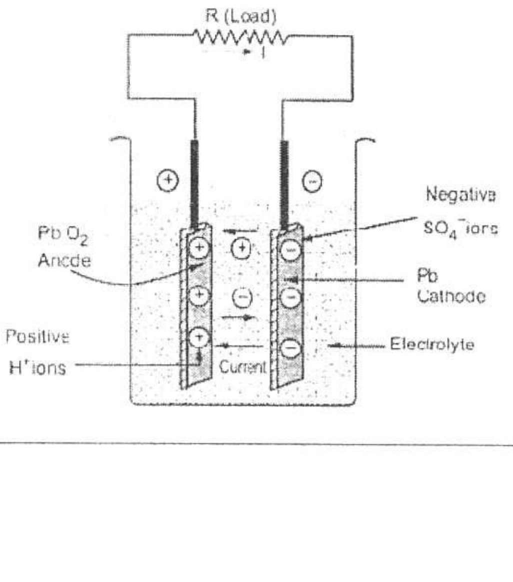
VI (a)

Thus anode is dark brown due to the layer of lead peroxide deposited on it while the cathode is spongy lead electrode.

So there exists a potential difference between the positive anode and the negative cathode which can be used to drive the external circuit. The electrical energy obtained from chemical reaction is drawn out of the battery to the external circuit, which is called discharging. 5

2. Discharging : When the external supply is disconnected and a resistance is connected across the anode and cathode then current flows through the resistance, drawing an electrical energy from the battery. This is **discharging.** The direction of current is opposite to the direction of current at the time of first charging. The discharging is shown in the

Fig.



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During the discharging, the directions of the ions are reversed. The H^+ ions now move towards anode and the SO_4^{--} ions move towards cathode.

This is because H_2SO_4 decomposes as,

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{--}$$

At the anode, the hydrogen ions become free atoms and react with lead peroxide alongwith the H_2SO_4 and ultimately lead sulphate $PbSO_4$ results as, 5

$$PbO_2 + H_2SO_4 + 2H \rightarrow PbSO_4 + 2H_2O \quad \text{... At Anode}$$

At the cathode, each SO_4^{--} ion become free SO_4 which reacts with the metallic lead to get lead sulphate.

$$Pb + SO_4 \rightarrow PbSO_4 \quad \text{... At Cathode}$$

Thus discharging results into formation of whitish lead sulphate on both the electrodes.

(b) The Norton's theorem can be stated as below,

Statement : *Any combination of linear bilateral circuit elements and active sources, regardless of the connection or complexity, connected to a given load R_L, can be replaced by a simple two terminal network, consisting of a single current source of I_N amperes and a single impedance R_{eq} in parallel with it, across the two terminals of the load R_L. The I_N is the short circuit current flowing through the short circuited path, replaced instead of R_L. It is also called Norton's current. The R_{eq} is the equivalent impedance of the given network as viewed through the load terminals with R_L removed and all the active sources are replaced by their internal impedances. If the internal impedances are unknown then the independent voltage sources must be replaced by short circuit while the independent current sources must be replaced by open circuit, while calculating R_{eq}.* 5 5

~~(b)~~

OR

VI a. **Solution :** Identify combinations of series and parallel resistances. ~~5~~ ~~5~~

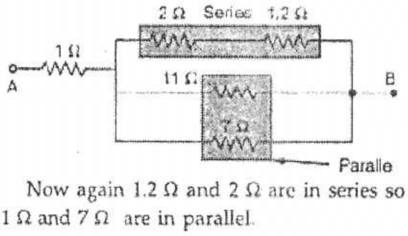
The resistances 5 Ω and 6 Ω are in series, as going to carry same current.

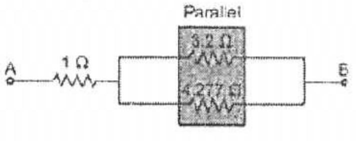
So equivalent resistance is 5 + 6 = 11 Ω

While the resistances 3 Ω, 4 Ω, and 4 Ω are in parallel, as voltage across them same but current divides.

∴ Equivalent resistance is, $\frac{1}{R} = \frac{1}{3}+\frac{1}{4}+\frac{1}{4} = \frac{10}{12}$

∴ $R = \frac{12}{10} = 1.2\ \Omega$





~~VI~~ (a)

Now again 1.2 Ω and 2 Ω are in series so equivalent resistance is 2 + 1.2 = 3.2 Ω while 11 Ω and 7 Ω are in parallel. 2

Using formula $\frac{R_1 R_2}{R_1 + R_2}$ equivalent resistance is $\frac{11 \times 7}{11+7} = \frac{77}{18} = 4.277\Omega$.

2

9

Replacing the respective combinations redraw the circuit as shown

Now 3.2 and 4.277 are in parallel. 4

$\therefore$ Replacing them by $\frac{3.2\times4.277}{3.2+4.277} = 1.8304\ \Omega$

$\therefore$ $R_{AB} = 1+1.8304 = 2.8304\ \Omega$ 2

10

b. This theorem is applicable for linear and bilateral networks. Let us see the statement of the theorem.

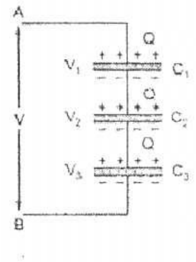
Statement : *In any multisource complex network consisting of linear bilateral elements, the voltage across or current through any given element of the network is equal to the algebraic sum of the individual voltages or currents, produced independently across or in that element by each source acting independently, when all the remaining sources are replaced by their respective internal resistances.* ~~2~~ 5 5

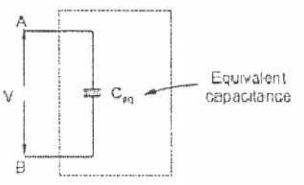
UNIT-III

VII c. **Capacitors in Series**

Consider the three capacitors in series connected across the applied voltage V Suppose this pushes charge Q on C_1 then the opposite plate of C_1 must have the same charge. This charge which is negative must have been obtained from the connecting leads by the charge separation which means that the charge on the upper plate of C_2 is also Q. In short, all the three capacitors have the same charge Q.

~~VII (a)~~





2

3

$$\boxed{Q = C_1 V_1 = C_2 V_2 = C_3 V_3}$$

Giving, $V_1 = \frac{Q}{C_1}$; $V_2 = \frac{Q}{C_2}$; $V_3 = \frac{Q}{C_3}$ — 7

If an equivalent capacitor also stores the same charge, when applied with the voltage, then it is obvious that,

$$C_{eq} = \frac{Q}{V} \quad \text{or} \quad V = \frac{Q}{C_{eq}}$$

But, $V = V_1 + V_2 + V_3$

$$\therefore \quad \frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$ — 2

$$\therefore \quad \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

It is easy to find V_1, V_2 and V_3 if Q is known

$$\boxed{\text{For 'n' capacitors in series, } \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}}$$

(b)

Solution : The capacitance can be calculated as,

$$C = \frac{\varepsilon A}{d} = \frac{\varepsilon_0 \varepsilon_r A}{d} = \frac{3 \times 8.854 \times 10^{-12} \times 10 \times 10^{-4}}{2 \times 10^{-3}}$$

$$= 1.328 \times 10^{-11} = 13.28 \text{ pF}$$

Electric intensity = Potential gradient — 4

$$E = 12 \text{ kV/cm} = \frac{12 \times 10^3}{1 \times 10^{-2}} \text{ V/m} = 1200 \times 10^3 \text{ V/m}$$

Now, $E = \frac{V}{d}$

$$\therefore \quad 1200 \times 10^3 = \frac{V}{2 \times 10^{-3}} \quad \text{i.e. } V = 2400 \text{ V}$$ — 8

This is the voltage across capacitor plates.

$$C = \frac{Q}{V}$$

$$\therefore \quad Q = CV = 13.28 \times 10^{-12} \times 2400 = 31.87 \times 10^{-9} \text{ C}$$ — 4

$\therefore$ Charge $= \mathbf{31.87 \text{ nC}}$

Electric flux, $\psi = Q = 31.87$ nC

$$\text{Electric flux density, } D = \frac{Q}{A} = \frac{31.87 \times 10^{-9}}{10 \times 10^{-4}} = 3.187 \times 10^{-5} \text{ C/m}^2$$

$$= \mathbf{31.87 \ \mu C / m^2}$$

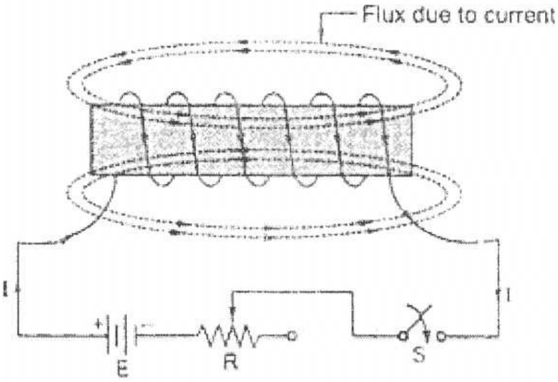
OR

VIII

(a)

Relative permittivity

	To define the permittivity of the dielectric medium, the vacuum or free space is considered to be a reference medium. So, **relative permittivity** of vacuum with respect to itself is unity.	4	
	The ratio of electric flux density in a dielectric medium to that produced in a vacuum by the same electric field strength under identical conditions is called **relative permittivity**. It is denoted by ε_r and has no units. $\varepsilon_r = \frac{D}{D_0}$ Now $D = \varepsilon E$ and $D_0 = \varepsilon_0 E$ $\therefore \varepsilon_r = \frac{\varepsilon E}{\varepsilon_0 E}$ $\boxed{\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}}$	4	8
	Absolute permittivity The ratio of the electric flux density D to electric field strength E at any point is defined as the **absolute permittivity**. It is denoted by ε and measured in units farads/metre, (F/m). $\boxed{\varepsilon = \frac{D}{E} \quad F/m}$		
(b)	**Solution:** $Q_1 = 750\ \mu C$, $Q_2 = 1000\ \mu C$, $Q_3 = 1500\ \mu C$, $Q_4 = 2000\ \mu C$. $V = 250\ V$ $Q_1 = C_1 V$ $\therefore C_1 = \frac{Q_1}{V} = \frac{750\times10^{-6}}{250} = 3\ \mu F$, $C_2 = \frac{Q_2}{V} = \frac{1000\times10^{-6}}{250} = 4\ \mu F$	4	7
	$\therefore C_3 = \frac{Q_3}{V} = \frac{1500\times10^{-6}}{250} = 6\ \mu F$, $C_4 = \frac{Q_4}{V} = \frac{2000\times10^{-6}}{250} = 8\ \mu F$ The equivalent $C = C_1 + C_2 + C_3 + C_4 = 21\ \mu F$	3	
IX	UNIT –IV		
(a)	**Self inducedemf** Consider a coil having 'N' turns and carrying current 'I' when switch 'S' is in closed position. The current magnitude can be varied with the help of variable resistance connected in series with battery, coil and switch as shown in the fig	4	



The flux produced by the coil links with the coil itself. The total flux linkages of coil will be N ϕ Wb-turns. Now if the current 'I' is changed with the help of variable resistance, then flux produced will also change, due to which flux linkages will also change.

Hence according to Faraday's law, due to rate of change of flux linkages there will be induced e.m.f. in the coil. So without physically moving coil or flux there is induced e.m.f. in the coil. The phenomenon is called **self induction.** 8

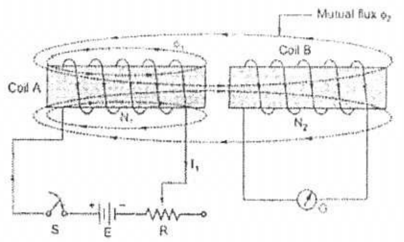
The e.m.f. induced in a coil due to the change of its own flux linked with it is called **self induced e.m.f.**

A circuit possesses a self inductance of 1 H when a current of 1 A through it produces flux linkages of 1 Wb-turn in it.

$$\therefore \quad \boxed{e = -L\frac{dI}{dt} \quad \text{volts}}$$

Mutually induced emf

If the flux produced by one coil is getting linked with another coil and due to change in this flux produced by first coil, there is induced e.m.f. in the second coil, then such an e.m.f. is called **mutually induced e.m.f.** 4



$$\boxed{e_2 = -M\frac{dI_1}{dt} \quad \text{volts}}$$

(b)

Solution : The field strength on the axis of a long solenoid is given by

$$H = \frac{NI}{l}\ \text{AT/m}$$

l = Length of coil = 100 cm = 1 m , N = Number of turns **4**

I = Current = 0.5 A

$$\therefore \quad 500 = \frac{N \times 0.5}{1}$$ **7**

$$N = 1000$$

So 1000 turns on solenoid are necessary to produce the required field strength. **3**

OR

X (a)

Let the induced e.m.f. in a coil be,

$$e = -L\frac{dI}{dt}$$

This opposes a supply voltage. So supply voltage 'V' supplies energy to overcome this, which ultimately gets stored in the magnetic field.

$$\therefore \quad V = -e = -\left[-L\frac{dI}{dt}\right] = L\frac{dI}{dt}$$

$\therefore$ Power supplied $= V \times I = L\frac{dI}{dt} \times I$ **3**

$\therefore$ Energy supplied in time dt is,

$$E = \text{Power} \times \text{Time} = L\frac{dI}{dt} \times I \times dt$$

$$= L\,di \times I \quad \text{joules.}$$ **6**

This is energy supplied for change in current of dI but actually current changes from zero to I.

$\therefore$ Integrating above total energy stored is,

$$E = \int_0^I L\,dI\,I = L\int_0^I dI\,I$$ **3**

$$= L\left[\frac{I^2}{2}\right]_0^I = L\left[\frac{I^2}{2} - 0\right]$$

$$\therefore \quad \boxed{E = \frac{1}{2}LI^2 \quad \text{joules}}$$

(b)

Solution : The magnitude of induced e.m.f. is,

$$= N\frac{d\phi}{dt}$$

where $d\phi$ is change in flux linkages i.e. change in $N\phi$. Now in this problem flux is 500×10^{-6} for given current. After reversing this current, flux will reverse its direction. So flux becomes (-500×10^{-6}).

$$\therefore \quad d\phi = \phi_2 - \phi_1 = -500 \times 10^{-6} - (+500 \times 10^{-6})$$ **3**

This happens in time dt = 0.1 sec.

$$\therefore \quad \text{Average e.m.f.} = -N\frac{d\phi}{dt} = -200 \times \frac{(-1 \times 10^{3})}{0.1} = 2 \text{ volts}$$ **6**

3

(c)	1.pinball machine 2.dot matrix printers 3.fuel injectors 4.lifting purpose 5.motor and generates 6.transformers 7.relay 8.electric bell 9.loudspeakers 10.MRI machines	**Any 3**	**3**