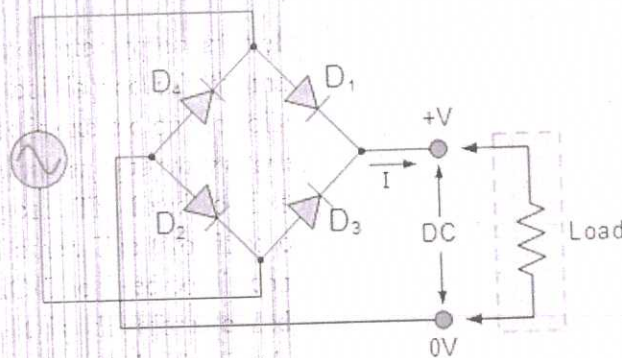


of conductor is reversed in the magnetic field. This is how a DC motor works.

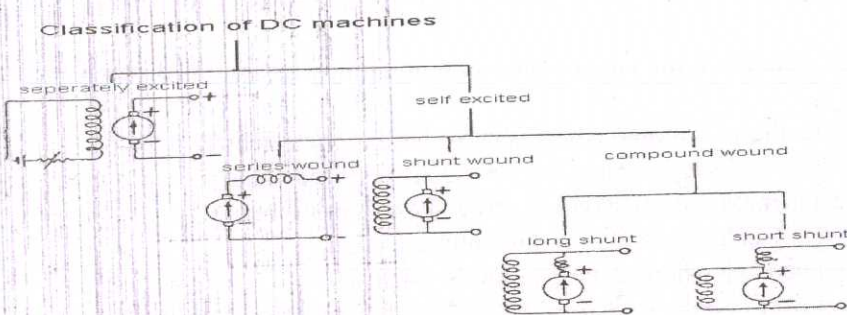
3. The basic **dynamometer type wattmeter working principle** is that when a current carrying moving coil is placed in the magnetic field produced by the current carrying fixed coil, a force is exerted on the coil sides of the moving coil and deflection takes place. A *dynamometer type wattmeter* essentially consists of two coils called fixed coil and moving coil. The fixed coil is splitted into two equal parts which are placed parallel to each other. The two fixed coils are air-cored to avoid hysteresis effects when used on AC. The fixed coil is connected in series with the load and carries the circuit current. It is, therefore, called current coil. The moving coil is pivoted between the two parts of the fixed coil and is mounted on the spindle. A pointer is attached to the spindle which gives deflection. The moving coil is connected in parallel with the load and carries the current proportional to the voltage. It is, therefore, called potential coil.

4.



The four diodes labelled D_1 to D_4 are arranged in "series pairs" with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D_1 and D_2 conduct in series while diodes D_3 and D_4 are reverse biased and the current flows through the load

5.



6.

Starters are used to protect DC motors from damage that can be caused by very high current and torque during start-up. They do this by providing external resistance to the motor, which is connected in series to the motor's armature winding and restricts the current to an acceptable level.

At start-up, when motor speed is zero, back EMF is also zero. Therefore, removing the E_b term and rearranging the voltage equation, we can see that, at start-up,

$$I_a = \frac{E}{R_a}$$

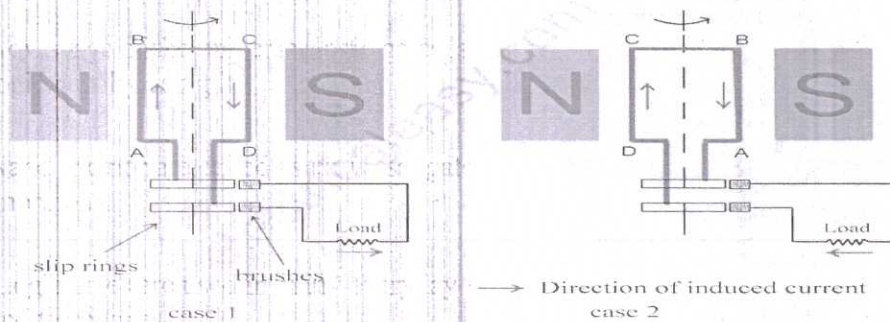
armature current is inversely proportional to armature resistance.

7. Advantage of the universal logic gates is that it can be used to made any kind of logic gate by using it. 2

Nand and nor are called as universal gates are used to make any gaates as or ,and, xnor,not. 2

Logic gates are used in many everyday electronic devices such as tv's, computers and telephones. 2

III
a. According to the Faraday's law of electromagnetic induction, whenever a conductor moves in a magnetic field EMF gets induced across the conductor. If the close path is provided to the conductor, induced emf causes current to flow in the circuit. 2

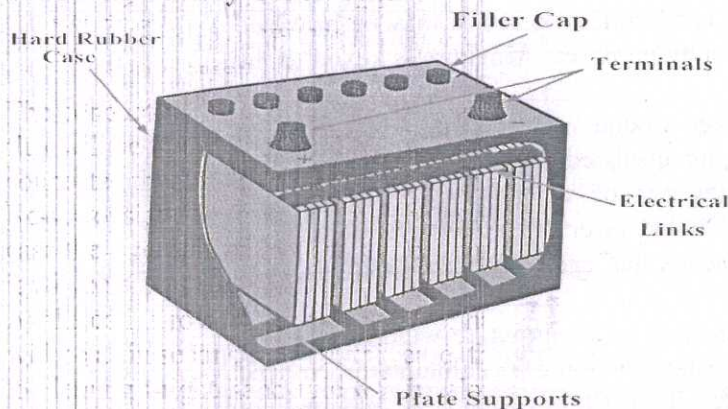


The conductor coil ABCD is placed in a magnetic field: The direction of magnetic flux will be form N pole to S pole. The coil is connected to slip rings, and the load is connected through brushes resting on the slip rings.

Now, consider the case 1 from above figure. The coil is rotating clockwise, in this case the direction of induced current can be given by Fleming's right hand rule, and it will be along A-B-C-D. 2

As the coil is rotating clockwise, after half of the time period, the position of the coil will be as in second case. In this case, the direction of the induced current according to Fleming's right hand rule will be along D-C-B-A. It shows that, the direction of the current changes after half of the time period, that means we get an alternating current.

b. **Lead-Acid Battery Construction.**



The lead-acid battery is made up of several cells, each of which consists of lead plates immersed in an electrolyte of dilute sulfuric acid. The voltage per cell is typically 2 V to 2.2 V. For a 6 V battery, three cells are connected in series, and for a 1

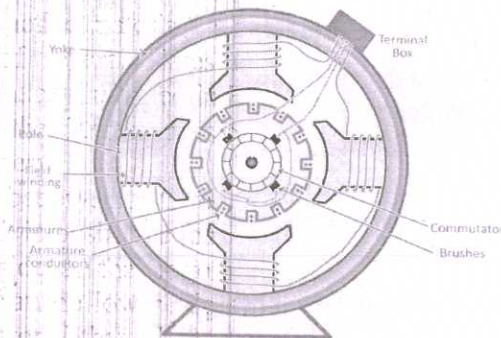
12 V battery, six cells are series-connected.

The electrodes are lead-antimony alloy plates with a pattern of recesses so that they are in the form of grids

Lead oxide (termed active material) is pressed into the recesses of the plates. Each electrode consists of several plates connected in parallel with porous rubber separators in between, as illustrated in Figure 1 (b). This arrangement and the shape of the plates give the largest possible electrode surface area within the size limitations of the battery.

The complete 12 V battery, illustrated in Figure has an outer case of hard rubber. The case is divided into six sections for the six separate cells. Projections are provided on the inside at the bottom of the case to support the plates. These projections ensure that the lower edges of the plates are normally well above the level of an active material that falls to the bottom of a cell. Such material can short out the positive and negative plates and render a cell useless.

Every cell has a threaded filler cap with a small hole in its centre. The filler caps provide access for adding electrolyte, and the holes allow gases to be vented to the atmosphere.



A DC machine consists of two basic parts; stator and rotor. Basic constructional parts of a DC machine are described below.

Yoke: The outer frame of a dc machine is called as yoke. It is made up of cast iron or steel. It not only provides mechanical strength to the whole assembly but also carries the magnetic flux produced by the field winding.

Poles and pole shoes: Poles are joined to the yoke with the help of bolts or welding. They carry field winding and pole shoes are fastened to them. Pole shoes serve two purposes: (i) they support field coils and (ii) spread out the flux in air gap uniformly.

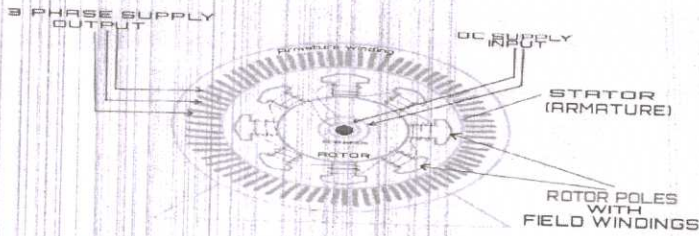
Field winding: They are usually made of copper. Field coils are former wound and placed on each pole and are connected in series. They are wound in such a way that, when energized, they form alternate North and South poles.

Armature core: Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding. The armature is built up of thin laminated circular steel disks for reducing eddy current losses. It may be provided with air ducts for the axial air flow for cooling purposes. Armature is keyed to the shaft.

Armature winding: It is usually a former wound copper coil which rests in armature slots. The armature conductors are insulated from each other and also from the armature core. Armature winding can be wound by one of the two methods; lap winding or wave winding. Double layer lap or wave windings are generally used. A double layer winding means that each armature slot will carry two different coils.

Commutator and brushes: Physical connection to the armature winding is made through a commutator-brush arrangement. The function of a commutator, in a dc generator, is to collect the current generated in armature conductors. Whereas, in case of a dc motor, commutator helps in providing current to the armature conductors.

b. Construction of Alternators:



An alternator has 3-phase winding on the stator and a d.c. field winding on the rotor.

a. Stator It is the stationary part of the machine and is built up of silicon steel laminations having slots on its inner periphery. A 3-phase winding is placed in these slots and serves as the armature winding of the alternator. The armature winding is always connected in star and the neutral is connected to ground.

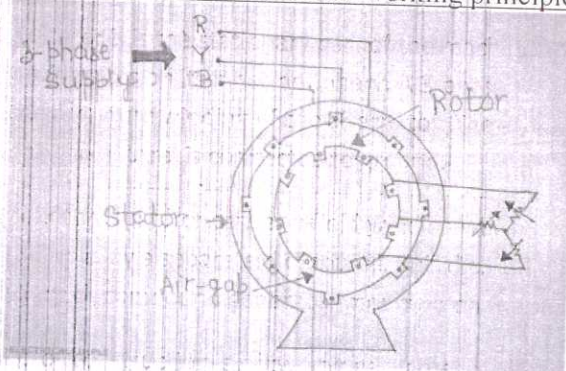
b. Rotor The rotor carries a field winding which is supplied with direct current through two slip rings by a separate d.c. source. This d.c. source (called exciter) is generally a small d.c. shunt or compound generator mounted on the shaft of the alternator.

Rotor construction is of two types, namely; 1. Salient (or projecting) pole type 2. Non-salient (or cylindrical) pole type

V

a.

Three phase Induction motor working principle



The stator hosts a three phase winding distributed symmetrically on its inner periphery. This stator winding is energised from a three phase supply.

The rotor also hosts a 3 phase winding on its periphery. But, the rotor winding is not energised from any source and is short-circuited on itself.

(1) When the 3 phase stator winding is energised from a 3 phase supply, a rotating magnetic field is produced which rotates around the stator at synchronous speed.

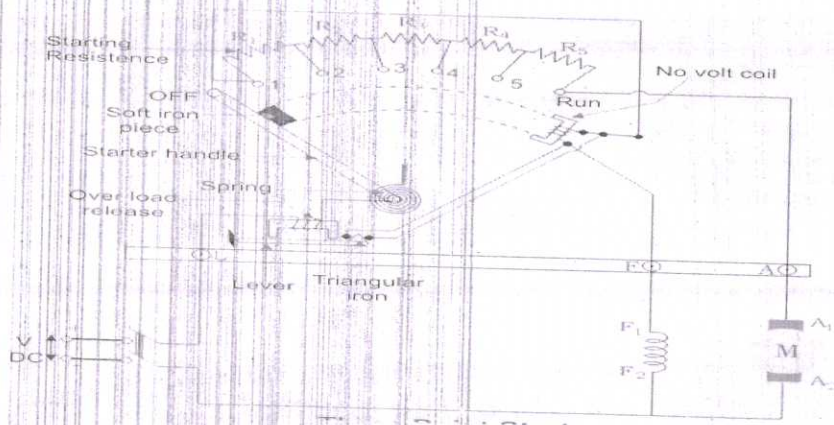
(2) The rotating magnetic field cuts the rotor conductors, which as yet, are stationary. Due to this flux cutting, emfs are induced in the rotor conductors. As rotor circuit is short circuited, therefore, currents start flowing in it.

(3) Now, as per Lenz's law, "the direction of induced current will be such that it opposes the very cause that produced it".

(4) Here, the cause of emf induction is the relative motion between the rotating field and the stationary rotor conductors. Hence, to reduce this relative motion, the rotor starts rotating in the same direction as that of the stator field and tries to catch it but, can never catch it due to friction and windage and therefore emf induction continues and motor keeps rotating.

b.

Three Point Starter



3

A "3-point starter" is extensively used to start a D.C shunt motor. It not only overcomes the difficulty of a plain resistance starter, but also provides additional protective features such as over load protection and no volt protection. The starter is shown enclosed within the dotted rectangular box having three terminals marked as A, L and F for external connections. Terminal A is connected to one armature terminal A1 of the motor. Terminal F is connected to one field terminal F1 of the motor and terminal L is connected to one supply terminal as shown. F2 terminal of field coil is connected to A2 through an external variable field resistance and the common point connected to supply (-ve).

8

The external armatures resistances consist of several resistances connected in series and are shown in the form of an arc. The junctions of the resistances are brought out as terminals and marked. Just beneath the resistances, a continuous copper strip also in the form of an arc is present.

2

There is a handle which can be moved in the clockwise direction against the spring tension. The spring tension keeps the handle in the OFF position when no one attempts to move it. Now let us trace the circuit from terminal L (supply + ve). The wire from L passes through a small electro magnet called OLRC, (the function of which we shall discuss a little later) and enters through the handle shown by dashed lines. Near the end of the handle two copper strips are firmly connected with the wire.

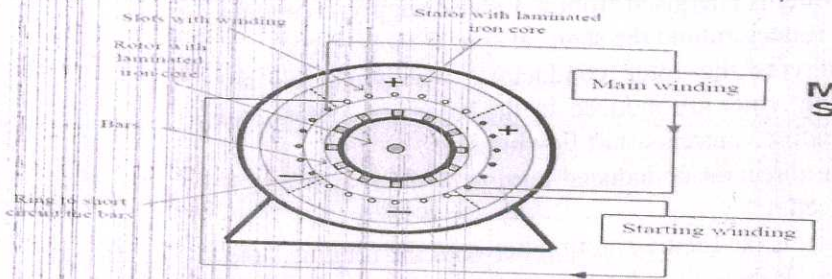
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2

VI

a.

Construction of Single Phase Induction Motor



3

The main components of the Single Phase induction motor are stator and rotor. Stator is known to be the stationary part. Usually, the single phase alternating supply is given to the stator winding. Rotor is the rotating part of the motor. Rotor is

1

connected to the mechanical load with the help of a shaft. A squirrel cage rotor is used here. It has a laminated iron core with many slots. Rotor slots are closed or semi-closed type. The rotor windings are symmetrical and at the same time it is short circuited. An air gap is there between the rotor and the stator. The most practical applications of this motor are in refrigerators, clocks, drills, pumps, washing machines etc.

1

7

The stator winding in the 1 ϕ induction motor has two parts: Main Winding and Auxiliary Winding. Usually, the Auxiliary winding is perpendicular to the main winding. In 1 ϕ induction motor the winding with more turns is known as main winding. While the other wire is called as auxiliary winding.

1

Principle of Operation ----- Single phase AC supply is given to the stator winding. Due to this a magnetic field is produced which pulsates in sinusoidal manner. After sometime the field polarity reverses and the alternating flux cannot provide the required rotation to the motor. But if the motor is moved by external means, the motor will rotate with finite speed.

1

b.

Types of Transformers

On the basis of construction, transformers can be classified into two types as;

(I) Core Type Transformer - In core type transformer, windings are cylindrical former wound, mounted on the core limbs as shown in the figure above. The cylindrical coils have different layers and each layer is insulated from each other. Materials like paper, cloth or mica can be used for insulation. Low voltage windings are placed nearer to the core, as they are easier to insulate.

2

(II) Shell Type Transformer - The coils are former wound and mounted in layers stacked with insulation between them. A shell type transformer may have simple reetangular form, or it may have a distributed form.

2

8

On the basis of Function, transformers can be classified into;

- 1. Power transformer
- 2. Distribution transformer
- 3. Instrument transformer

2 + 2

VII

a.

There are two general types of moving-iron instruments namely:

- 1. **Repulsion** (or double iron) type (figure 1)
- 2. **Attraction** (or single-iron) type (figure 2)

The brief description of different components of a moving-iron instrument is given below: **(Explanation of any one type needed)**

1

Moving element: a small piece of soft iron in the form of a vane or rod.

Coil: to produce the magnetic field due to current flowing through it and also to magnetize the iron pieces.

In repulsion type, a fixed vane or rod is also used and magnetized with the same polarity.

3

Moving iron instruments having scales that are nonlinear and somewhat crowded in the lower range of calibration.

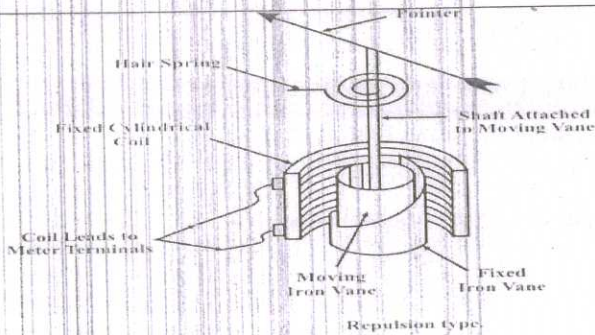


Figure 1 – Repulsion moving iron-instrument

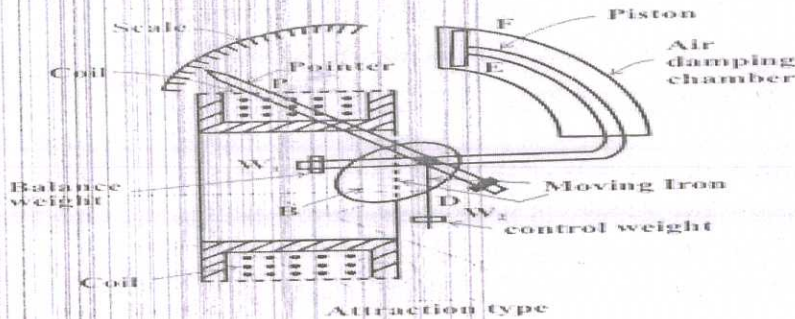
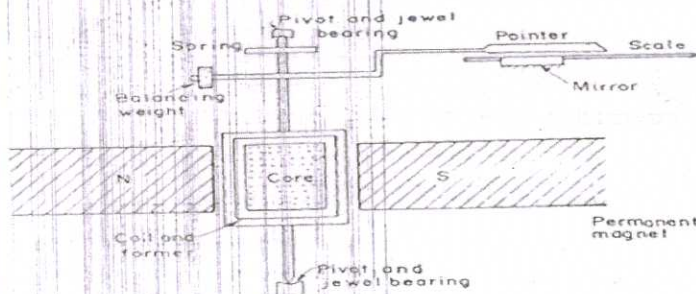


Figure 2 – Attraction moving iron instrument

- b. Annealing, surface hardening, brazing, welding, drying points of metals, heat bonding, sterilizing, melting and soldering, wood gluing, food processing, sewing, curing of sand and wood, chemical processing... (ANY 8, ONE MARK EACH)

VIII
a.



When a current flow through the coil, it generates a magnetic field which is proportional to the current in case of an ammeter. The deflecting torque is produced by the electromagnetic action of the current in the coil and the magnetic field.

When the torques are balanced the moving coil will stop and its angular deflection represents the amount of electrical current to be measured against a fixed reference, called a scale. If the permanent magnet field is uniform and the spring linear, then the pointer deflection is also linear.

The controlling torque is provided by two phosphorous bronze flat coiled helical springs. These springs serve as a flexible connection to the coil conductors.

Damping is caused by the eddy current set up in the aluminum coil which prevents the oscillation of the coil.

7

3 mark

Any one figure needed

1 X 8

8

3

2

1

7

1

b. 4 functions of induction furnace --MAKING TOOL STEEL, LOW CARBON ALLOYS, DIE STEEL, HEAT RESISTANT STEEL 4

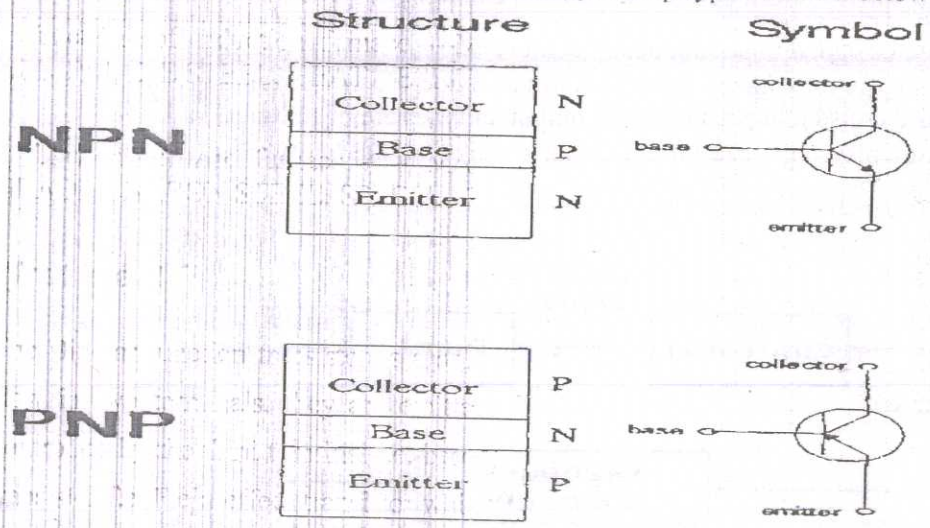
8

4 functions of Arc furnace ----- MAKING SPECIAL ALLOY STEEL, HIGH GRADE CARBON STEEL, SPECIAL TOOL STEEL, HIGH SPEED STEEL 4

IX

a. What is a BJT

The Bipolar junction transistor is a solid state device and in the BJTs the current flow in two terminals, they are emitter and collector and the amount of current controlled by the third terminal i.e. base terminal. It is different to the other type of transistor i.e. Field effect transistor which is the output current is controlled by the input voltage. The basic symbol of the BJTs n-type and p-type is shown below.



PNP Junction Transistor

In PNP transistor, the emitter is more positive with base and also with respect to the collector. The PNP transistor is a three terminal device which is made from the semiconductor material. The three terminals are collector, base, and the emitter and the transistor are used for switching and amplifying applications. The operation of PNP transistor is shown below.

Generally the collector terminal is connected to the positive terminal and the emitter to a negative supply with resistor either the emitter or collector circuit. To the base terminal the voltage is applied and it operates transistor as an ON/OFF state. The transistor is in OFF state when the base voltage is same as the emitter voltage. The transistor mode is in ON state when the base voltage decreases with respect to the emitter. By using this property the transistor can act on both applications like switch and amplifier. The basic diagram of PNP transistor is shown below.

NPN Junction Transistor

The NPN transistor is exactly opposite to the PNP transistor. The NPN transistor contains three terminals which are same as the PNP transistor which are emitter, collector, and base. Generally the positive supply is given to the collector terminal

3 mark for explanation.

Any one explanation is needed

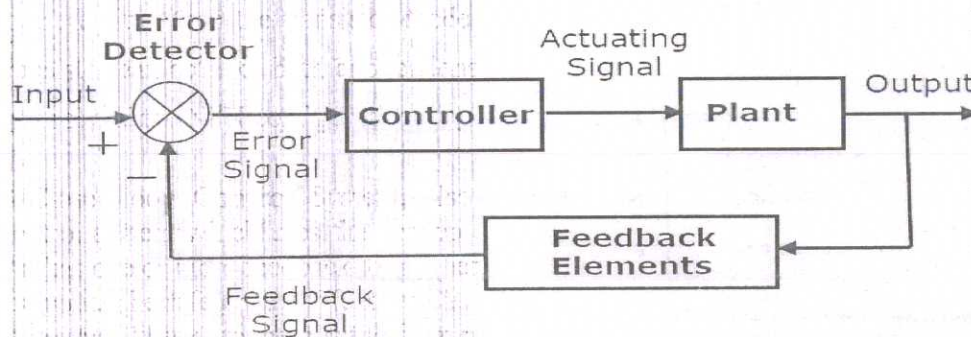
7

and the negative supply to the emitter terminal with a resistor either the emitter or collector or emitter circuit. To the base terminal the voltage is applied and it operated as an ONN/OFF state of a transistor. The transistor is in OFF state when the base voltage is same as the emitter. If the base voltage is increased with respect to the emitter then the transistor mode is in ON state. By using this condition the transistor can act like both applications which are amplifier and switch. The basic symbol and the NPN configuration diagram as shown below.

b.

A **Closed-loop Control System**, also known as a *feedback control system* is a control system which uses the concept of an open loop system as its forward path but has one or more feedback loops (hence its name) or paths between its output and its input. The reference to "feedback", simply means that some portion of the output is returned "back" to the input to form part of the systems excitation.

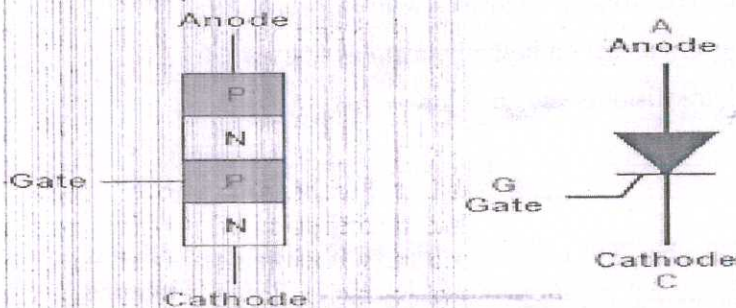
Closed-loop systems are designed to automatically achieve and maintain the desired output condition by comparing it with the actual condition. It does this by generating an error signal which is the difference between the output and the reference input. In other words, a "closed-loop system" is a fully automatic control system in which its control action being dependent on the output in some way.



This sensor would monitor the actual dryness of the clothes and compare it with (or subtract it from) the input reference. The error signal (error = required dryness - actual dryness) is amplified by the controller, and the controller output makes the necessary correction to the heating system to reduce any error. For example if the clothes are too wet the controller may increase the temperature or drying time. Likewise, if the clothes are nearly dry it may reduce the temperature or stop the process so as not to overheat or burn the clothes, etc.

X
a.

Silicon Controlled Rectifier (SCR)



Thyristor (SCR) Structure & Symbol

2
2
2
8
2
3

The silicon controlled rectifier (SCR) is a three terminal semiconductor switching device which can be used as a controlled switch to perform various functions such as rectification, inversion and regulation of power flow.

An SCR can handle currents upto several thousand amperes and voltages upto more than 1kV.

The SCR has appeared in the market under different names such as thyristor, thyrode transistor.

Like the diode, SCR is a unidirectional device,i.e. it will only conduct current in one direction only, but unlike a diode, the SCR can be made to operate as either an open-circuit switch or as a rectifying diode depending upon how its gate is triggered.

In other words, SCR can operate only in the switching mode and cannot be used for amplification.

Hence, it is extensively used in switching d.c. and a.c., rectifying a.c. to give controlled output, converting d.c. into a.c. etc.

Constructional Details of SCR

When a pn junction is added to a junction transistor, the resulting three pn junctions device is called a silicon controlled rectifier.

Three terminals are taken; one from the outer p-type material called anode A, second from the outer layer of n-type material called cathode K and the third from the base of transistor section and is called gate G.

b. APPLICATIONS OF CONTROL SYSTEM

1. Automatic Electric Iron – Heating elements are controlled by output temperature of the iron.
2. Servo Voltage Stabilizer – Voltage controller operates depending upon output voltage of the system.
3. Water Level Controller – Input water is controlled by water level of the reservoir.
4. Missile Launched and Auto Tracked by Radar – The direction of missile is controlled by comparing the target and position of the missile.
5. An Air Conditioner – An air conditioner functions depending upon the temperature of the room.
6. Cooling System in Car – It operates depending upon the temperature which it controls.
7. Automobile car assembling plant – starting and stopping of work.
8. Automatic door opening – sensing the persons and opening the doors at offices and malls.

1

1

1

1

1 X 8

1 mark each

7

8

QUESTION WISE ANALYSIS

COURSE: 3021- ELECTRICAL AND ELECTRONICS ENGINEERING

VERSION: 2015

Qn No.	Type of question	Module	Objective	Score	Time in minute
I 1	Generalizing	I	1.1.7. Flemings right hand rule	2	3
I 2	Evaluating	II	Application of DC motor.	2	3
I 3	Evaluating	III	MI and MC Instruments.	2	3
I 4	Generalizing	IV	Logic gates	2	3
I 5	Generalizing	III	Induction heating.	2	3
II 1	Synthesizing	I	Single phase & 3 phase systems.	6	11
II 2	Analyzing	II	DC motor - working	6	11
II 3	Applying	III	Dynamometer type wattmeter.	6	11
II 4	Generalizing	IV	Full wave rectifier	6	11
II 5	Analyzing	I	DC Generator - working	6	11
II 6	Applying	II	starter for motors	6	11
II 7	Inferring	IV	Universal gates.	6	11
III a	Synthesizing	I	Single phase AC Generator.	7	13
III b	Analyzing	I	Lead acid battery - working.	8	14

QUESTION WISE ANALYSIS

COURSE: 3021- ELECTRICAL AND ELECTRONICS ENGINEERING

VERSION: 2015

Qn No.	Type of question	Module	Objective	Score	Time in minute
IV a	Analyzing	I	DC generator - working	7	13
IV b	Evaluating	I	3 phase alternator.	8	14
V a	Generalizing	II	3 phase Induction motor	7	13
V b	Generalizing	II	3 point starter - working	8	14
VI a	Creating	II	Single phase Induction motor	7	13
VI b	Evaluating	II	Transformers - classification.	8	14
VII a	Evaluating	III	MI Instruments - working	7	13
VII b	Analyzing	III	Electric heating - applications.	8	14
VIII a	Inferring	III	MC Instrument - working	7	13
VIII b	Evaluating	III	Induction & Arc Furnace.	8	14
IX a	Creating	IV	BJT working.	7	13
IX b	Generalizing	IV	Closed loop control system.	8	14
X a	Generalizing	IV	SCR - working	7	13
X b	Inferring	IV	Control system - applications.	8	14

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VERSION: 2015

Sl No.	Module	Type of questions							
		Part A		Part B		Part C		Total	
		No.of Qns	Score	No.of Qns	Score	No.of Qns	Score	No.of Qns	Score
	I	1	2	2	12	4	30	7	44
	II	1	2	2	12	4	30	7	44
	III	2	4	1	6	4	30	7	40
	IV	1	2	2	12	4	30	7	44
	Total	5	10	7	42	16	120	28	172