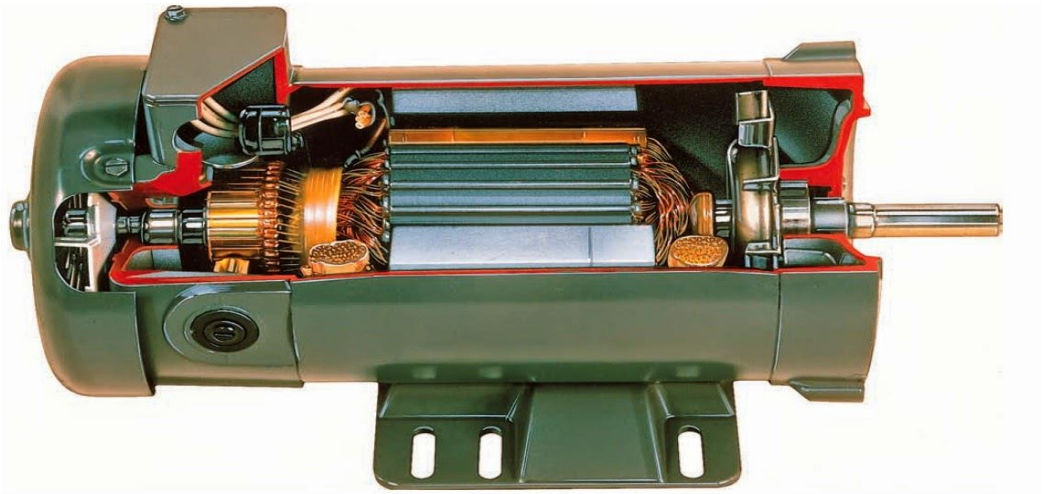
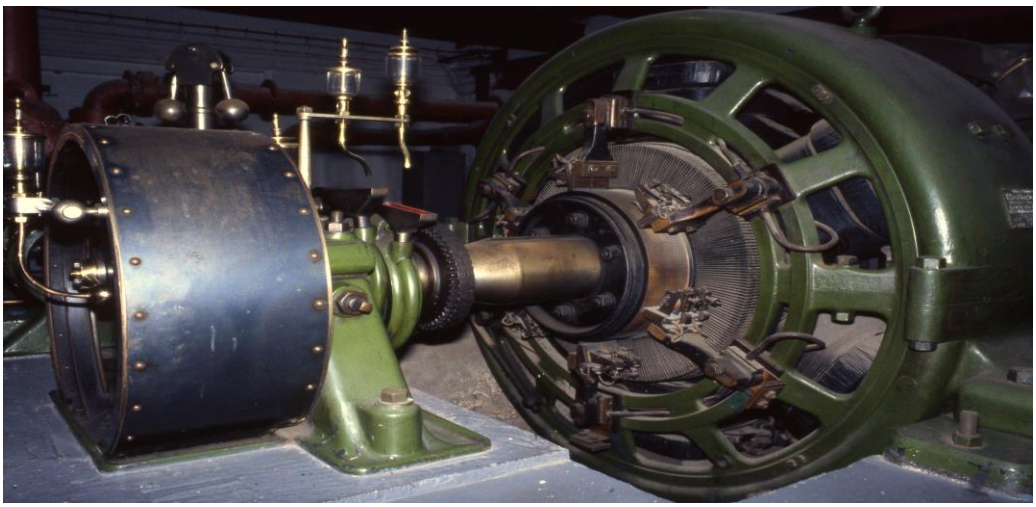
DC MACHINES & TRANSFORMERS LABORATORY

II B.Tech EEE-I Sem

STUDENT OBSERVATION RECORD



DC motor, field structure, and armature assembly. (Courtesy Reliance Electric Co.)



Department of Electrical and Electronics Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

DC MACHINES & TRANSFORMERS LAB MANUAL

Name:_____

H.T.No:_____

Year/Semester:_____

Department of Electrical and Electronics Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

VEMU INSTITUTE OF TECHNOLOGY

DEPT.OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF THE INSTITUTE

- To be a premier institute for professional education producing dynamic and vibrant force of technocrats with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

MISSION OF THE INSTITUTE

- To create a learning environment with state-of-the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.
- To facilitate the learners to foster innovative ideas, inculcate competent research and consultancy skills through Industry-Institute Interaction.
- To develop hard work, honesty, leadership qualities and sense of direction in rural youth by providing value based education.

VISION OF THE DEPARTMENT

- To produce professionally deft and intellectually adept Electrical and Electronics Engineers and equip them with the latest technological skills, research & consultancy competencies along with social responsibility, ethics, Lifelong Learning and leadership qualities.

MISSION OF THE DEPARTMENT

- To produce competent Electrical and Electronics Engineers with strong core knowledge, design experience & exposure to research by providing quality teaching and learning environment.
- To train the students in emerging technologies through state - of - the art laboratories and thus bridge the gap between Industry and academia.
- To inculcate learners with interpersonal skills, team work, social values, leadership qualities and professional ethics for a holistic engineering professional practice through value based education.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

Programme Educational Objectives (PEOs) of B.Tech (Electrical and Electronics Engineering) **program are:**

Within few years of graduation, the graduates will

PEO 1: Provide sound foundation in mathematics, science and engineering fundamentals to analyze, formulate and solve complex engineering problems.

PEO 2: Have multi-disciplinary Knowledge and innovative skills to design and develop Electrical & Electronics products and allied systems.

PEO 3: Acquire the latest technological skills and motivation to pursue higher studies leading to research.

PEO 4: Possess good communication skills, team spirit, ethics, modern tools usage and the life-long learning needed for a successful professional career.

PROGRAM OUTCOMES (POs)

PO-1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO-4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO-9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO-11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On completion of the B.Tech. (Electrical and Electronics Engineering) degree, the graduates will be able to

PSO-1: Higher Education: Apply the fundamental knowledge of Mathematics, Science, Electrical and Electronics Engineering to pursue higher education in the areas of Electrical Circuits, Electrical Machines, Electrical Drives, Power Electronics, Control Systems and Power Systems.

PSO-2: Employment: Get employed in Public/Private sectors by applying the knowledge in the domains of design and operation of Electronic Systems, Microprocessor based control systems, Power systems, Energy auditing etc.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPURAM

(20A02302P) DC MACHINES & TRANSFORMERS LABORATORY

COURSE OUTCOMES

C220.1	Able to conduct and analyze load test on DC shunt generators
C220.2	Able to understand and analyze magnetization characteristics of DC shunt generator
C220.3	Able to understand and analyze speed control techniques and efficiency of DC machines
C220.4	Able to understand to predetermine efficiency and regulation of single phase Transformers

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPURAM

B.Tech II - I Sem (E.E.E)

(20A02302P) DC MACHINES & TRANSFORMERS LABORATORY

OBJECTIVES:

To conduct various experiments on
- DC motors and DC Generators
- The speed control techniques of DC motors.
- To conduct various experiments for testing on 1-phase transformers

The following experiments are required to be conducted as compulsory experiments:

1. Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.
2. Load test on DC shunt generator. Determination of characteristics.
3. Brake test on DC shunt motor. Determination of performance curves.
4. Swinburne's test on DC shunt motor, Predetermination of efficiency.
5. Speed control of DC shunt motor (Armature control and Field control method).
6. Hopkinson's tests on DC shunt machines. Predetermination of efficiency.
7. OC and SC test on single phase transformer
8. Parallel operation of single phase transformers.
9. Sumpner's test on single phase transformers.
10. Load test on DC long shunt compound generator. Determination of characteristics.
11. Load test on DC short shunt compound generator. Determination of characteristics.
12. Separation of losses in DC shunt motor.

Note: Minimum ten experiments are required to be conducted as compulsory experiments:

Course Outcomes:

CO1Able to conduct and analyze load test on DC shunt generators
CO2 Able to understand and analyze magnetization characteristics of DC shunt generator
CO3Able to understand and analyze speed control techniques and efficiency of DC machines
CO4 Able to understand to predetermine efficiency and regulation of single phase Transformers

CONTENTS

DC MACHINES & TRANSFORMERS LAB

GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

DO'S

1. Without Prior permission do not enter into the Laboratory.
2. While entering into the LAB students should wear their ID cards.
3. The Students should come with proper uniform.
4. Students should sign in the LOGIN REGISTER before entering into the laboratory.
5. Students should come with observation and record note book to the laboratory.
6. Students should maintain silence inside the laboratory.
7. Circuit connections must be checked by the lab-in charge before switching the supply

DONT'S

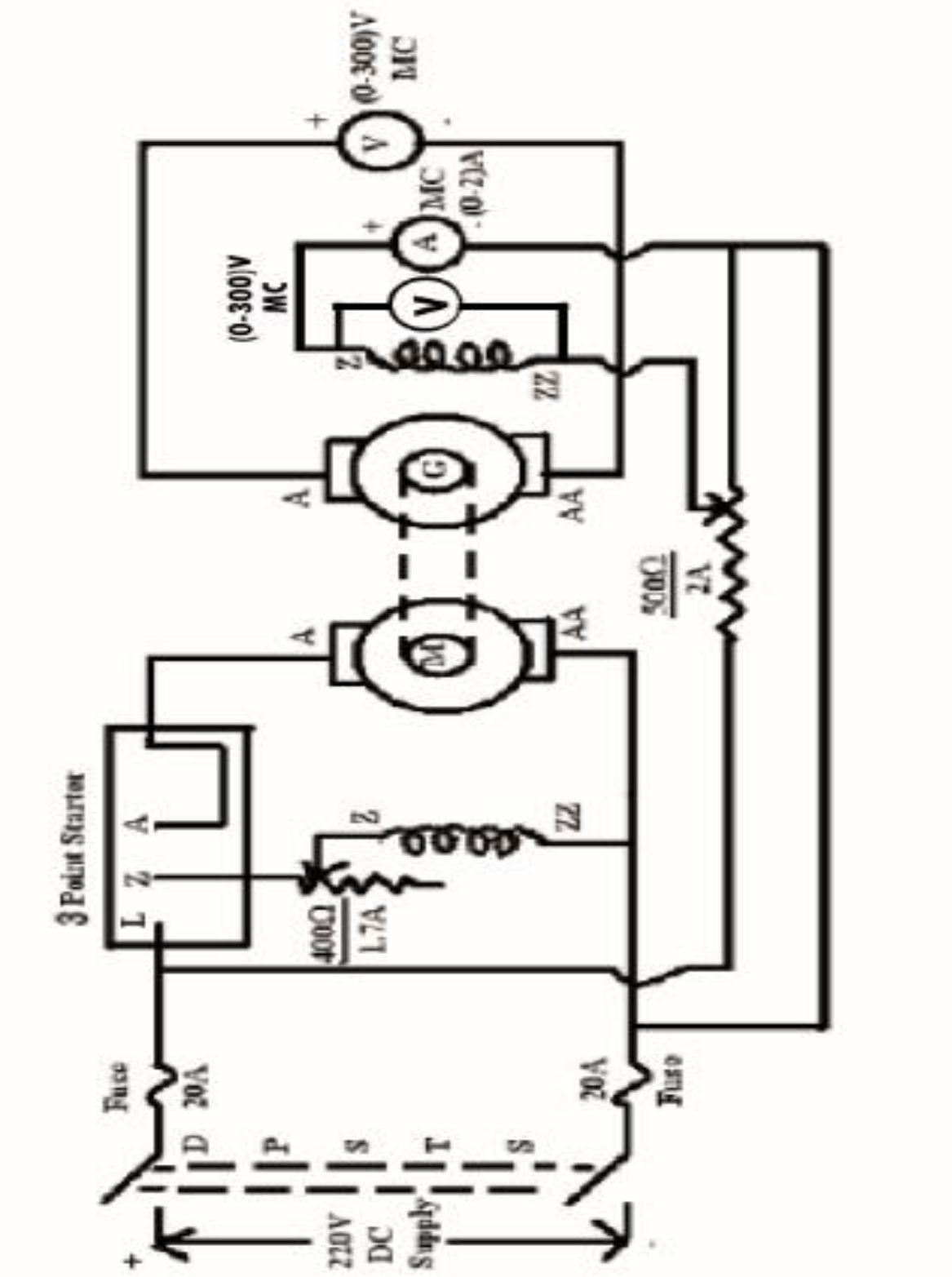
8. Students bringing the bags inside the laboratory..
9. Students wearing slippers/shoes insides the laboratory.
10. Students scribbling on the desk and mishandling the chairs.
11. Students using mobile phones inside the laboratory.
12. Students making noise inside the laboratory.
13. Students mishandle the devices.
14. Students write anything on the devices

SCHEME OF EVALUATION

S.No	Experiment name	Date	Marks Awarded				Total 30(M)
			Record (10M)	Observation (10M)	Viva Voce (5M)	Attendance (5M)	
1	MAGNETIZATION CHARACTERISTICS OF A D.C SHUNT GENERATOR						
2	LOAD TEST ON D.C SHUNT GENERATOR						
3	BRAKE TEST ON D.C SHUNT MOTOR						
4	SWINBURNE'S TEST						
5	SPEED CONTROL OF A D.C SHUNT MOTOR						
6	HOPKINSON'S TEST ON DC SHUNT MACHINES						
7	O.C & S.C TESTS ON 1-Ø TRANSFORMER						
8	SUMPNER'S TEST						
9	LOAD TEST ON D.C COMPOUND GENERATOR						
10	SEPARATION OF LOSSES IN A D.C SHUNT MOTOR						
Additional Experiments							
11	FIELD'S TEST						
12	RETARDATION TEST ON DC SHUNT MOTOR						

Signature of Lab In-charge

CIRCUIT DIAGRAM:



EXP.NO:01 **DATE:**

MAGNETIZATION CHARACTERISTICS OF A D.C SHUNT GENERATOR

Aim: To find critical field resistance of a separately excited D.C generator from its open circuit characteristics.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
2	Ammeter	(0-2)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	1
		500Ω/2A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Motor field rheostat must be kept in minimum resistance position.
2. Potential Divider must be kept in maximum resistance position.
3. Starter arm must be in OFF position.

Procedure:

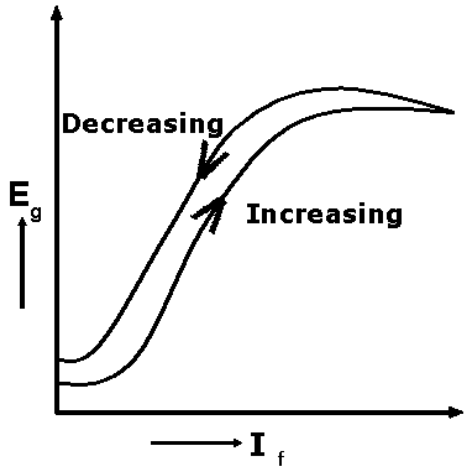
1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the Motor Generator set with the help of starter.
4. Adjust the speed of the Motor Generator Set to rated speed value by adjusting motor field rheostat.
5. Increase the excitation of the generator in steps by adjusting the potential divider and note down the corresponding voltmeter and ammeter readings.
6. Take the readings up to a value little higher than the rated voltage of the generator.

7. Again decrease the excitation in the same steps till field current is zero by adjusting the potential divider noting down the corresponding voltmeter and ammeter readings.
8. Observing the precautions switch OFF the supply.

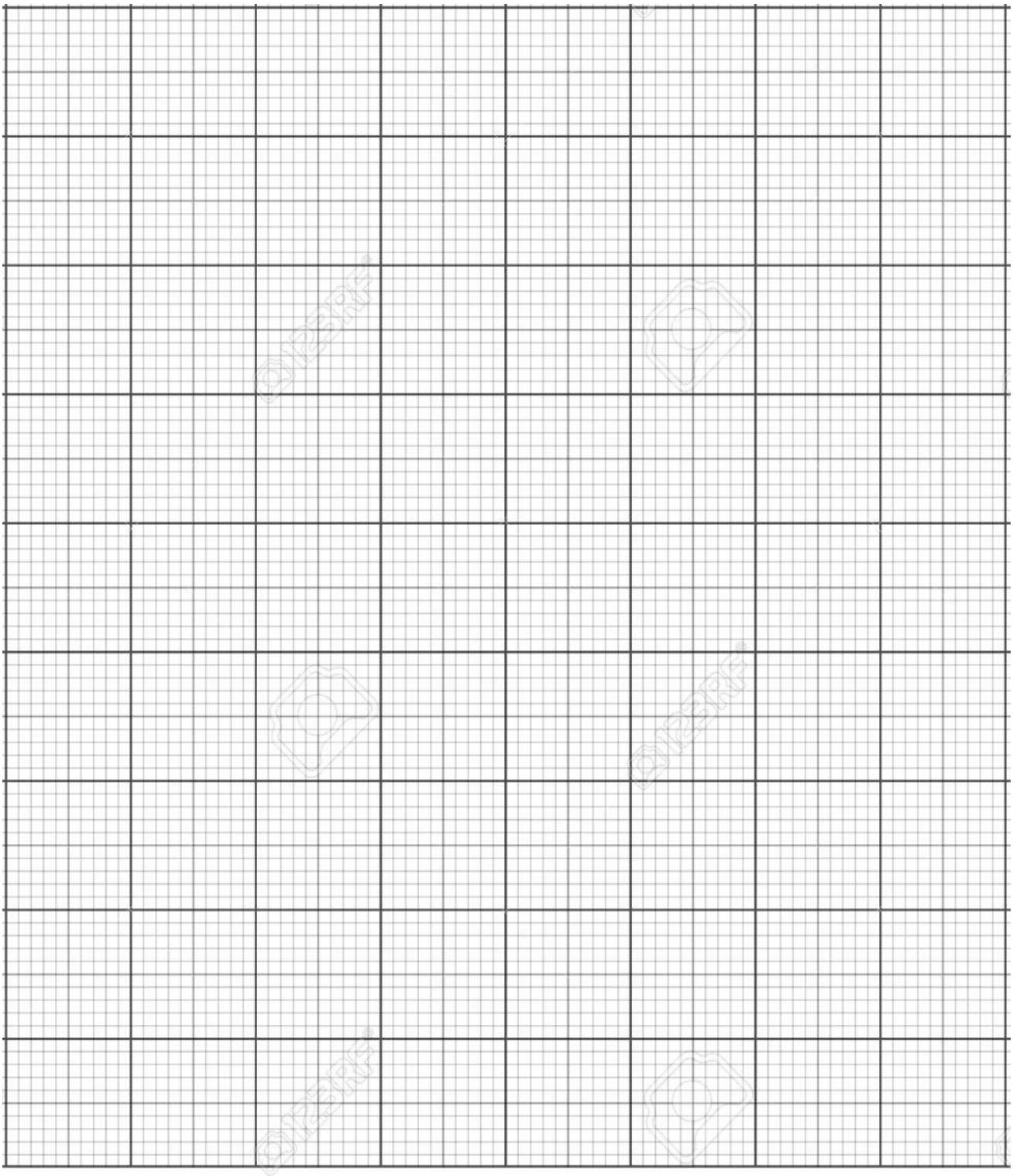
Tabular Column:

S. No.	I_f (A)	E_g (V) Increasing	E_g (V) Decreasing
1			
2			
3			
4			
5			
6			
7			
8			

Model Graph:



Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) Why the magnetization curve is a non linear curve?

2) What is critical Speed and Critical Resistance?

3) What are conditions to failure the self excitation?

4) What are the different methods of excitations?

5) Magnetization curves are also known as?

6) What are the characteristics of a dc generator?

7) What is Residual magnetism?

8) What is meant by magnetic saturation?

9) What is meant by the field flashing method?

10) What is meant by the residual voltage?

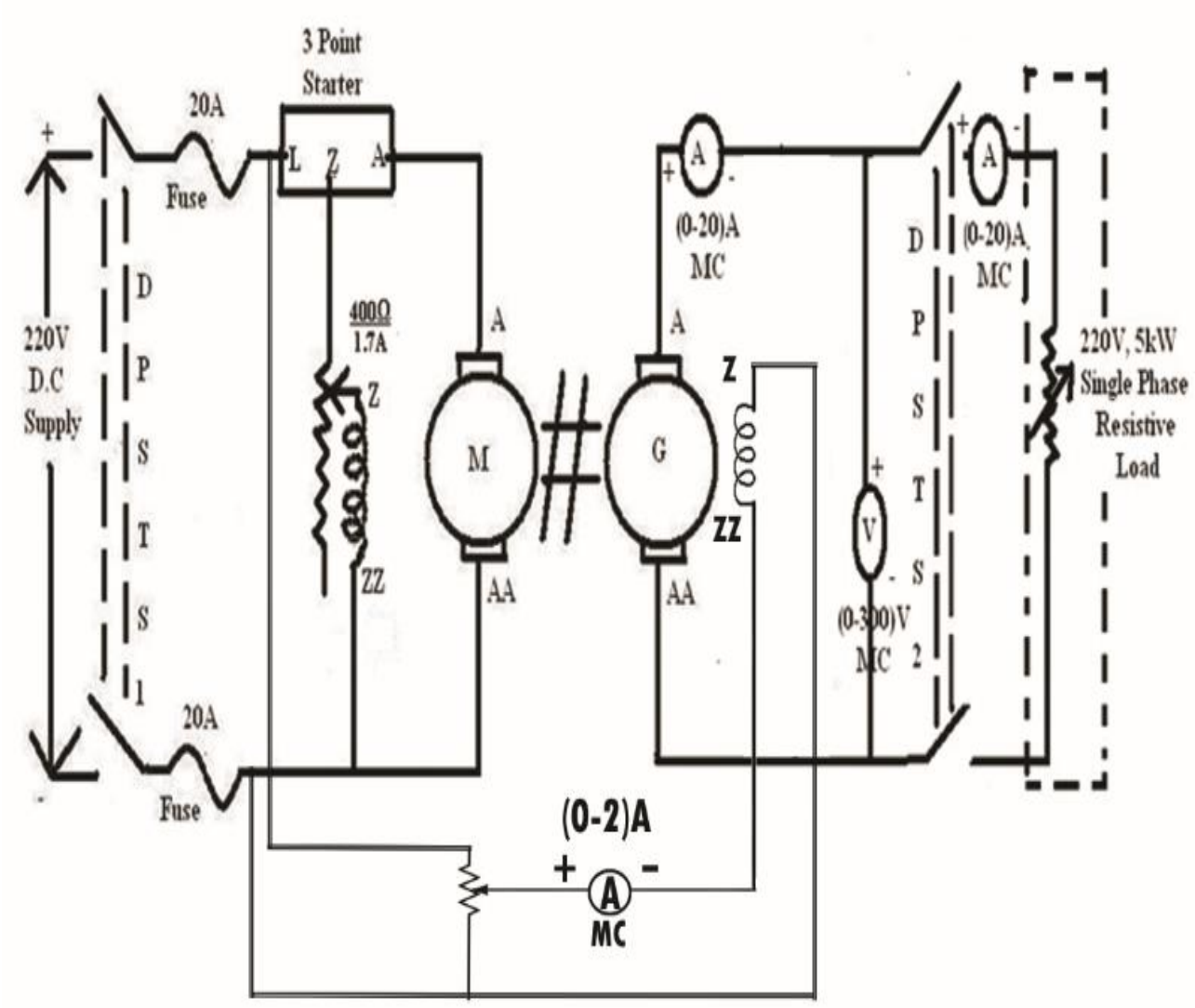
11) Why saturation curve for DC generator does not start with zero?

12) What is Open Circuit Characteristics of DC generator?

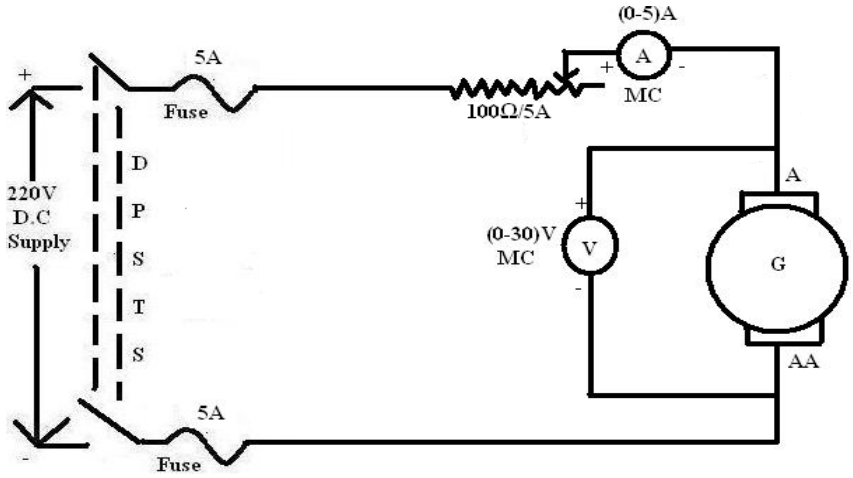
13) What are the different types of DC generators?

14) What are the characteristics of DC generators?

Circuit Diagram:



To find Armature Resistance of the Generator:



EXP.NO:02 **DATE:**

LOAD TEST ON D.C SHUNT GENERATOR

Aim: To conduct load test on a D.C Shunt Generator and to determine the internal and external characteristics.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
		(0-30)V	MC	1
2	Ammeter	(0-20)A	MC	2
		(0-5)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	2
		100Ω/5A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Field rheostat of the motor must be kept in minimum resistance position.
2. Field rheostat of the generator must be kept in maximum resistance position.
3. Armature rheostat of the generator must be kept in maximum resistance position.
4. DPST Switch on the generator side must be kept open.
5. Initially load must be in OFF position.
6. Starter arm must be in OFF position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the motor-generator set with the help of starter.
4. Adjust the motor field rheostat and bring the motor to its rated speed and by varying the field rheostat of the generator apply the rated voltage of the load and close the DPSTS2 switch.
5. Now load the generator in steps till maximum rated current of the generator and note down all the meter readings.
6. Observing the precautions switch OFF the supply.

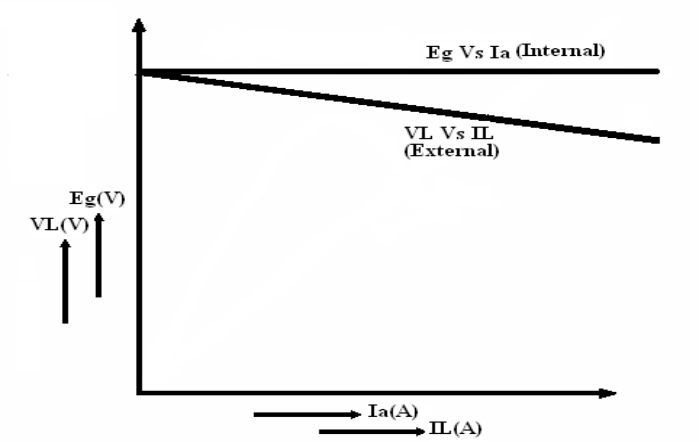
Tabular Columns:

S. No.	V (V)	I_L (A)	I_f (A)	$I_a = I_L + I_f$ (A)	$E_g = V + I_aR_a$ (V)
1					
2					
3					
4					
5					
6					

To find Armature Resistance of the Generator:

S.No.	I_a (A)	V_a (V)	R_a (Ω)
1			
2			

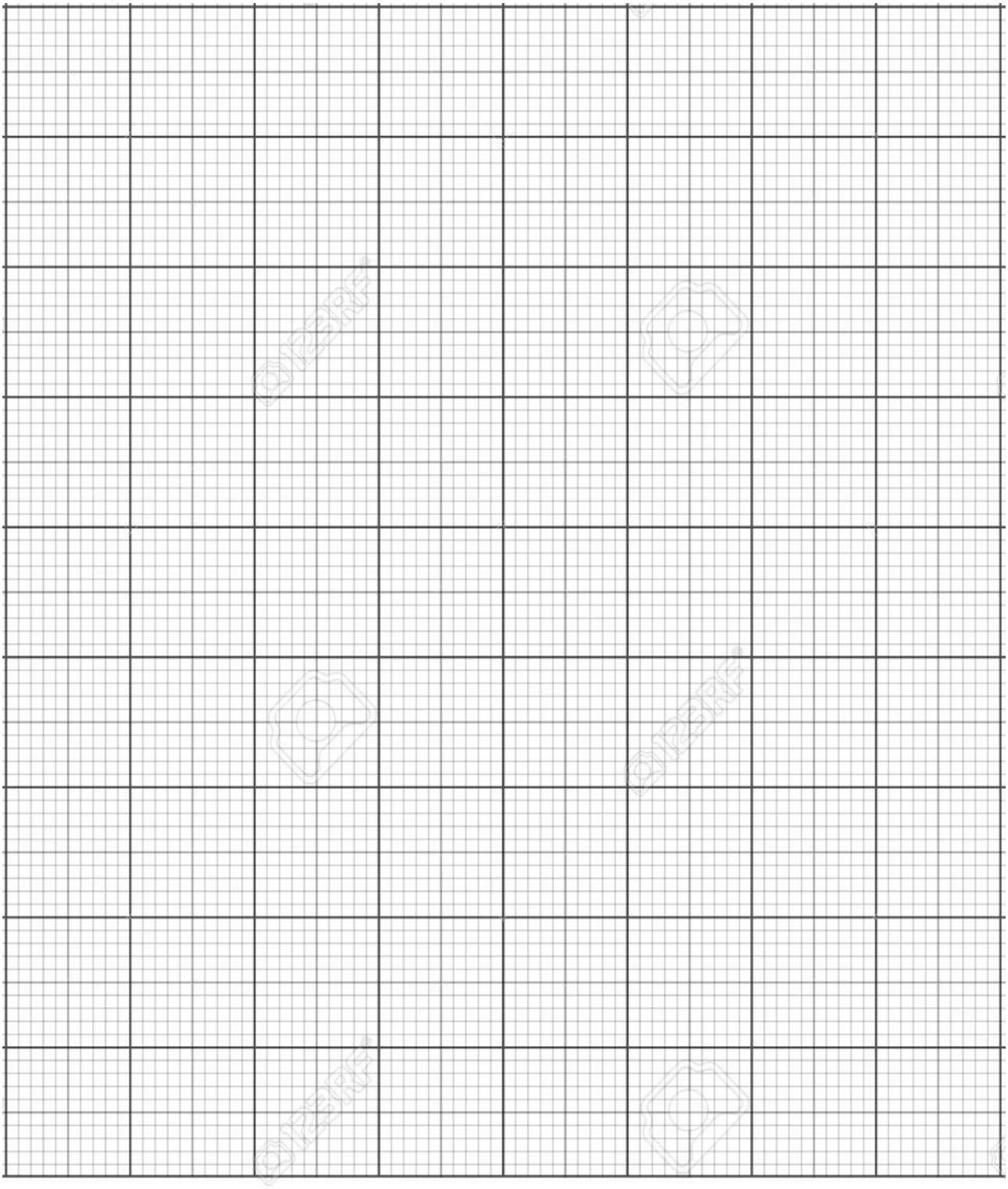
Model Graph:



To find Armature Resistance of the Generator:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat note down all the meter readings.
4. Observing the precautions switch OFF the supply.

Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What is no load voltage of Dc shunt Generator?

2) What is meant DC shunt generator?

3) What is rated current of Dc shunt Generator?

4) What is the field current of DC shunt generator?

5) What versus we can draw internal characteristics of Dc shunt Generator?

6) What are the applications of DC shunt Generator?

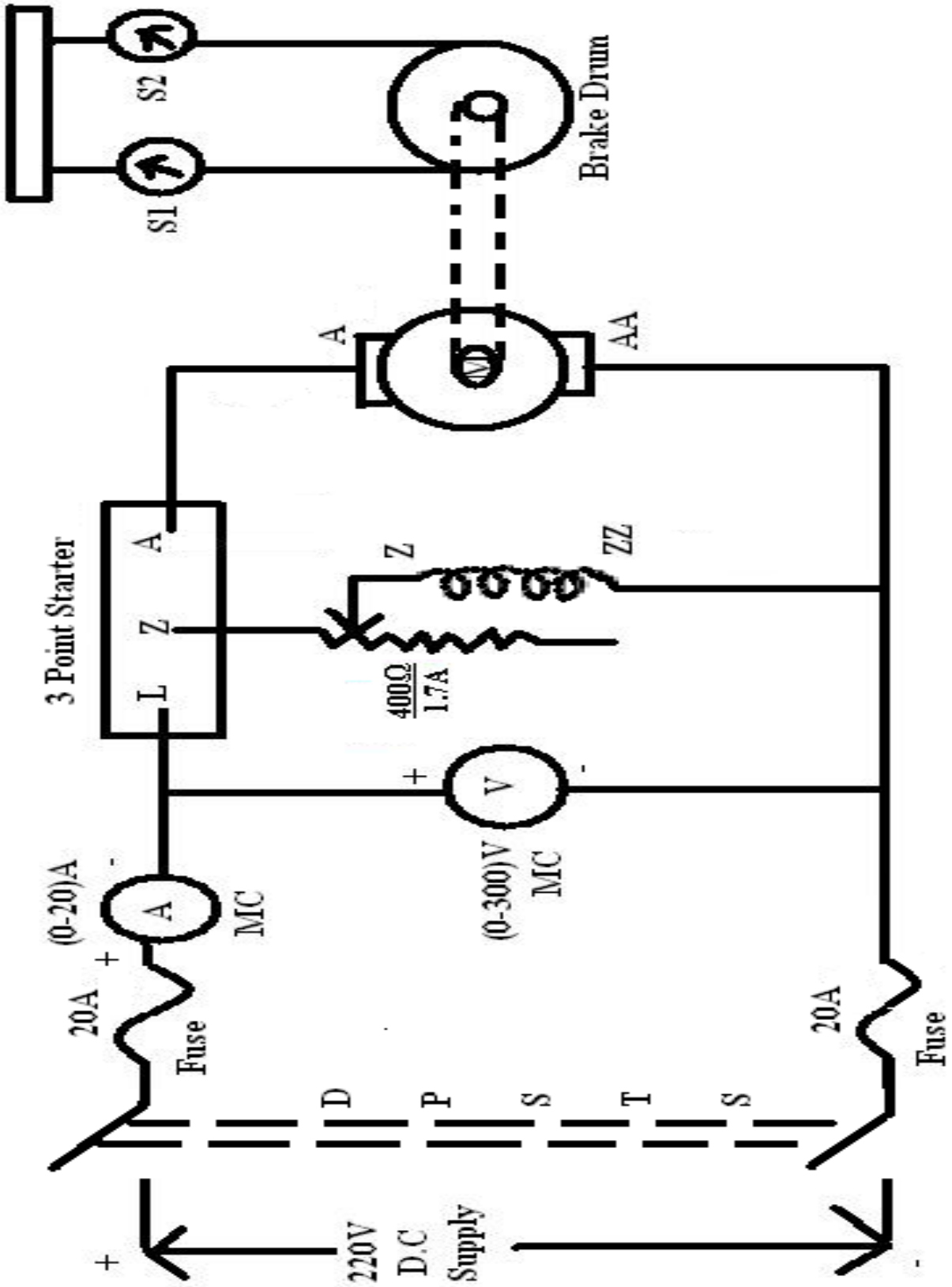
7) What versus we can draw internal characteristics of Dc shunt Generator?

8) Why the Dc shunt Generator having drooping nature of characteristics?

9) What is armature reaction of Dc shunt Generator?

10) Why the armature reaction drop is very low?

Circuit Diagram:



EXP.NO:03 **DATE:**

BRAKE TEST ON D.C SHUNT MOTOR

Aim: To obtain the performance characteristics of D.C Shunt Motor by direct loading.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
2	Ammeter	(0-20)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Motor field rheostat must be kept in minimum resistance position.
2. Starter arm must be in OFF position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions switch ON 220V D.C supply.
3. Start the motor with the help of the starter.
4. By adjusting the motor field rheostat bring the motor to its rated speed.
5. Now load the motor in steps to its full load and note down all the meter readings.
6. Observing the precautions switch OFF the supply.

Tabular Column:

S. No.	V_L (V)	I_L (A)	N (rpm)	Spring Balance Reading			Torque (N-m)	Input (kW)	Output (kW)	ŋ (%)
				S_1	S_2	S_1-S_2				
1										
2										
3										
4										
5										
6										

Formulae:

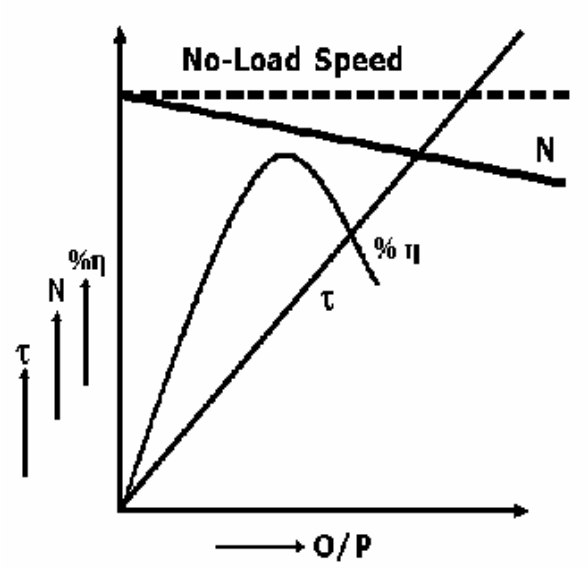
Torque = 9.81 X (S_1-S_2) X R N-m

Input = V_L I_L kW

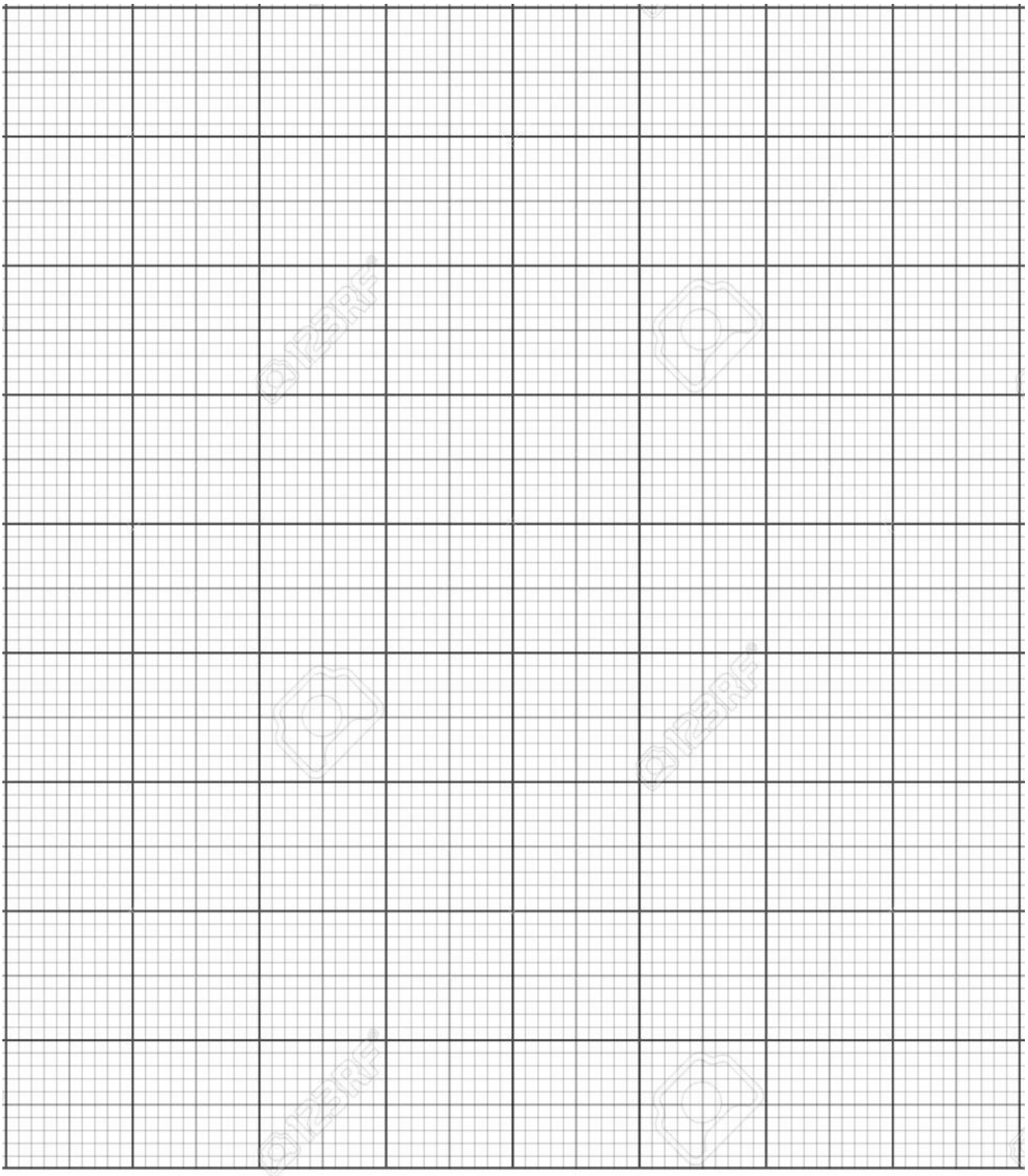
Output = (2∏N)τ/60 kW

Efficiency = ŋ % = (Output/Input) X 100

Model Graph:



Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What is the principle operation of DC motor?

2) What is the Range of Shunt field Resistance?

3) What is no load current of Dc shunt motor?

4) How the Direction of a motor can be reversed?

5) What is Back emf or counter EMF?

6) Why the Shunt motor is called a constant speed motor?

7) What are the applications of DC shunt motor?

8) What is purpose of starter?

9) What meant by the DPDTS?

10) What is the output power the dc motor?

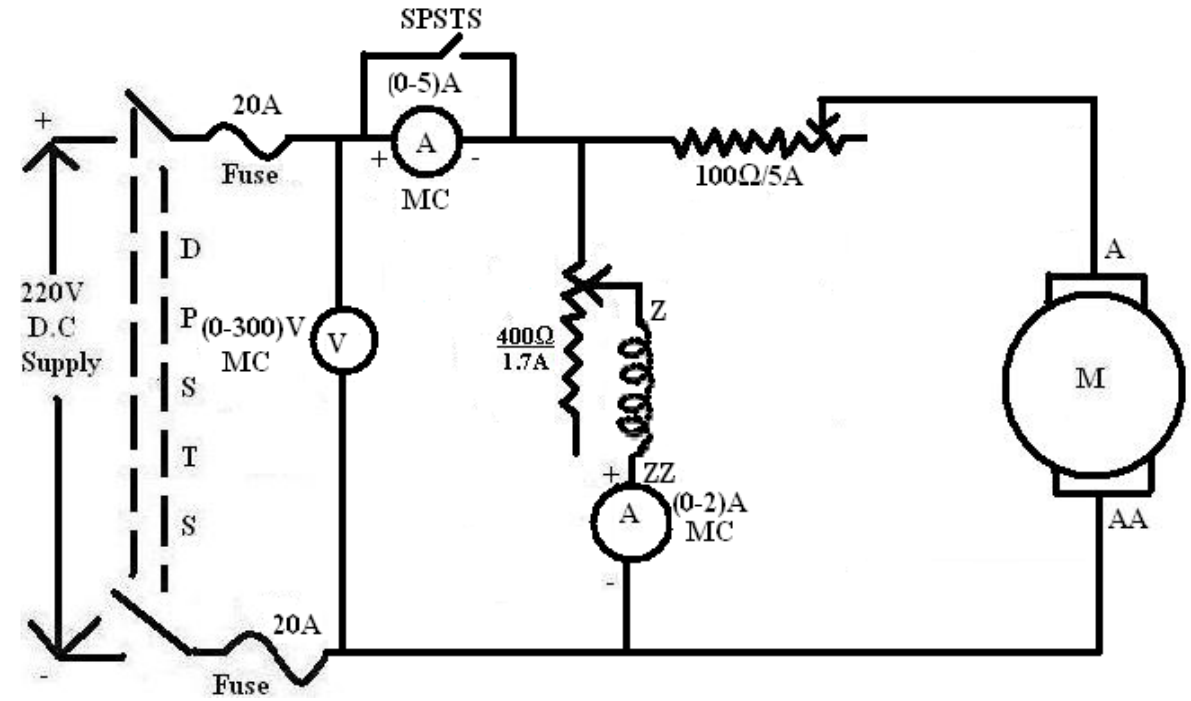
11) What is speed regulation of DC motor?

12) Explain principle of operation of DC motor?

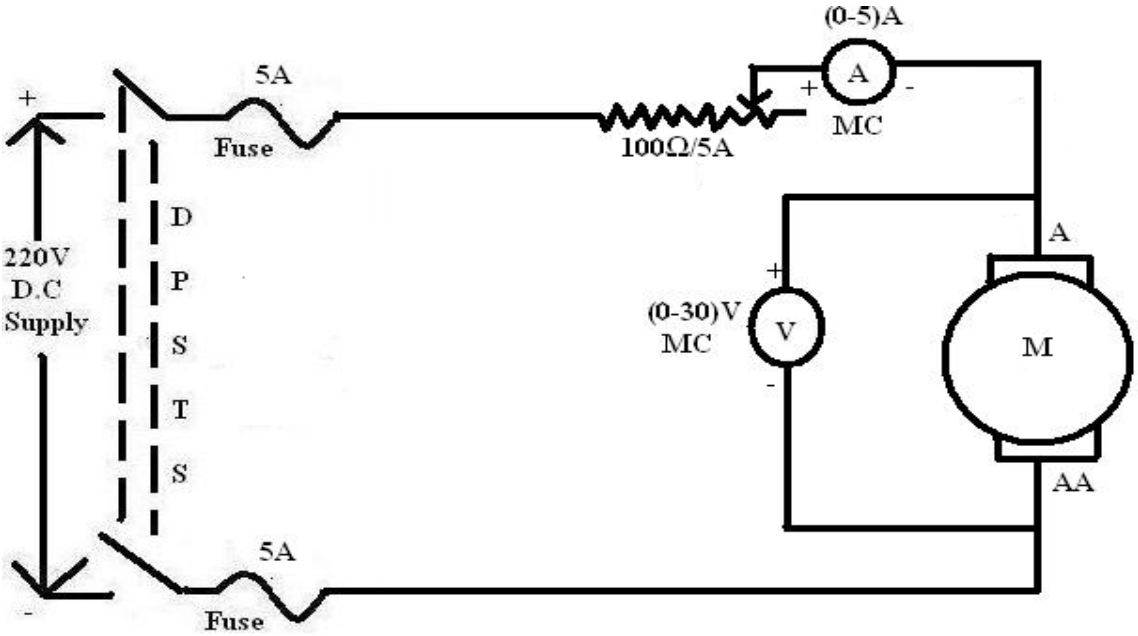
13) Why shunt motor field winding has more no of turns?

14) What happens when DC motor is connected across AC supply?

Circuit Diagram:



Armature Resistance:



EXP.NO:04 **DATE:**

SWINBURNE'S TEST

Aim: To predetermine the efficiency of a D.C Shunt Machine when run both as generator and motor.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
		(0-30)V	MC	1
2	Ammeter	(0-5)A	MC	1
		(0-2)A	MC	1
3	SPSTS	-	Knife	1
4	Rheostat	400Ω/1.7A	Wire Wound	1
		100 Ω/5A	Wire Wound	1
5	Tachometer	(0-9999)rpm	Digital	1
6	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Field rheostat must be kept in minimum resistance position.
2. Armature rheostat must be kept in maximum resistance position.
3. SPST Switch must be kept in closed position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Adjust the speed of motor to its rated value by adjusting field and / or armature rheostat.
4. Now open the SPST Switch & note down all the meter readings.
5. Observing the precautions switch OFF the supply.

To find Armature Resistance:

1. Connect the circuit as shown in circuit diagram.
2. Keeping the rheostat in its maximum resistance position close the DPST Switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat for different values of current note down the meter readings.
4. Observing the precautions switch OFF the supply.

Tabular Columns:

S. No.	Supply Voltage (V)	Line Current I_L (A)	Shunt Current I_f (A)
1			

To find Armature Resistance:

S. No.	V_a (V)	I_a (A)	R_a (Ω)
1			
2			
3			

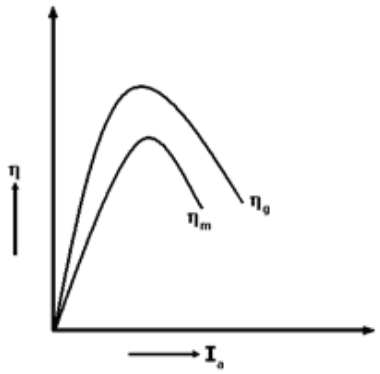
Machine when run as Motor:

S. No.	Voltage (V)	I_L (A)	I_f (A)	I_a (A)	Input (W)	W_{Cu} (W)	W_C (W)	Output (W)	ŋ (%)	W_T
1										
2										
3										
4										

Machine when run as Generator:

S. No.	Voltage (V)	I_L (A)	I_f (A)	I_a (A)	Input (W)	W_{Cu} (W)	W_C (W)	Output (W)	ŋ (%)	W_T
1										
2										
3										
4										

Model Graph:



Formulae:

Motor:

$I_a = I_L - I_f$

Input = $V_L I_L$

$W_C = V_L I_L - I_a^2 R_a$

$W_{Cu} = I_a^2 R_a$

$W_T = W_{Cu} + W_C$

Output = Input - W_T

η = (Output/Input) X 100

Generator:

$I_a = I_L + I_f$

Output = $V_L I_L$

$W_C = V_L I_L - I_a^2 R_a$

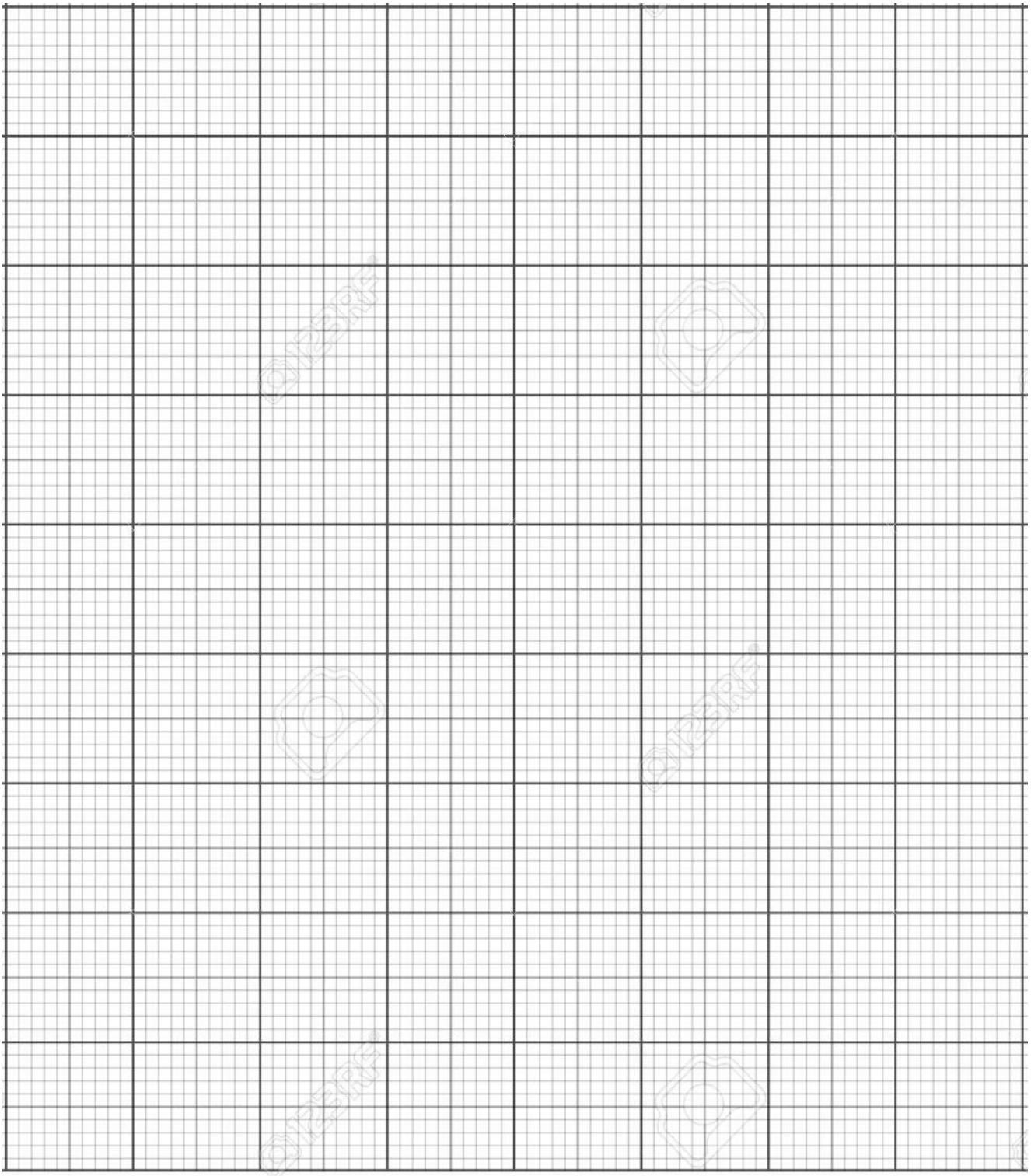
$W_{Cu} = I_a^2 R_a$

$W_T = W_{Cu} + W_C$

Input = Output + W_T

η = (Output/Input) X 100

Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What is the necessity of Swinburne's test?

2) Why this test is conducted on no load?

3) Why this test is not suitable for series machines?

4) Whether the test is a direct method or indirect method?

5) What are the advantages of Swinburne's test?

6) What is meant by the efficiency?

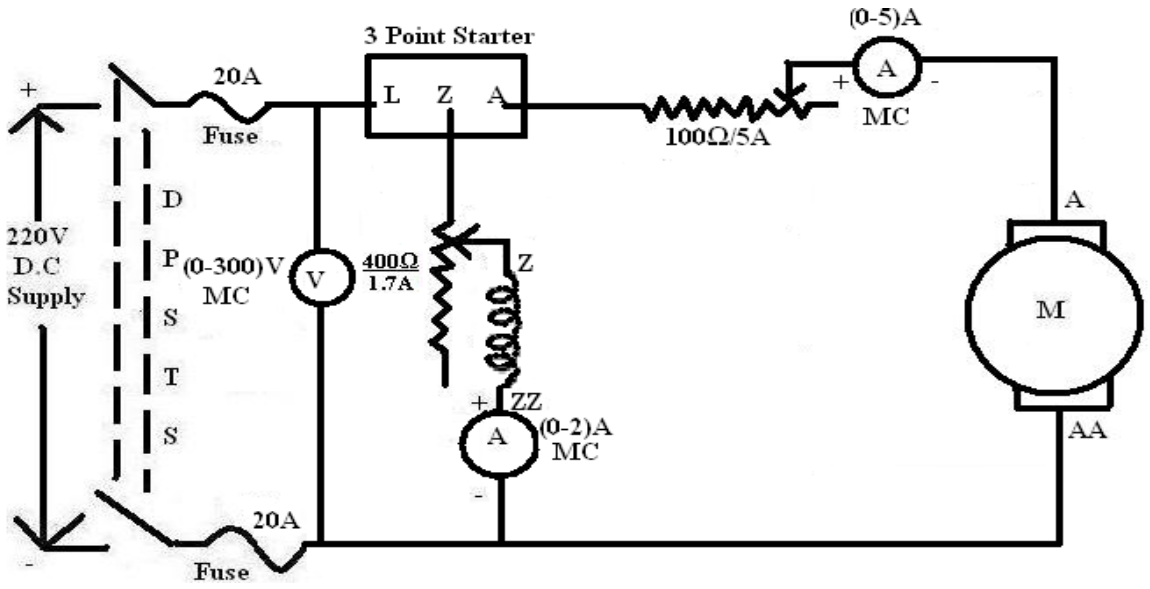
7) What is rated current of motor as well as generator of dc shunt machine?

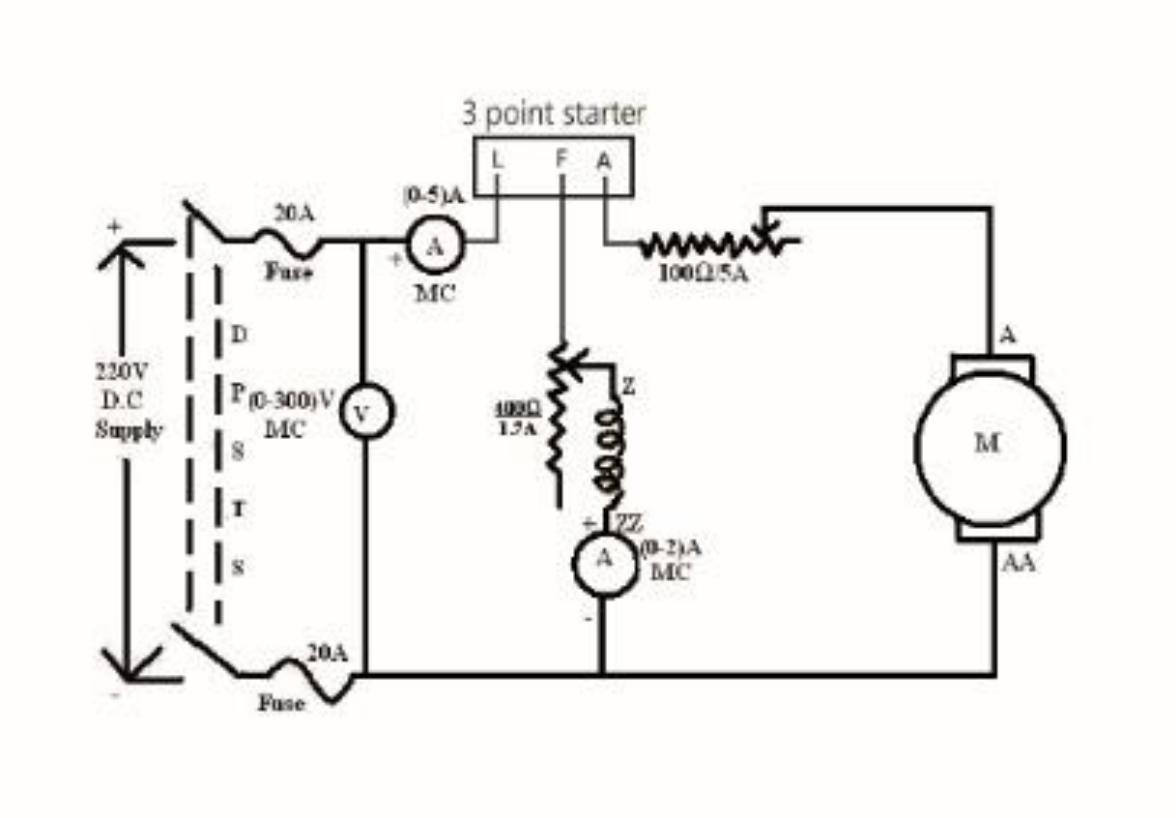
8) How do you estimate the half load efficiency?

9) How do you estimate the half load copper losses?

10) Explain Faradays Laws of Electro Magnetic Induction

Circuit Diagram:





EXP.NO:05 **DATE:**

SPEED CONTROL OF A D.C SHUNT MOTOR

Aim: To obtain the speed characteristics of D.C Shunt Motor by

1. Armature Controlled Method.
2. Field Controlled Method.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
2	Ammeter	(0-2)A	MC	1
		(0-5)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	1
		100 Ω/5A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Field rheostat must be kept in minimum resistance position.
2. Armature rheostat must be kept in maximum resistance position.
3. Starter arm must be in OFF position.

Procedure:
Armature Controlled Method:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions switch ON 220V D.C supply.
3. Start the motor with the help of starter.
4. By adjusting the field rheostat set the field current to a constant value.
5. By adjusting the armature rheostat for an armature voltage note down the speed and voltmeter readings.
6. Repeat step 5 for another constant field current.

Field Controlled Method:

1. By adjusting the armature rheostat set the voltage to a constant value.
2. By adjusting the field rheostat for a field current note down the speed and armature current readings.
3. Repeat the above step for another constant armature voltage.

Tabular Columns:
Armature Controlled Method:

Field Current=0.8A		**Field Current=0.6A**	
V_a (V)	**Speed (rpm)**	**V_a (V)**	**Speed (rpm)**

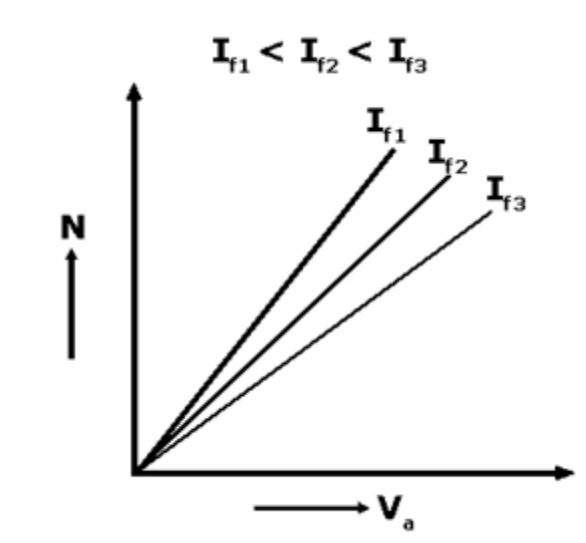
Field Controlled Method:

Armature Voltage=160V	**Armature Voltage=200V**

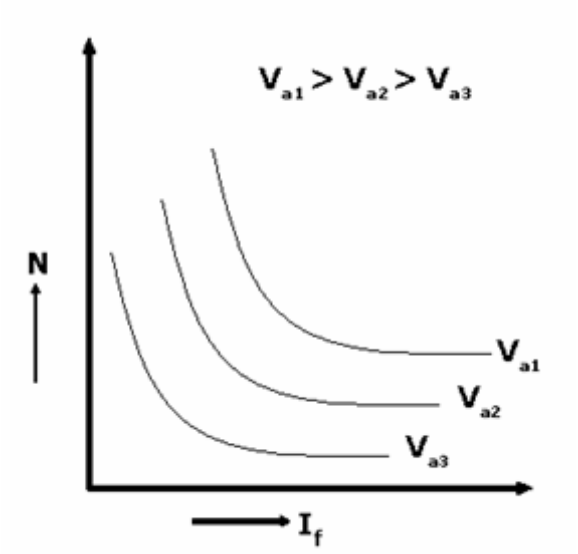
I_f (A)	Speed (rpm)	I_f (A)	Speed (rpm)

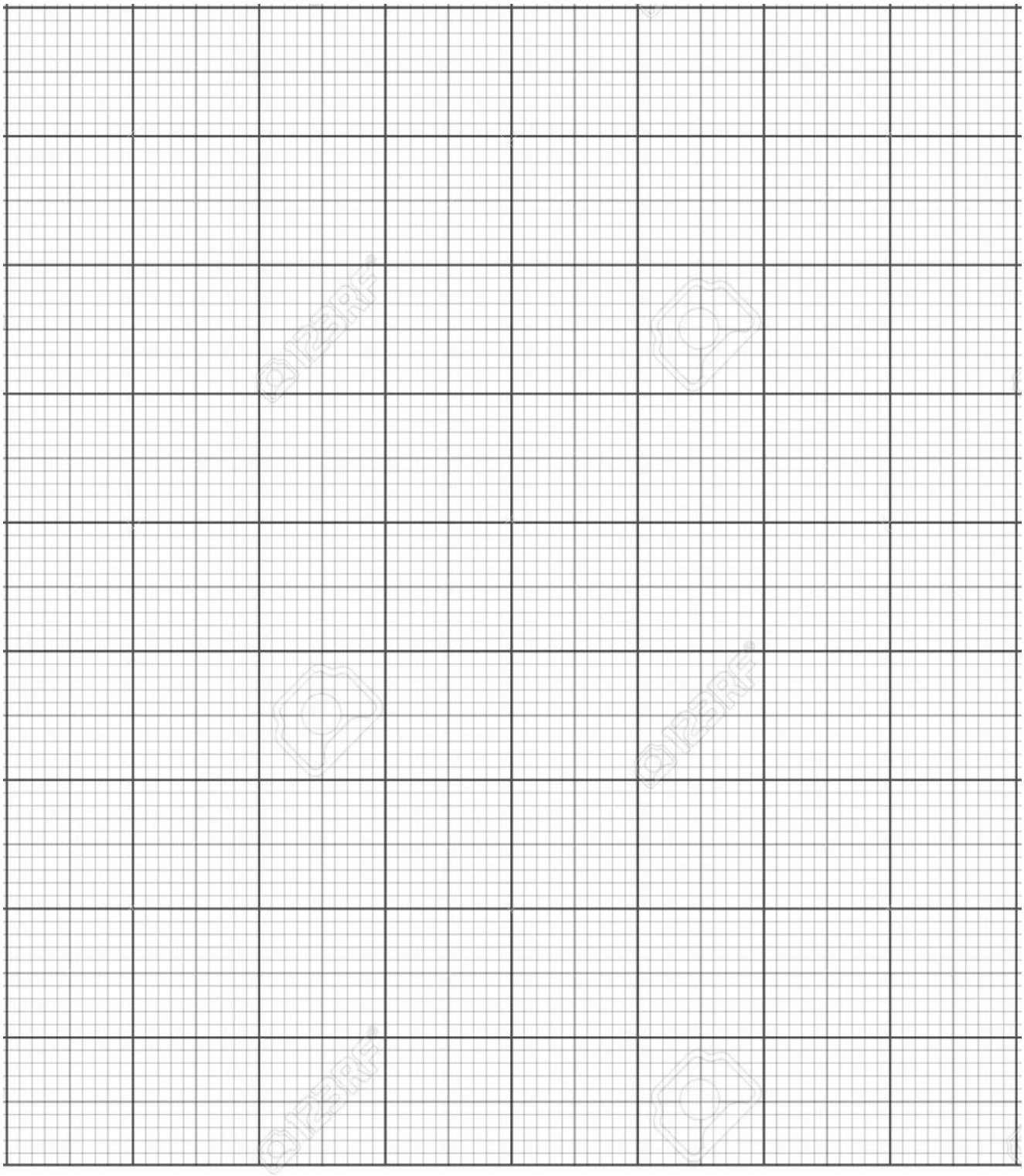
Model Graphs:

Armature Controlled Method:



Field Controlled Method:





Result:

VIVA VOICE QUESTIONS:

1) What is speed equation of DC shunt motor?

2) What is the no load speed of DC shunt motor?

3) What are the various speed control techniques of a dc motor?

4) Why DC shunt motor is called Constant speed motor?

5) What happens when the field of dc shunt motor gets open circuited during running condition?

6) Why field rheostat is kept minimum position at starting condition?

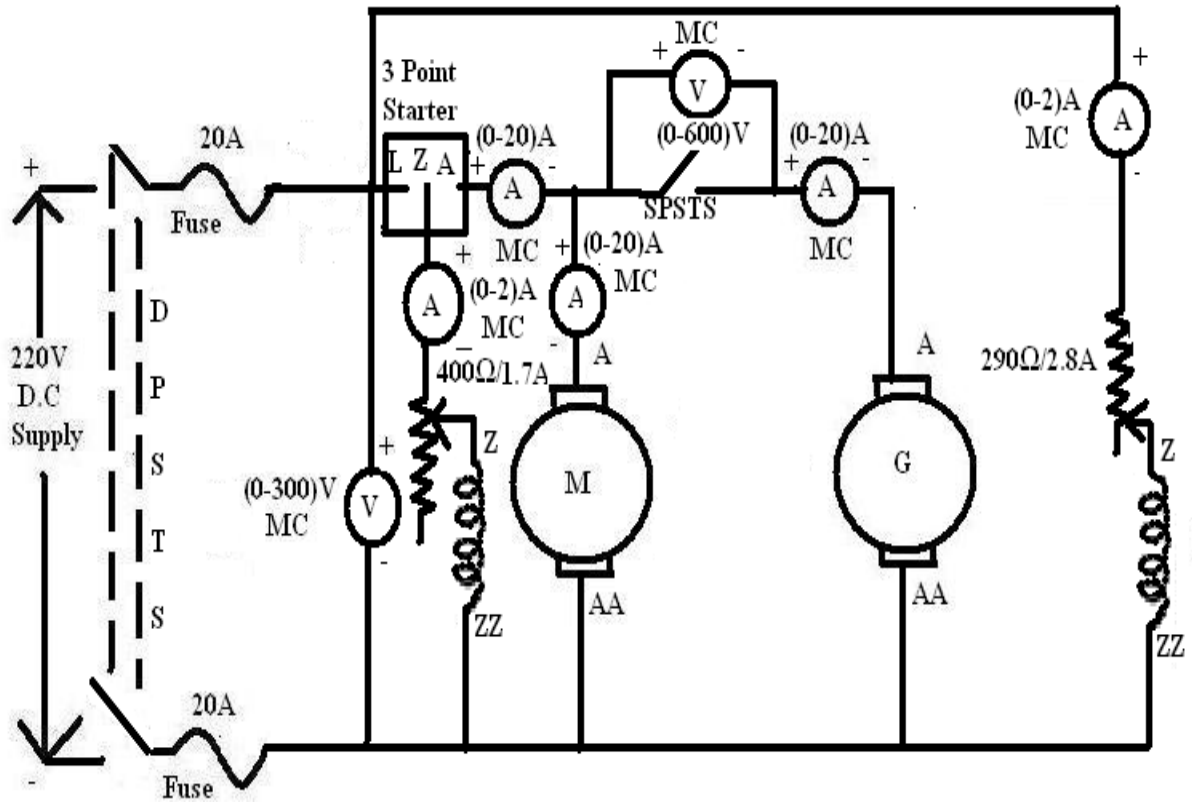
7) Which method we can obtain speed of motor is above its rated speed?

8) Which method we can obtain speed of motor is below its rated speed?

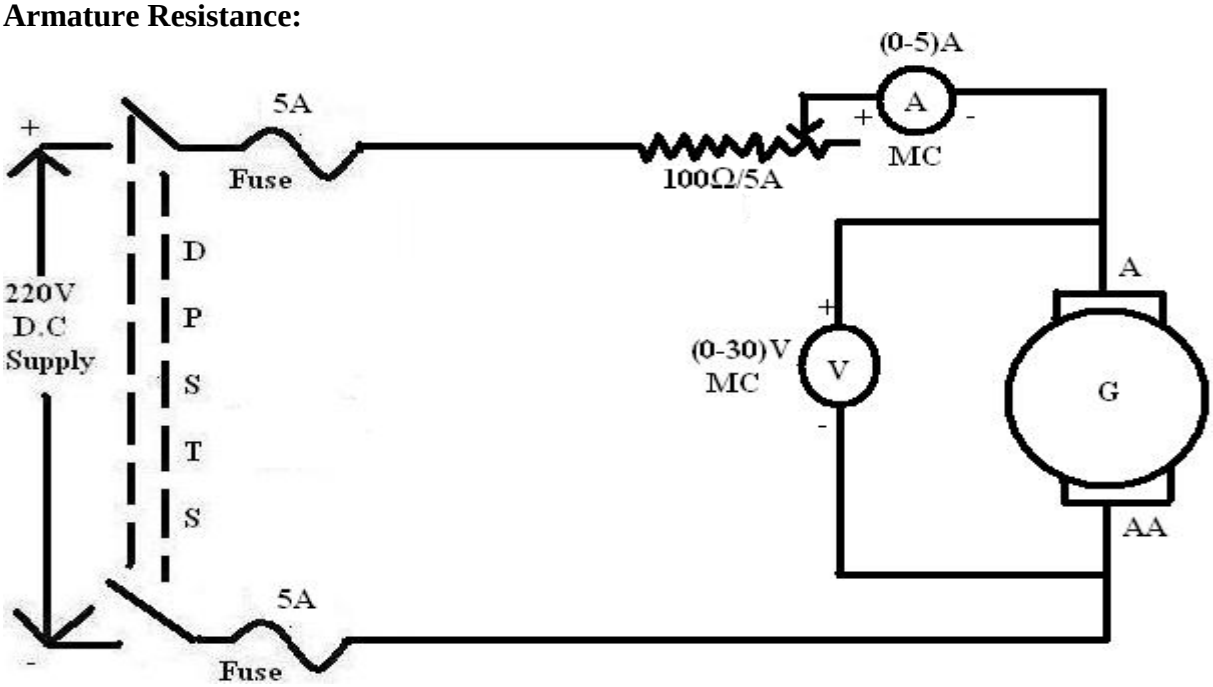
9) what versus we can draw speed curve field controlled method?

10) what versus we can draw speed curve armature controlled method?

Circuit Diagram:



Armature Resistance:



EXP.NO:06 **DATE:**

HOPKINSON'S TEST ON DC SHUNT MACHINES

Aim: To conduct a regenerative test on two identical mechanically coupled D.C shunt machines to determine the efficiency of each machine.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-600)V	MC	1
		(0-300)V	MC	1
		(0-30)V	MC	1
2	Ammeter	(0-20)A	MC	3
		(0-5)A	MC	1
		(0-2)A	MC	2
3	Rheostat	400Ω/1.7A	Wire Wound	1
		290Ω/2.8A	Wire Wound	1
		100Ω/5A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Field rheostat of the motor must be kept in minimum resistance position.
2. Field rheostat of the generator must be kept in maximum resistance position.
3. Armature rheostat of the generator must be kept in maximum resistance position.
4. Starter arm must be in OFF position.
5. SPST Switch must be kept open.

Procedure:

To Conduct Load Test:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the Motor Generator set with the help of starter.
4. Adjust the field rheostat of the motor and bring the Motor Generator set to its rated speed.
5. Adjust the field rheostat of the generator and bring the voltage across the SPST Switch to zero.
6. By using the field rheostat of the generator in steps note down all the meter readings till maximum rated current of any of the machine i.e., Motor or Generator.
7. Observing the precautions switch OFF the supply.

Tabular Columns:
For Motor:

V_L (V)	I_{fm} (A)	I_L (A)	I_{am} (A)	I_{ag} (A)	I_{fg} (A)	Losses W_{TL} (kW)	Output (kW)	Input (kW)	ŋ (%)

For Generator:

V_L (V)	I_1 (A)	I_2 (A)	I_3 (A)	I_4 (A)	I_5 (A)	Losses W_{TL} (kW)	Output (kW)	Input (kW)	ŋ (%)

To find Armature Resistance:

S. No.	V_a (V)	I_a (A)	R_a (Ω)
1			
2			
3			

To find Armature Resistance:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C supply.
3. By adjusting the rheostat for different values note down all the meter readings.
4. Observing the precautions switch OFF the supply.

Formula:

Generator:

Armature Copper Losses = $I_{ag}^2 R_a$

Stray Losses = $W_s = VI_L - (I_{am}^2 R_a + I_{ag}^2 R_a)$

Output = $I_{ag} V$

Input = Output + Losses

Total Losses = $\frac{W_S}{2} + I_{ag}^2 R_a + I_{fg} v_L$

Efficiency = ŋ % = (Output/Input) X 100

Motor:

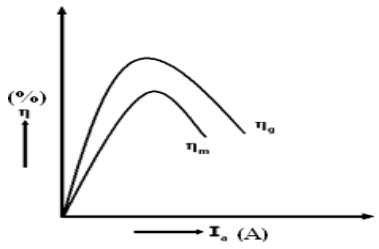
Total Losses = $\frac{W_S}{2} + I_{am}^2 R_a + I_{af} v$

Input = $V I_{am}$

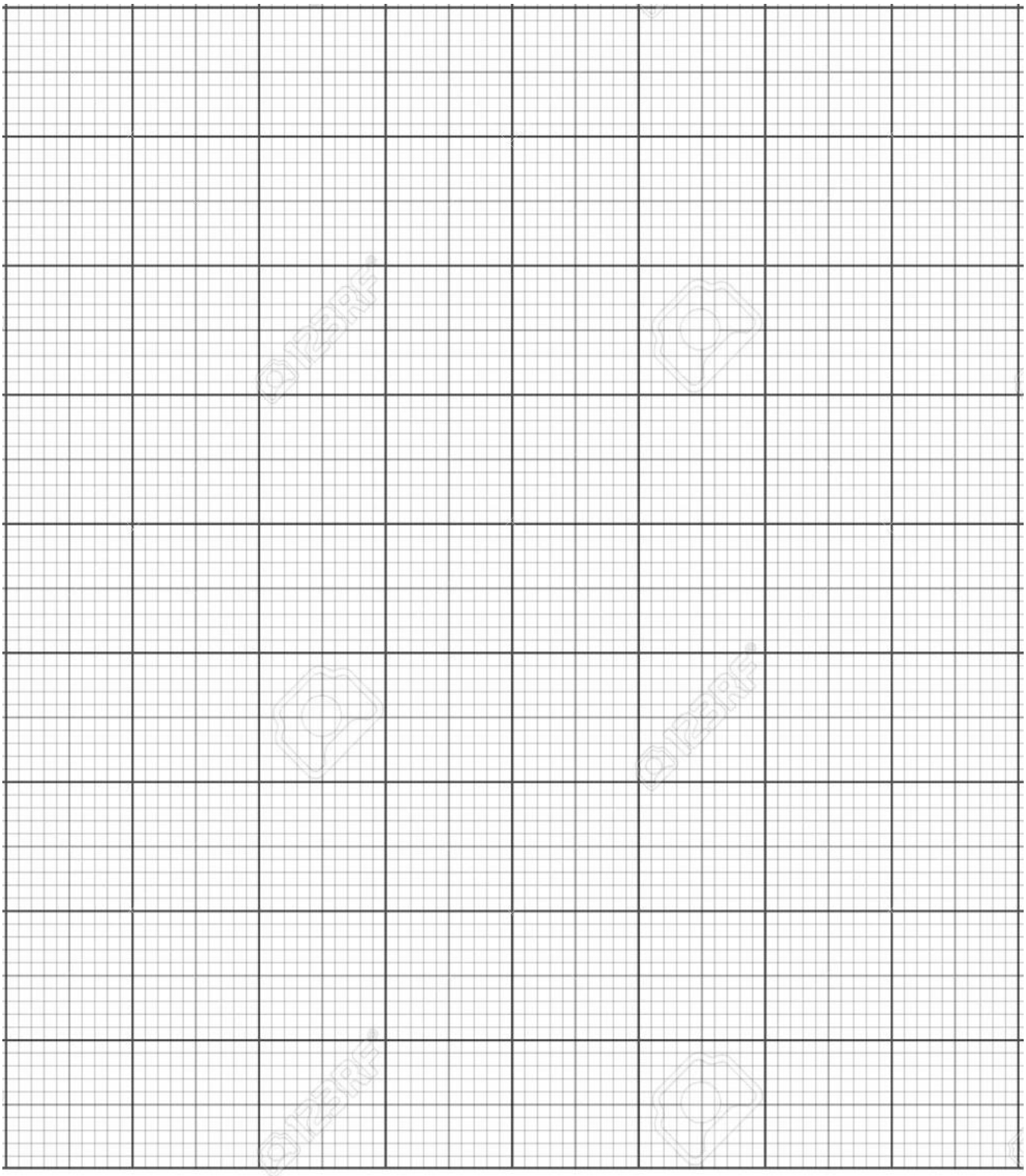
Output = Input – Losses

Efficiency = ŋ % = (Output/Input) X 100

Model Graph:



Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What are the other names of Hopkinson's test?

2) Why this test is conducted on two identical machines?

3) Why the energy is not sufficient to drive the motor from the generator?

4) What are the advantages and disadvantages of the test?

5) Why the test is called as regenerative test?

6) Why field rheostat of motor kept minimum position at starting condition?

7) Why field rheostat of generator kept maximum position at starting condition?

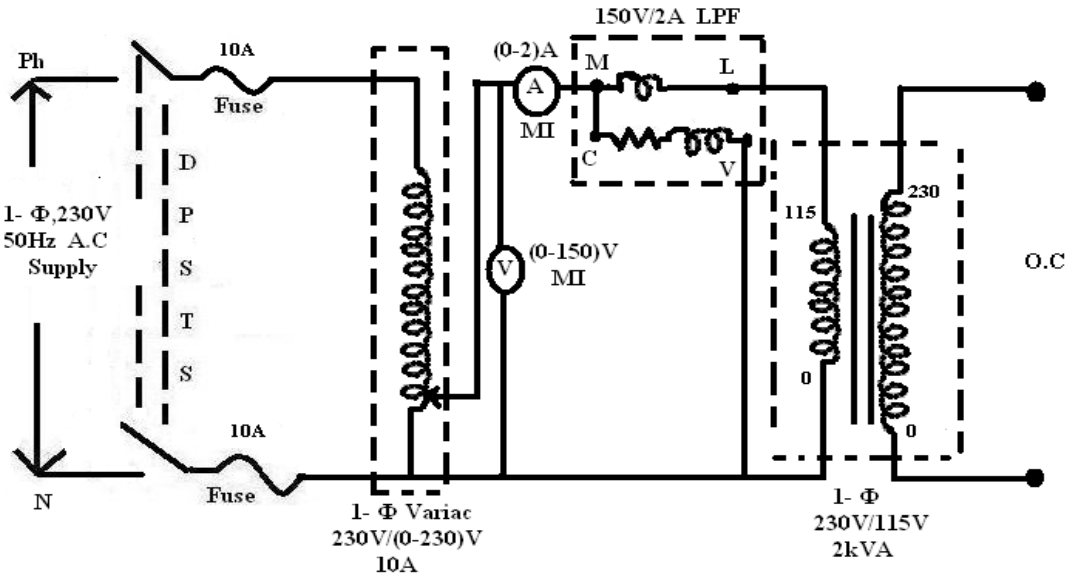
8)What are different types of testing of DC machines?

9) Difference between direct and indirect testing?

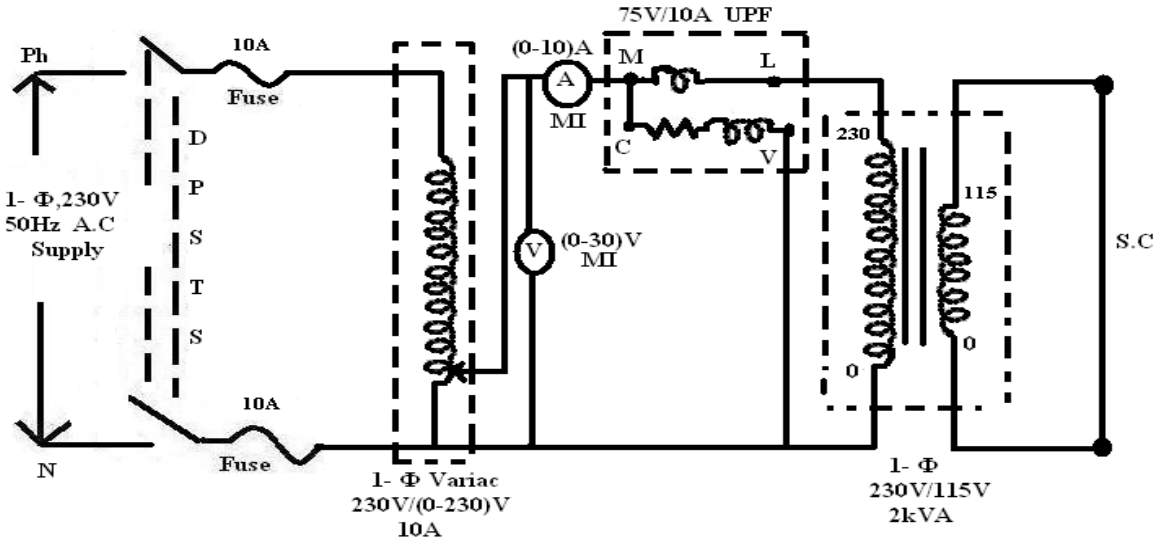
10)Explain difference between DC and AC supply systems

Circuit Diagram:

O.C Test:



S.C Test:



Exp. No.:07 **Date:**

O.C & S.C TESTS ON 1-Ø TRANSFORMER

Aim:

a) To determine the efficiency and regulation of 1- Ø transformer by conducting no-load and S.C Test.
b) To draw the equivalent circuit of 1- Ø transformer referred to L.V side as well as H.V side.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	1- Ø Variac	230V/(0-270)V, 10A	-	1
2	1- Ø Transformer	115V/230V, 2kVA	Core	1
3	Ammeter	(0-10)A	MI	1
		(0-2)A	MI	1
4	Voltmeter	(0-150)V	MI	1
		(0-30)V	MI	1
5	Wattmeter	150V/2A	LPF	1
		75V/10A	UPF	1
6	Connecting Wires	-	-	Required Some

Precautions:

1. Connections should be made tight.
2. 1- Ø Variac should be in minimum position.

Procedure:

1. Connect the circuit as shown in circuit diagram for O.C test.
2. Observing the precautions switch ON 1- Ø A.C supply and by using the 1-Φ variac apply the rated voltage of the primary of the transformer.
3. Note down all the meter readings. Here wattmeter reading gives iron loss.
4. Observing the precautions switch OFF the supply.
5. Connect the circuit as shown in circuit diagram for S.C test.
6. Observing the precautions switch ON 1- Ø A.C supply and by using the 1-Φ variac apply the rated current to the transformer. (Rated power of the transformer/Voltage of primary of transformer)
7. Note down all the meter readings, here wattmeter reading gives full-load copper loss.
8. Observing the precautions switch OFF the supply.

Tabular Columns:

O.C Test:

V_o (V)	I_o (A)	W_o = W X M.F (W)

S.C Test:

V_{SC} (V)	I_{SC} (A)	W_{SC} = W X M.F (W)

Efficiencies at different loads and power factor:

Load	cosθ =				cosθ =			
	Cu Loss (W)	Output (W)	Input (W)	Efficiency (%η)	Cu Loss (W)	Output (W)	Input (W)	Efficiency (%η)

Lagging Power Factor		Leading Power Factor	
Power Factor	% Regulation	Power Factor	% Regulation

Model Calculations:

Let the transformer be the step-down transformer (O.C Test)

Primary is H.V side and secondary is L.V side

$R_o=V_1/I_w$ (Ω) where $I_w=I_o\cos\Phi_o$

$X_o=V_1/I_\mu$ (Ω) where $I_w=I_o\cos\Phi_o$

$R_{o1}=W_{SC}/I_{SC}^2$ (Ω)

$Z_{O1}=V_{SC}/I_{SC}$

$X_{o1}=\sqrt{(Z_{O1}^2 - R_{o1}^2)}$

$R_{o2}=K^2 R_{o1}$

$X_{o2}=K^2 X_{o1}$

where,

$K=V_2/V_1$=Transformation Ratio

Calculations to find efficiency:

For example, at $1/4^{th}$ full load,

Copper Losses=W_{SC} x $(1/4)^2$ (w)

where, W_{SC}=Full Load Copper Losses

Constant Losses=W_o (W)

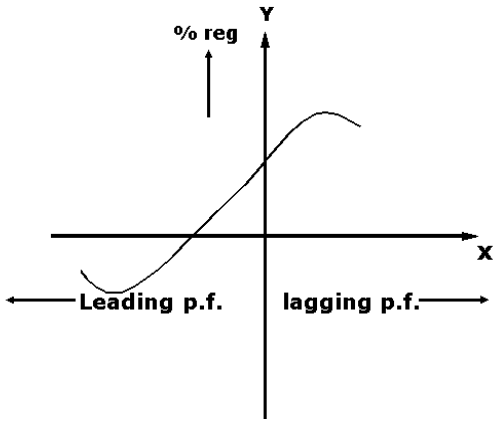
Output=(1/4) X VA X cosΦ (cosΦ may be assumed)

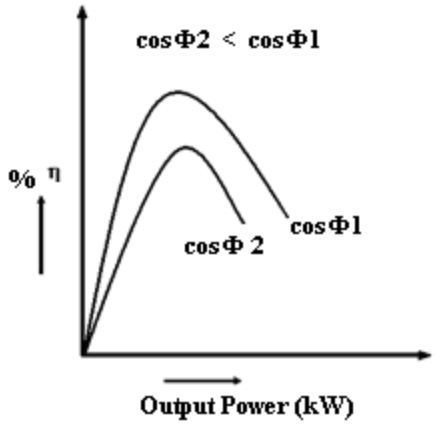
Input=Output + Copper Loss + Constant Loss

Efficiency (%η) = (Output/Input) X 100

Efficiency at different loads and power factor can be calculated.

Model Graph:





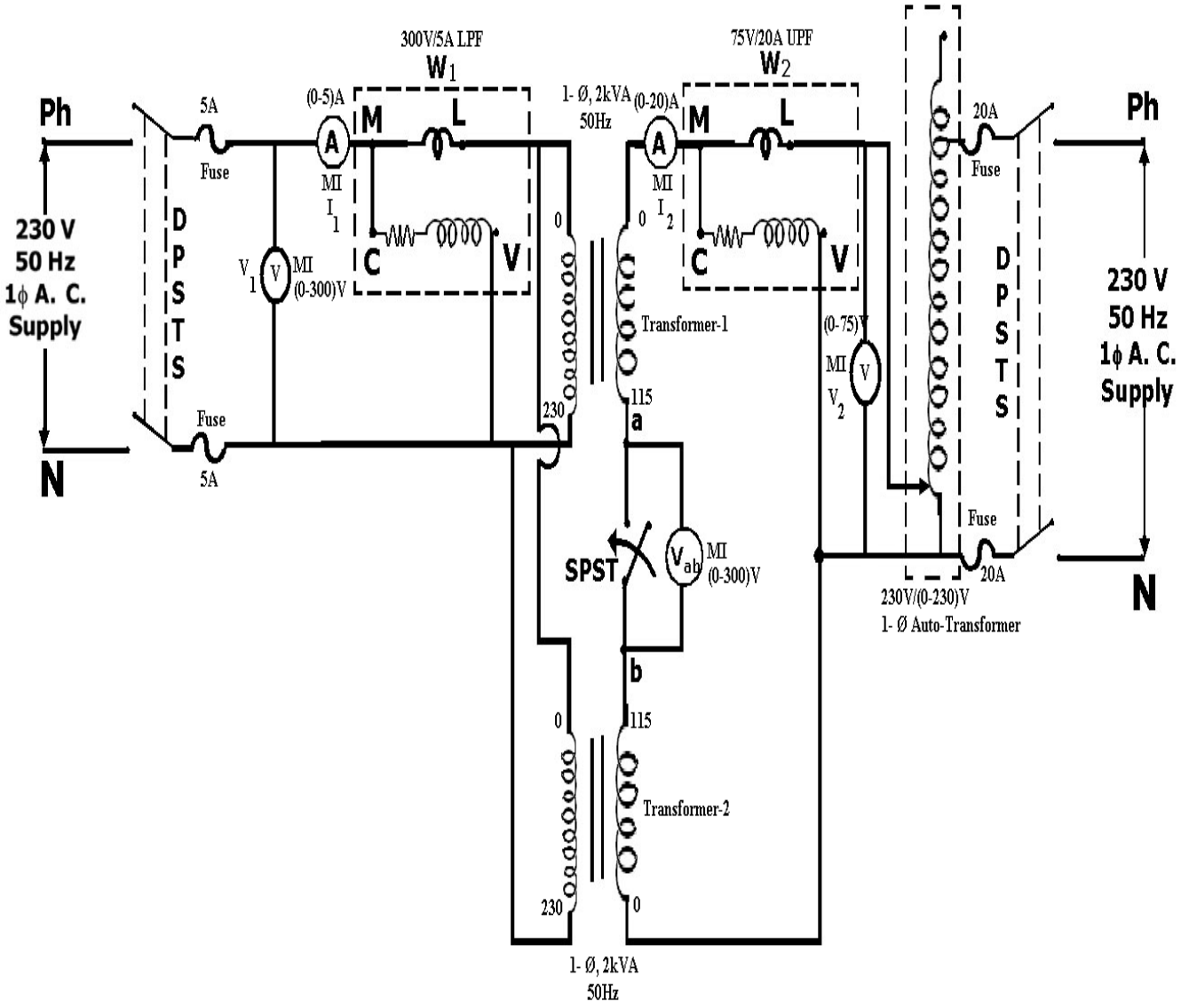
Calculations:

Result:

Viva Voce Questions:

1. Define transformer.
2. Distinguish the statically induced EMF and dynamically induced EMF.
3. Which losses can be determined from the O.C Test and S.C Test.
4. What is the main AIM's to conduct the O.C and S.C tests?
5. Define efficiency and voltage regulation of the transformer.
6. Why the O.C Test is conduct on L.V side.
7. Why the S.C Test is conducted on H.V side.
8. What is the difference between U.P.F and L.P.F wattcmeters?
9. No load power factor angle of transformer is around……
10. For which type of load negative voltage regulation occurs.
11. For which type of load maximum voltage regulation occurs

Circuit Diagram:



Exp. No.: 08 **Date:**

SUMPNER'S TEST

Aim:

i. To conduct Sumpner's Test on two identical 1- Ø transformers.
ii. To find out the iron loss, copper loss and the efficiency of each transformer.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	1- Ø Variac	230V/(0-270)V, 10A	-	1
2	1- Ø Transformer	115V/230V, 2kVA	Core	2
3	Ammeter	(0-5)A	MI	1
		(0-20)A	MI	1
4	Voltmeter	(0-300)V	MI	2
		(0-75)V	MI	1
5	Wattmeter	300V/5A	LPF	1
		75V/20A	UPF	1

Precautions:

1. The range of voltmeter should be doubled the induced e.m.f of secondary winding.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Connect the primaries of both transformers in parallel..
3. Connect the secondaries in series opposition and connect a switch as shown in the circuit diagram.
4. Initially keep the SPST in open circuit.
5. Give supply as per the primary rating of transformers.
6. Observe the readings of all the meters, close the SPST Switch when voltage V_{ab} = 0 (see circuit diagram)if it is not so inter change the terminals of primary or secondary but not both.
7. By slowly varying the auto transformer-1 up to the rated voltage and note down the all the meter readings .Here wattmeter gives the core losses of two transformers.

8. By slowly varying the auto transformer-2 up to the rated current passing through both primaries and secondary's and note down the all the meter readings .Here wattmeter gives the copper losses of two transformers.
9. By varying auto transformers 1 & 2, Observe the same readings as per steps 7 & 8. At this condition the temperature rise of the transformer can be determined.

Tabular Columns:

O.C Test:

V_o (V)	I_o (A)	W_o = W X M.F (W)

S.C Test:

V_{SC} (V)	I_{SC} (A)	W_{SC} = W X M.F (W)

Efficiencies at different loads and power factor:

Load	cosθ =				cosθ =			
	Cu Loss (W)	Output (W)	Input (W)	Efficiency (%η)	Cu Loss (W)	Output (W)	Input (W)	Efficiency (%η)

To find % regulation:

Lagging Power Factor		Leading Power Factor	
Power Factor	% Regulation	Power Factor	% Regulation

Model Calculations:

Let the transformer be the step-down transformer (O.C Test)

Primary is H.V side and secondary is L.V side

$R_o=V_1/I_w$ (Ω) where $I_w=I_o\cos\Phi_o$

$X_o=V_1/I_\mu$ (Ω) where $I_w=I_o\cos\Phi_o$

$R_{o1}=W_{SC}/I_{SC}^2$ (Ω)

$Z_{O1}=V_{SC}/I_{SC}$

$X_{o1}=\sqrt{(Z_{O1}^2 - R_{o1}^2)}$

$R_{o2}=K^2 R_{o1}$

$X_{o2}=K^2 X_{o1}$

where,

$K=V_2/V_1$=Transformation Ratio

Calculations to find efficiency:

For example, at $1/4^{th}$ full load,

Copper Losses=W_{SC} x $(1/4)^2$ (w)

where, W_{SC}=Full Load Copper Losses

Constant Losses=W_o (W)

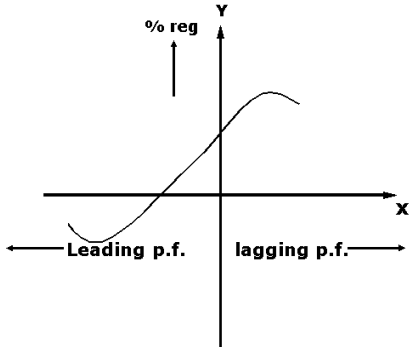
Output=(1/4) X VA X cosΦ (cosΦ may be assumed)

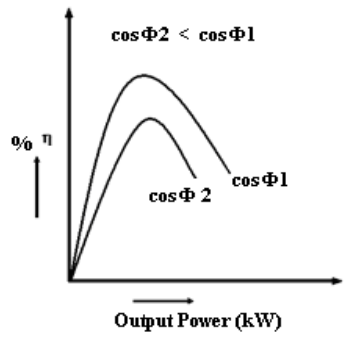
Input=Output + Copper Loss + Constant Loss

Efficiency (%η) = (Output/Input) X 100

Efficiency at different loads and power factor can be calculated.

Model Graph:





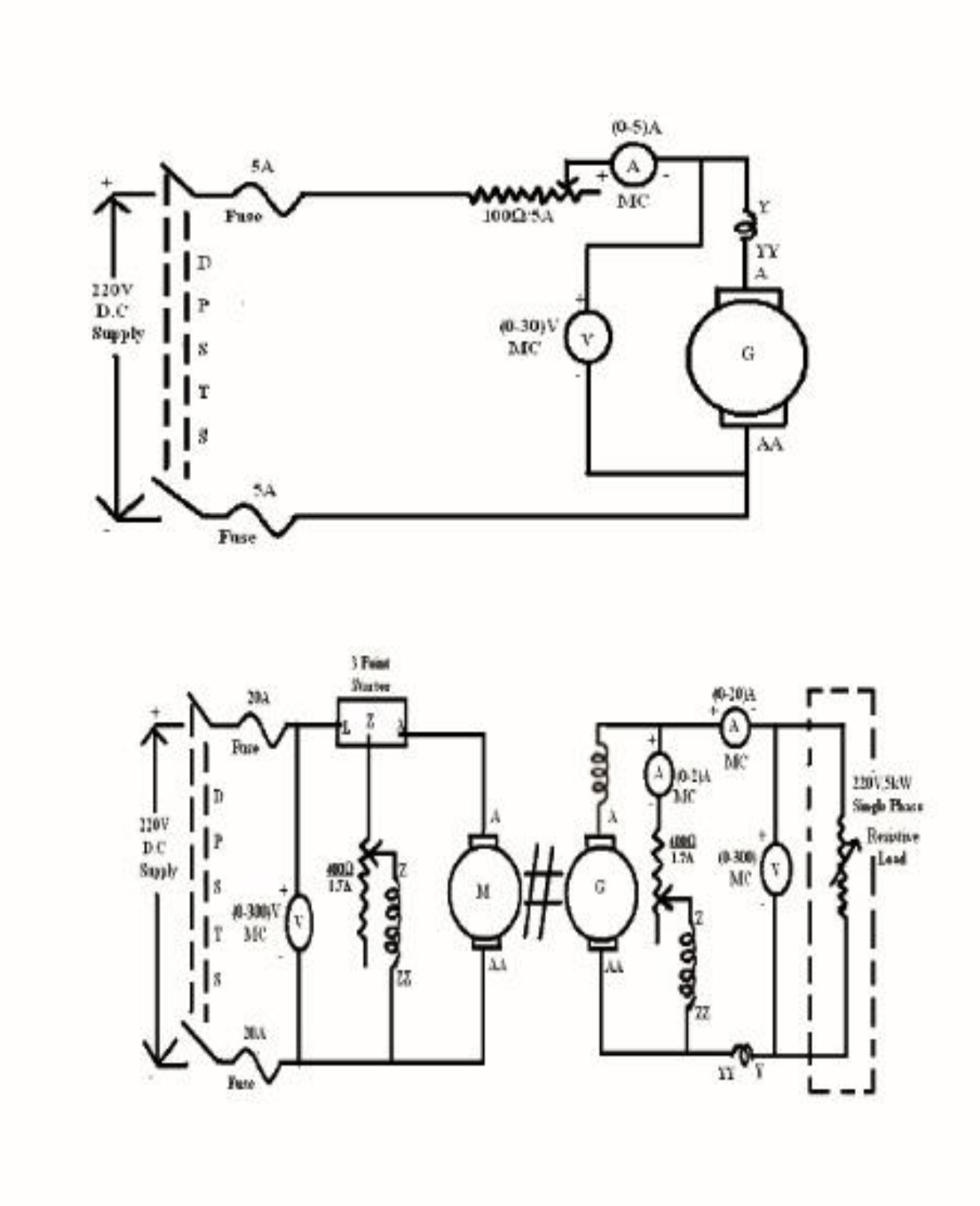
Calculations:

Result:

Viva Voce Questions:

1. What are the disadvantages of O.C and S.C Tests?
2. What is the need of sumper's test?
3. What are the other names for sumpner's test?
4. What are the requirements for the sumpner's test?
5. Why it is called as heat run test?
6. At what power factor maximum efficiency occurs in transformer.
7. Why it is called as back to back test?
8. How the voltages are applied at low voltage side and high voltage side during sumpner's test?
9. Formula for voltage regulation, for which power factor voltage regulation is positive, negative and zero.
10. At unity power factor voltage regulation of transformer is……..

Circuit Diagram:



EXP.NO:09 **DATE:**

LOAD TEST ON D.C COMPOUND GENERATOR

Aim: To perform load test on D.C Compound Generator and plot its load characteristics.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	2
		(0-30)V	MC	1
2	Ammeter	(0-20)A	MC	1
		(0-2)A	MC	1
		(0-5)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	2
		100Ω/5A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name plate details:

Precautions:

1. Field rheostat of the motor must be kept in minimum resistance position.
2. Field rheostat of the generator must be kept in maximum resistance position.
3. Armature rheostat of the generator must be kept in maximum resistance position.
4. Initially the load must be in OFF position.
5. Starter arm must be in OFF position.

Procedure:

To Conduct Load Test:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the Motor Generator set with the help of starter.
4. Adjust the motor field rheostat and bring the motor speed to its rated value.

5. Adjust the field rheostat of the generator so that generator gives rated terminal voltage of the load.
6. Now load the generator in steps and note down all the meter readings. If the voltmeter shows an increase in voltage that indicates the compounding is cumulative otherwise differential.
7. Repeat the procedure for another compounding by reversing the series field terminals of the generator.
8. Observing the precautions switch OFF the supply.

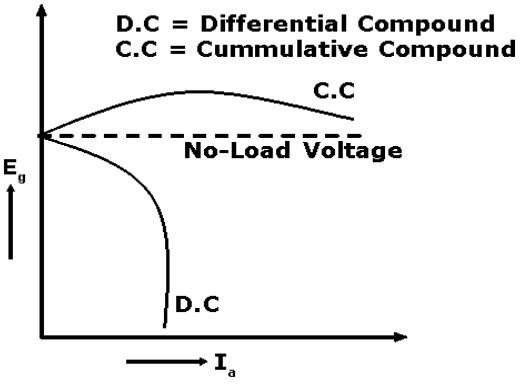
Tabular Columns:

Differential Compounding Generator					Cumulative Compounding Generator				
I_L (A)	I_f (A)	V_L (V)	I_a (A)	E_g (V)	I_L (A)	I_f (A)	V_L (V)	I_a (A)	E_g (V)

To find Armature & Series Field Resistance of the Generator:

S. No.	V_a (V)	I_a (A)	$R_a + R_{Se}$ (Ω)
1			
2			
3			

Model Graph:



To find Armature & Series Field Resistance of the Generator:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat for different values note down the meter readings.
4. Observing the precautions switch OFF the supply.

Formulae:

For Cumulative Compound:

$I_L = I_a + I_f$

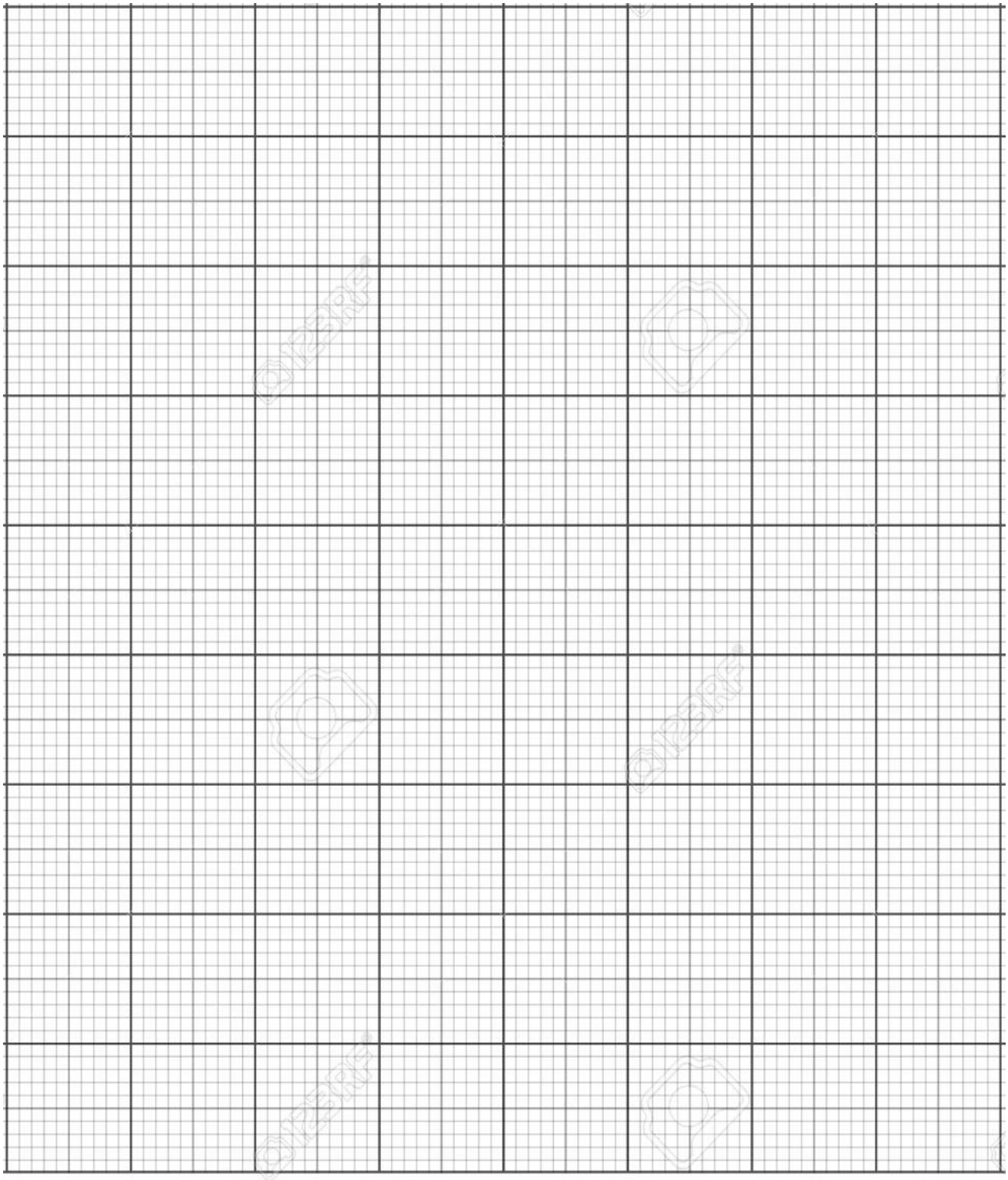
$E_g = V_L + I_L (R_a + R_{Se})$

For Differential Compound:

$I_L = I_a + I_f$

$E_g = V + I_a (R_a + R_{Se})$

Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What are the different types of compound generators?

2) What are the types of load characteristics of a dc compound generator?

3) What is meant by flat compound Generator?

4) What is no load voltage of Dc compound Generator?

5) What is the voltage regulation of a dc compound generator?

6) What are the applications of dc differential compound generator?

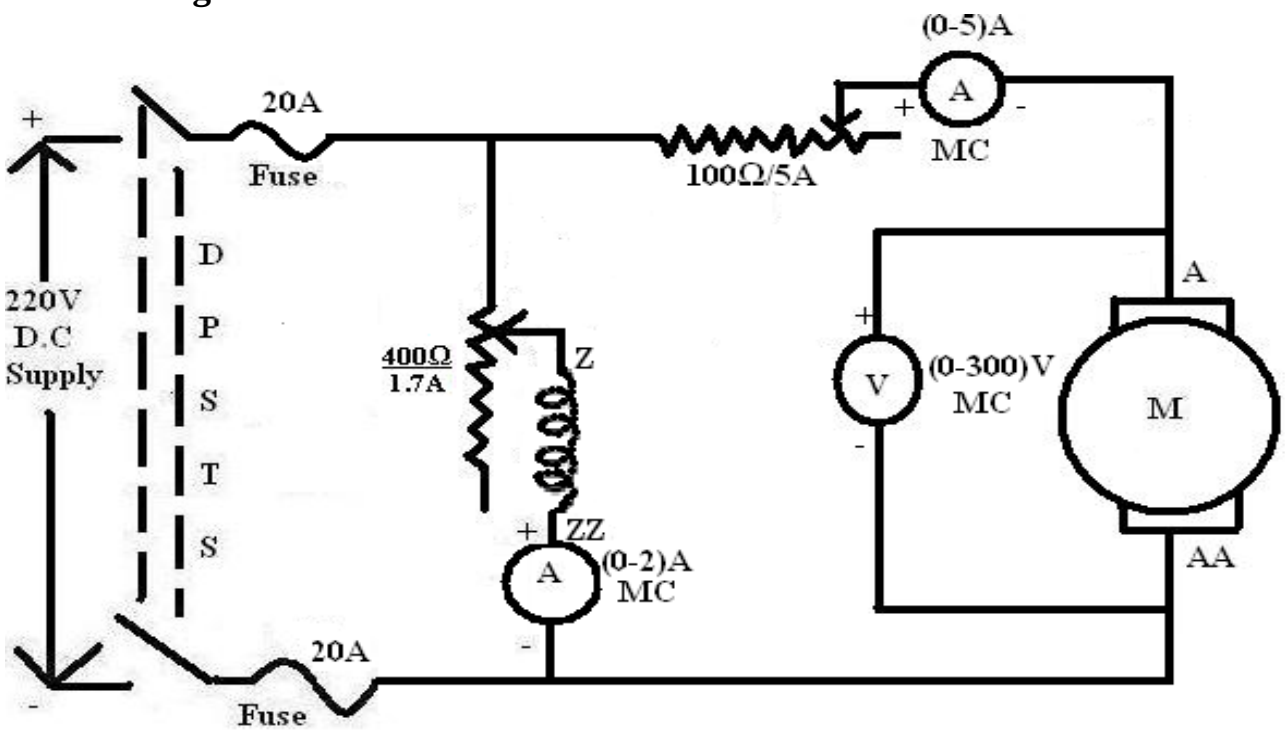
7) What are the applications of dc cumulative compound generator?

8) What are the differences between under, flat and over compound generators?

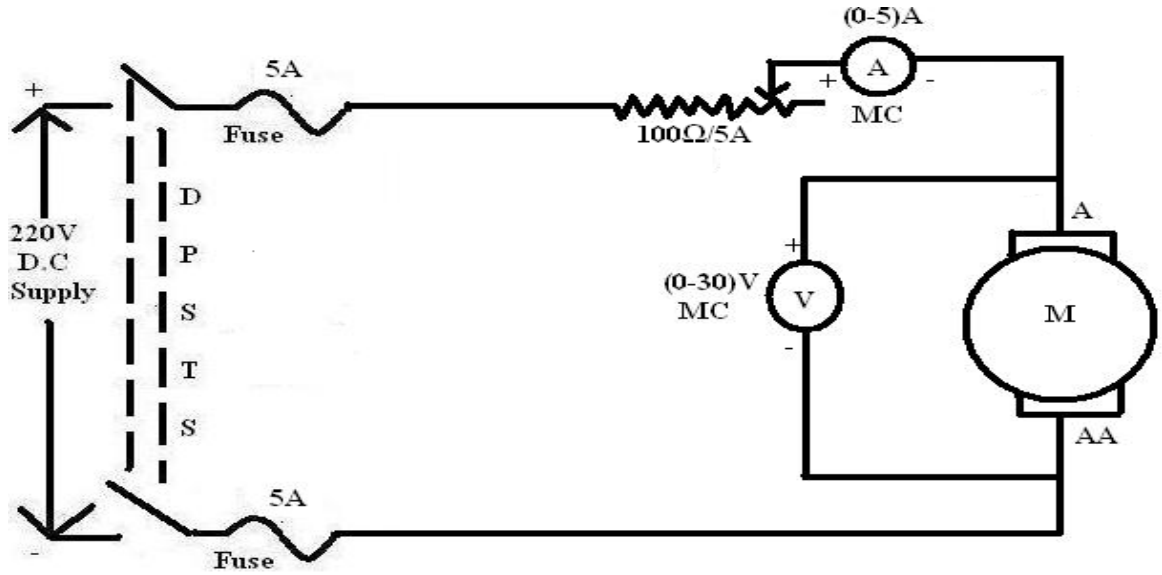
9) What is formula for induced voltage of compound generator?

10) Up to where we can load the dc compound generator?

Circuit Diagram:



Find Armature Resistance:



EXP.NO:10 **DATE:**

SEPARATION OF LOSSES IN A D.C SHUNT MOTOR

Aim: To separate hysteresis, eddy current and mechanical losses of a D.C Shunt Machine.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
		(0-30)V	MC	1
2	Ammeter	(0-5)A	MC	1
		(0-2)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	1
		100 Ω/5A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Name Plate details

Precautions:

1. Field rheostat must be kept in minimum resistance position.
2. Armature rheostat must be kept in maximum resistance position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C supply.
3. Start the motor by adjusting the armature rheostat and obtain the rated voltage across the terminals of the armature. Now adjust the field rheostat and bring the speed of motor to its rated value.
4. Now vary the armature rheostat in steps and for each step note down the speed and all the meter readings.
5. Repeat the procedure for another excitation (3/4 or ½ the rated value) suitably adjusting the field rheostat.

6. Observing the precautions switch OFF the supply.

To find Armature Resistance:

1. Connect the circuit as shown in circuit diagram.
2. Keeping the rheostat in its maximum resistance position close the DPST Switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat for different values of current note down the meter readings.
4. Observing the precautions switch OFF the supply.

Tabular Columns:

Field Current=0.6A						Field Current=0.8A					
V_L (V)	I_a (A)	N (rpm)	$I_L = I_a + I_f$ (A)	W_C (W)	W_C/N (W/A)	V_L (V)	I_a (A)	N (rpm)	$I_L = I_a + I_f$ (A)	W_C (W)	W_C/N (W/A)

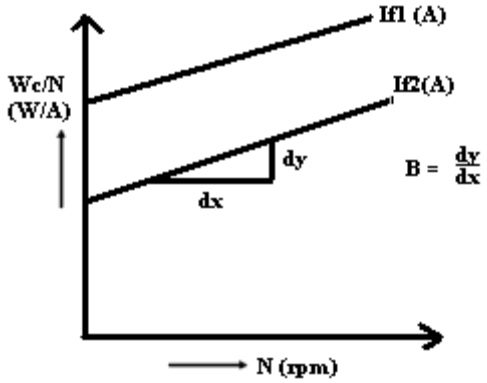
To find Losses:

Speed N (rpm)	Hysteresis Losses AN	Eddy Current Losses BN^2	Mechanical Losses $W_C - (W_h + W_e)$

To find Armature Resistance:

S. No.	V_a (V)	I_a (A)	R_a (Ω)
1			
2			
3			

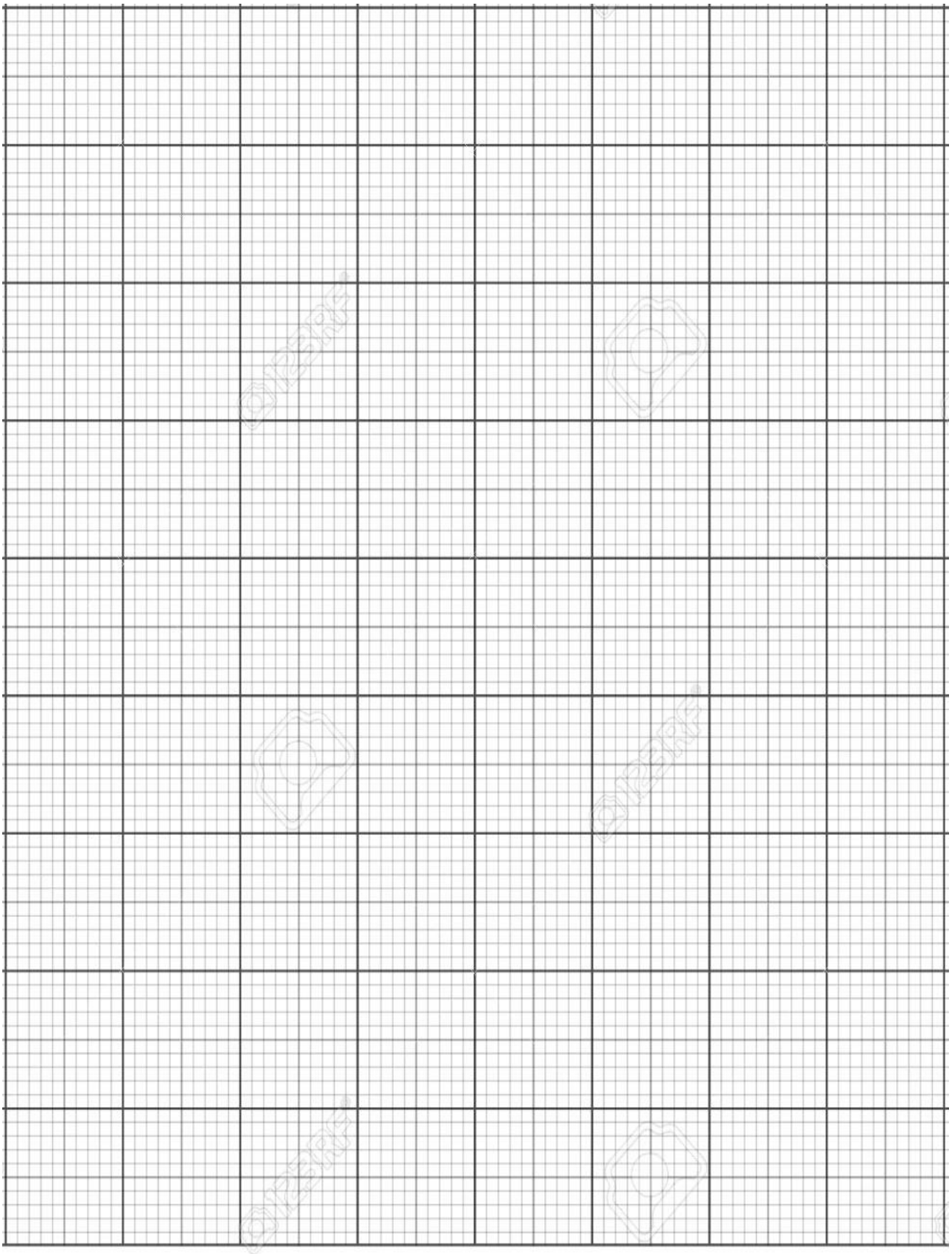
Model Graphs:



Formulae:

$W_C = V_L I_L - I_a^2 R_a$
$W_i = W_h + W_e$
$W_h = AN$
$W_e = BN^2$
$W_{mech} = W_C - (W_h + W_e)$

Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What are the types of losses that occur in a dc machine?

2) Why the test is conducted on no load?

3) Whether the test is direct or indirect?

4) Why the motor is operated in more than the rated speed?

5) Why this method is not suitable for series machines?

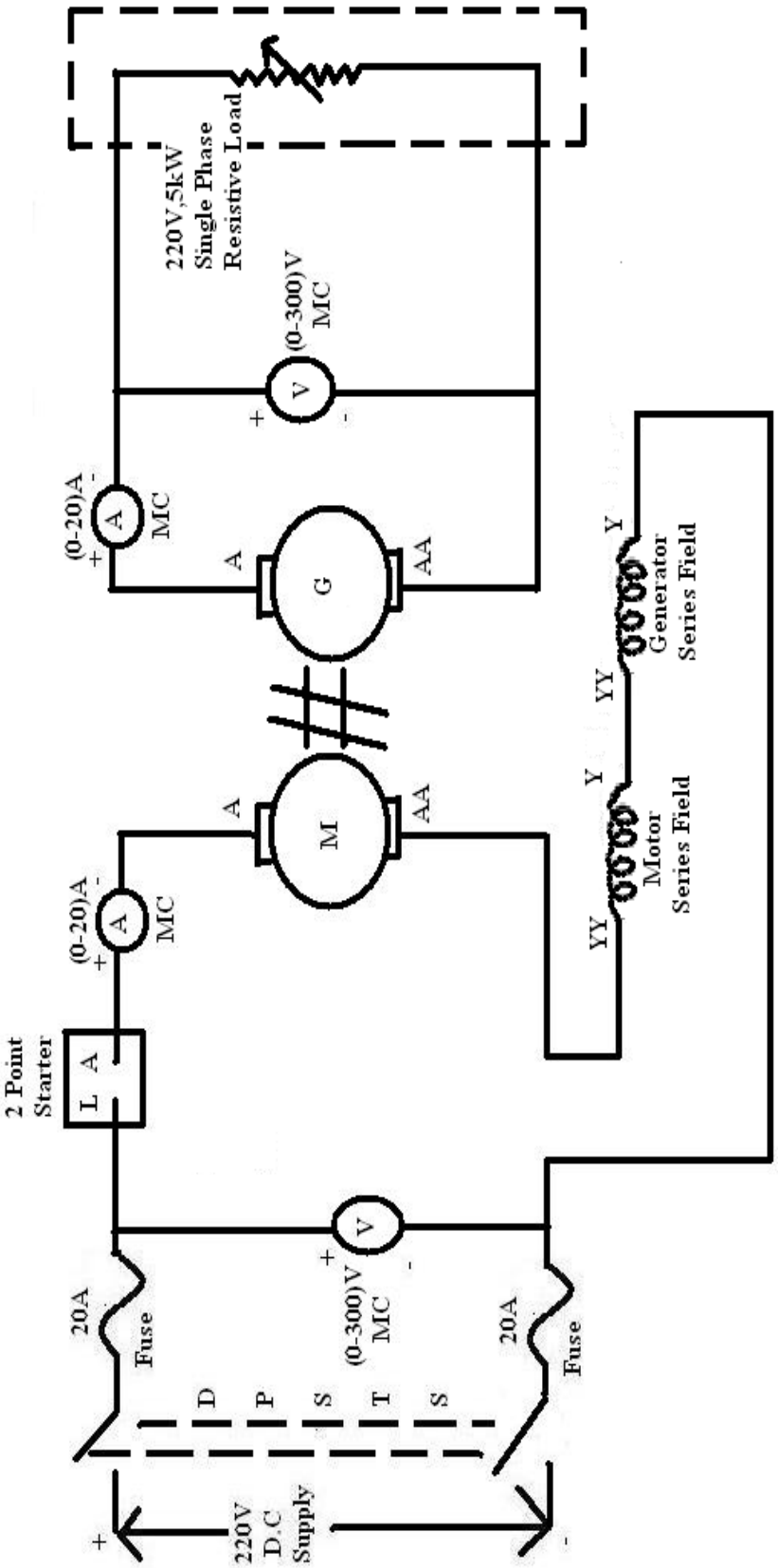
6) What are the advantages and disadvantages of this test?

8) What are the different types of iron losses?

9) How the eddy current losses occur in a dc machine?

10) How the hysteresis current losses occur in a dc machine?

Circuit Diagram:



EXP.NO:11 **DATE:**

FIELD'S TEST ON DC SERIES MACHINES

Aim: To determine the performance characteristics of a D.C Series motor using Field Test.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	2
2	Ammeter	(0-20)A	MC	2
3	Tachometer	(0-9999)rpm	Digital	1
4	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1. Make the connections tightly.
2. Starter arm must be in OFF position.
3. Initial Machine – II i.e., Generator is loaded with 7A of load.
4. Readings should not be taken when there is any fluctuation.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C Supply.

3. Machine – I is started as motor by keeping the load on Machine – II (i.e., generator) to such a value that Machine – II is kept in safe speed limit.
4. By gradually loading in Machine – II in steps till maximum rated current of any of the machine, note down the meter readings and speed at each step at each.
5. Observing the precautions switch OFF the supply.

Tabular Column:

V_1 (V)	V_2 (V)	I_1 (A)	I_2 (A)	N (rpm)	Motor			Generator		
					Input (W)	Total Losses (W)	ŋ (%)	Output (W)	Losses (W)	ŋ (%)

Formulae:

Motor:

Motor Input = V_1I_1

Motor Losses = Armature + Field Losses + Stray Losses

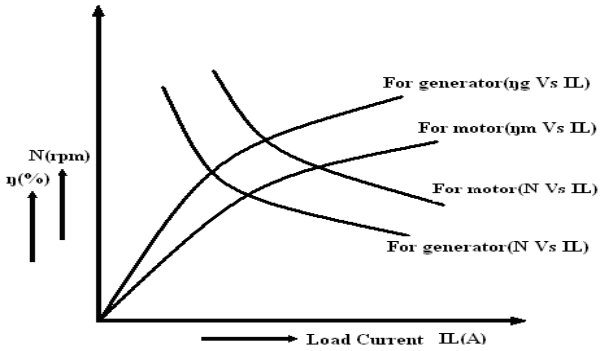
$W_m = (R_a + R_{se})\, I_1^2 + W_s$

$\%\ \eta_m = (V_1I_1 - W_m) / (V_1I_1)$

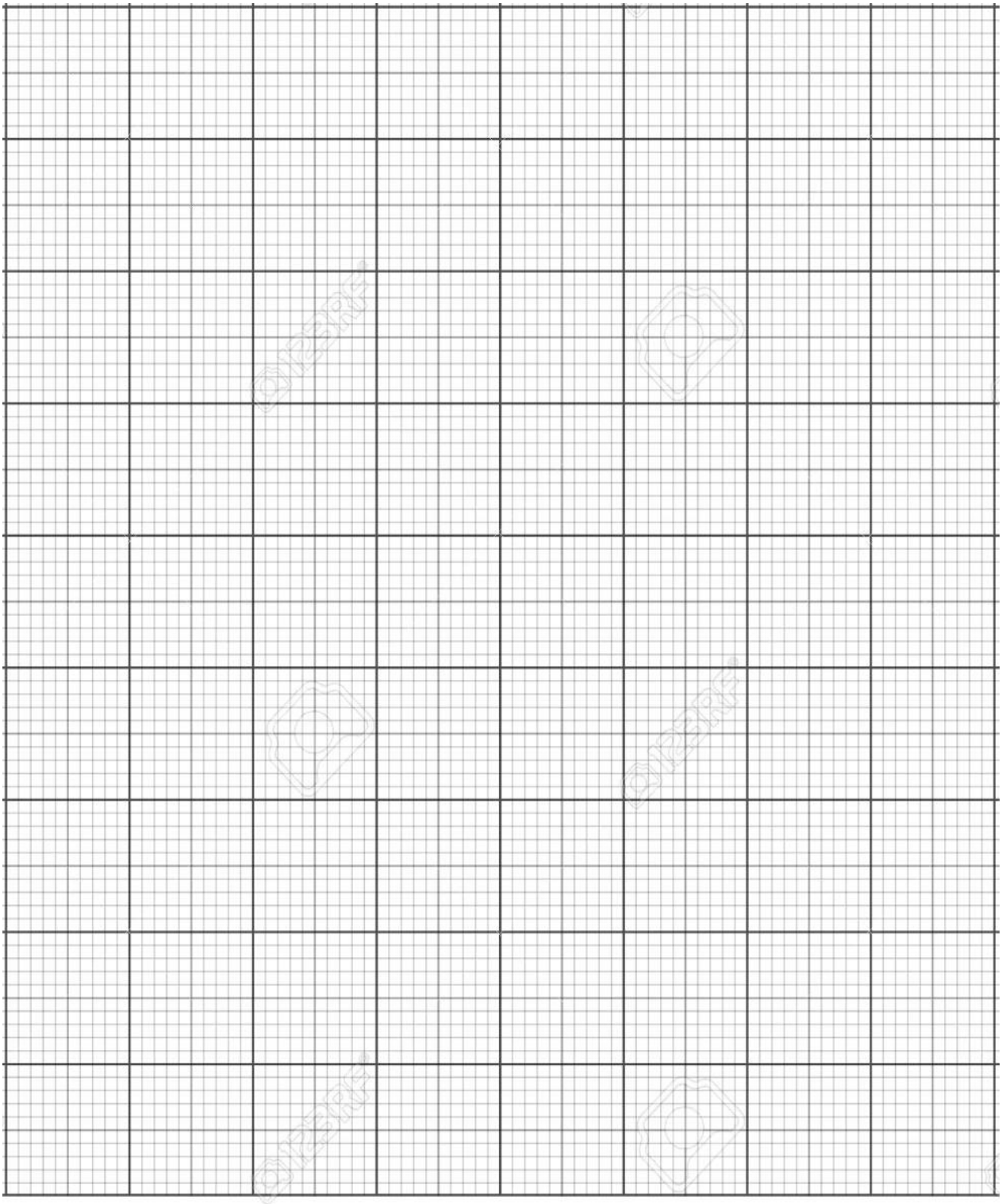
Generator:

Generator Output = V_2I_2
Field Losses = $I_1^2R_{se}$
Armature Cu Losses = $I_2^2R_a$
Stray Losses = $W_s = \frac{W_i - W_c}{2}$
Total Losses = $I_1^2R_{se} + I_2^2R_a + W_s = W_g$
Total Losses = $W_t = V_1I_1 - V_2I_2$
$W_c = (R_a + 2\, R_{Se})\, I_1^2 + I_2^2\, R_a$
$\%\ \eta_g = (V_2I_2) / (V_2I_2 + W_g)$

Model Graph:



Theoretical Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What is the necessity of field test on series machines?

2) What is the no load speed of dc series motor?

3) What is the no load current of dc series generator?

4) What are the advantages of compensating windings for series motor?

5) What are the applications of dc series motor?

6) Why the series motor can't operate under no load condition?

7) Why it is not a regenerative test?

8) What is rated currant of series generator?

9) Explain Principle operation of motor

10) Explain Faradays laws of Electromagnetic Induction

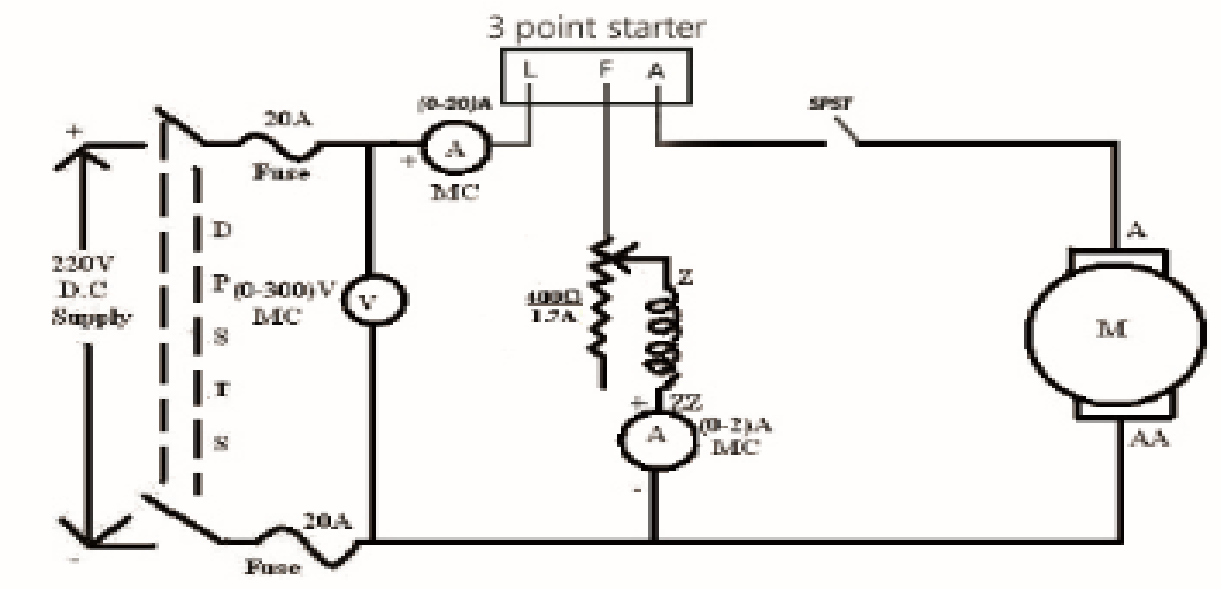
11).Why a DC series motor should never be stared without load?

12). Why a DC series motor has a high starting torque?

13).Compare the resistances of the field windings of DC shunt and series motor?

14). Comment on the Speed – Torque characteristics of a DC series motor.

Circuit Diagram:



EXP.NO:12 **DATE:**

RETARDATION TEST

Aim:

To determine the angular velocity of D.C Shunt Motor

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
2	Ammeter	(0-5)A	MC	1
		(0-2)A	MC	1
3	SPSTS	-	Knife	1
4	Rheostat	360Ω/1.2A	Wire Wound	1
5	Tachometer	(0-9999)rpm	Digital	1
6	Connecting Wires	-	-	Required Some

Name Plate details:

Precautions:

1 Field rheostat must be kept in minimum resistance position.

2 Armature rheostat must be kept in maximum resistance position.

3 SPST Switch must be kept in closed position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Adjust the speed of motor to its rated value by using field rheostat.
4. Now open the SPST Switch & note down all the meter readings.
5. Observing the precautions switch OFF the supply.

Tabular Columns:

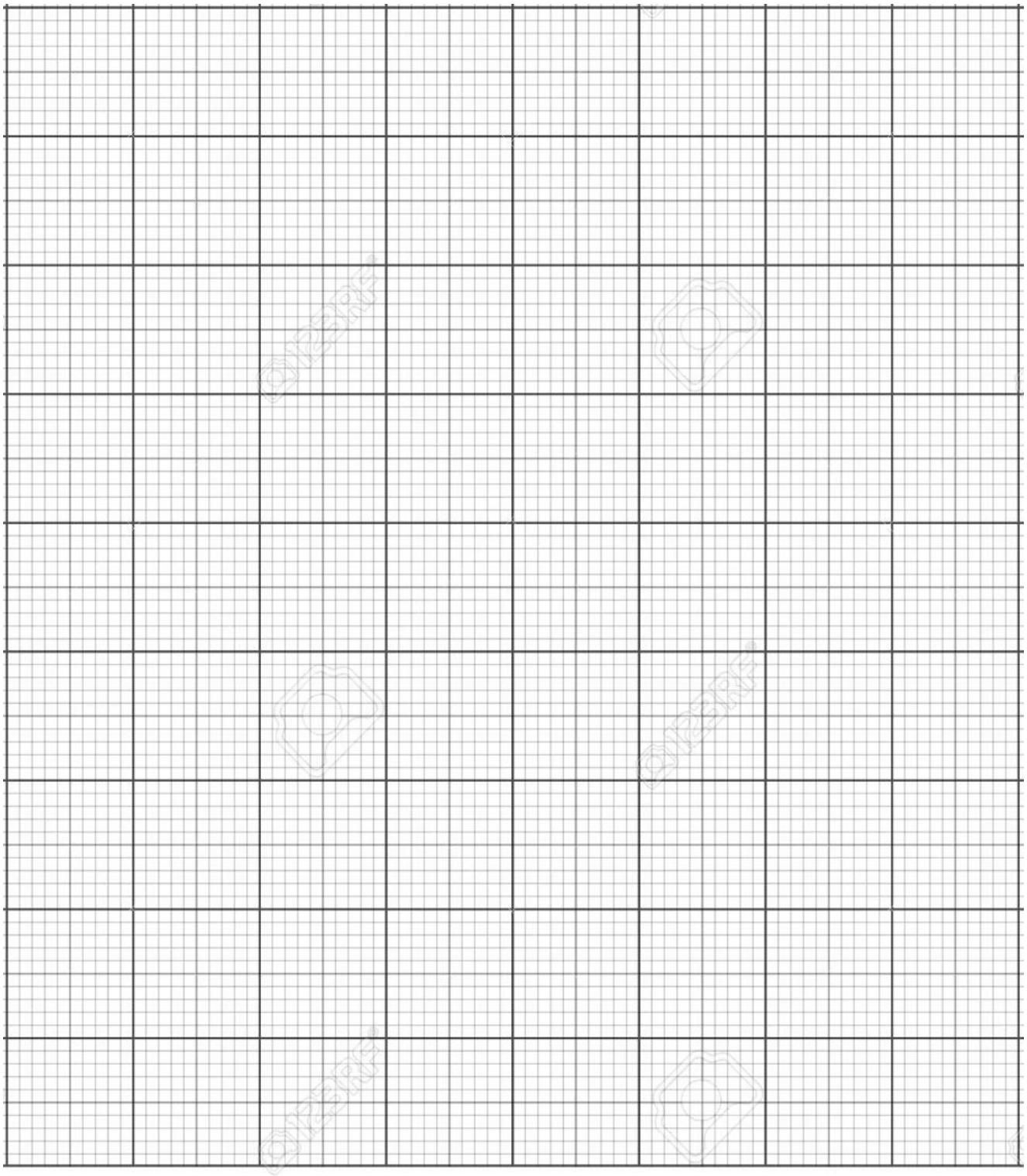
For rated speed :

S. No.	Speed	Time(sec)	Angular velocity
1			

Formulae:

$W_s=2pi\ N/60$

Calculations:



Result:

VIVA VOICE QUESTIONS:

1) What is the necessity of retardation test?

2) Why this test is conducted on no load?

3) Why this test is not suitable for series machines?

4) Whether the test is a direct method or indirect method?

5) What are the advantages of retardation test?