ELECTRICAL MACHINES-I LABORATORY

M A N U A L

DEPARTMENT OF ELECRICAL & ELECTRONICS ENGINEERING

BALAJI INSTITUTE OF TECHNOLOGY AND SCIENCE
NARSAMPET, WARANGAL.

Vision and Mission of EEE Department

Vision: To nurture excellence in the field of Electrical & Electronics Engineering by imparting core values to the learners and to mould the institution into a centre of academic excellence and advanced research.
Mission: M1: To impart students with high technical knowledge to make globally adept to the new Technologies M2: To create, disseminate and integrate knowledge of engineering, science and technology that expands the electrical engineering knowledge base towards research M3: To provide the students with a platform for developing new products and systems that can help industry and society as a whole.

Program Outcomes

PO1	**Engineering knowledge:** Apply the knowledge of basic sciences and fundamental engineering concepts in solving engineering problems.
PO 2	**Problem analysis:** Identify and define engineering problems, conduct experiments and investigate to analyze and interpret data to arrive at substantial conclusions.
PO 3	**Design/development of solutions:** Propose an appropriate solution for engineering problems complying with functional constraints such as economic, environmental, societal, ethical, safety and sustainability.
PO 4	**Conduct investigations of complex problems:** Perform investigations, design and conduct experiments, analyze and interpret the results to provide valid conclusions.
PO 5	**Modern tool usage:** Select/ develop and apply appropriate techniques and IT tools for the design and analysis of the systems.
PO 6	**The engineer and society:** Give reasoning and assess societal, health, legal and cultural issues with competency in professional engineering practice.
PO 7	**Environment and sustainability:** Demonstrate professional skills and contextual reasoning to assess environmental/ societal issues for sustainable development.
PO 8	**Ethics:** An ability to 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 multi-disciplinary situations.
PO 10	**Communication:** An ability to communicate effectively.
PO 11	**Project management and finance:** Demonstrate apply engineering and management principles in their own / team projects in multi-disciplinary environment.
PO 12	**Life-long learning:** An ability to do the needs of current technological trends at electrical industry by bridging the gap between academic and industry.

Program Specific Outcomes

PSO1	Apply fundamental knowledge to identify, analyze diverse problems associated with electrical and electronic circuits, power electronics drives and power systems.
PSO2	Understand the current technological developments in Electrical & Electronics Engineering and develop the innovative products/software to cater to the needs of society & Industry.

Program Educational Objectives

PEO1	To prepare students with solid foundation in Mathematics, Sciences and Basic Engineering to cover multi-disciplinary subjects enabling them to comprehend, analyze Electrical & Electronics Engineering problems and develop solutions.
PEO2	To design and develop an electrical system component or process to meet the needs of society and industry with in realistic constraints.
PEO3	To prepare students with technical competence to use advance techniques, skills and modern engineering tools that allow them to work effectively as electrical and electronics engineer.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp .No	Name of the Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Speed Control of DC Shunt Motor	PO1, PO9	PSO1
2	SWINBURNE'S TEST	PO1, PO9	PSO1
3	Brake test on a DC Compound Motor	PO1, PO9	PSO1
4	Magnetization characteristics of DC shunt Generator	PO1, PO9	PSO1
5	Load Test on DC shunt Generator	PO1, PO9	PSO1
6	Field Test on DC Series Machines	PO1, PO9	PSO1
7	LOAD TEST ON D.C COMPOUND GENERATOR	PO1, PO9	PSO1
8	Brake Test on DC shunt Motor	PO1, PO9	PSO1
9	RETARDATION TEST	PO1, PO9	PSO1
10	HOPKINSON'S TEST	PO1, PO9	PSO1
11	Seperation of losses of DC Shunt Motor	PO1, PO9	PSO1

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PREFACE

This Laboratory book in Electrical Measurements has been revised in order to be up to date with Curriculum changes, laboratory equipment upgrading and the latest circuit simulation.

Every effort has been made to correct all the known errors, but nobody is perfect, if you find any additional errors or anything else you think is an error, please contact the HOD/EEE at mallik95_eee@yahoo.com

The Authors thanked all the staff members from the department for their valuable Suggestion and contribution.

The author would welcome the advice and suggestions leading to the improvement of the book.

The Authors,
Department of EEE.


Danger
High voltage

LABORATORY PRACTICE

SAFETY RULES

1. SAFETY is of paramount importance in the Electrical Engineering Laboratories.

2. Electricity NEVER EXECUSES careless persons. So, exercise enough care and attention in handling electrical equipment and follow safety practices in the laboratory. (Electricity is a good servant but a bad master).

3. Avoid direct contact with any voltage source and power line voltages. (Otherwise, any such contact may subject you to electrical shock)

4. Wear rubber-soled shoes. (To insulate you from earth so that even if you accidentally contact a live point, current will not flow through your body to earth and hence you will be protected from electrical shock)

5. Wear laboratory-coat and avoid loose clothing. (Loose clothing may get caught on an equipment/instrument and this may lead to an accident particularly if the equipment happens to be a rotating machine)

6. Girl students should have their hair tucked under their coat or have it in a knot.

7. Do not wear any metallic rings, bangles, bracelets, wristwatches and neck chains. (When you move your hand/body, such conducting items may create a short circuit or may touch a live point and thereby subject you to Electrical shock)

8. Be certain that your hands are dry and that you are not standing on wet floor. (Wet parts of the body reduce the contact resistance thereby increasing the severity of the shock)

9. Ensure that the power is OFF before you start connecting up the circuit. (Otherwise you will be touching the live parts in the circuit).

10. Get your circuit diagram approved by the staff member and connect up the circuit strictly as per the approved circuit diagram.

11. Check power chords for any sign of damage and be certain that the chords use safety plugs and do not defeat the safety feature of these plugs by using ungrounded plugs.

12. When using connection leads, check for any insulation damage in the leads and avoid such defective leads.

13. Do not defeat any safety devices such as fuse or circuit breaker by shorting across it. Safety devices protect YOU and your equipment.

14. Switch on the power to your circuit and equipment only after getting them checked up and approved by the staff member.

15. Take the measurement with one hand in your pocket. (To avoid shock in case you accidentally touch two points at different potentials with your two hands)

16. Do not make any change in the connection without the approval of the staff member.

17. In case you notice any abnormal condition in your circuit (like insulation heating up, resistor heating up etc), switch off the power to your circuit immediately and inform the staff member.

18. Keep hot soldering iron in the holder when not in use.

19. After completing the experiment show your readings to the staff member and switch off the power to your circuit after getting approval from the staff member.

20. Determine the correct rating of the fuse/s to be connected in the circuit after understanding correctly the type of the experiment to be performed: no-load test or full-load test, the maximum current expected in the circuit and accordingly use that fuse-rating.(While an over-rated fuse will damage the equipment and other instruments like ammeters and watt-meters in case of over load, an under-rated fuse may not allow one even to start the experiment)

21. Moving iron ammeters and current coils of wattmeters are not so delicate and hence these can stand short time overload due to high starting current. Moving iron meters are cheaper and more rugged compared to moving coil meters. Moving iron meters can be used for both a.c. and d.c. measurement. Moving coil instruments are however more sensitive and more accurate as compared to their moving iron counterparts and these can be used for d.c. measurements only. Good features of moving coil instruments are not of much consequence for you as other sources of errors in the experiments are many times more than those caused by these meters.

22. Some students have been found to damage meters by mishandling in the following ways:

i. Keeping unnecessary material like books, labrecords, unused meters etc. causing meters to fall down the table.
ii. Putting pressure on the meter (especially glass) while making connections or while talking or listening somebody.

STUDENTS ARE STRICTLY WARNED THAT FULL COST OF THE METER WILL BE RECOVERED FROM THE INDIVIDUAL WHO HAS DAMAGED IT IN SUCH A MANNER.

Copy these rules in your Lab Record. Observe these yourself and help your friends to observe.

I have read and understand these rules and procedures. I agree to abide by these rules and procedures at all times while using these facilities. I understand that failure to follow these rules and procedures will result in my immediate dismissal from the laboratory and additional disciplinary action may be taken.

Signature Date Lab

GUIDELINES FOR LABORATORY NOTEBOOK

The laboratory notebook is a record of all work pertaining to the experiment. This record should be sufficiently complete so that you or anyone else of similar technical background can duplicate the experiment and data by simply following your laboratory notebook. Record everything directly into the notebook during the experiment. Do not use scratch paper for recording data. Do not trust your memory to fill in the details at a later time.

Organization in your notebook is important. Descriptive headings should be used to separate and identify the various parts of the experiment. Record data in chronological order. A neat, organized and complete record of an experiment is just as important as the experimental work.

1. Heading:
The experiment identification (number) should be at the top of each page.Your name and date should be at the top of the first page of each day's experimental work.

2. Object:
A brief but complete statement of what you intend to find out or verify in the experiment should be at the beginning of each experiment

3. Diagram:
A circuit diagram should be drawn and labeled so that the actual experiment circuitry could be easily duplicated at any time in the future. Be especially careful to record all circuit changes made during the experiment.

4. Equipment List:
List those items of equipment which have a direct effect on the accuracy of the data. It may be necessary later to locate specific items of equipment for rechecks if discrepancies develop in the results.

5. Procedure:
In general, lengthy explanations of procedures are unnecessary. Be brief. Short commentaries alongside the corresponding data may be used. Keep in mind the fact that the experiment must be reproducible from the information given in your notebook.

6. Data:
Think carefully about what data is required and prepare suitable data tables. Record instrument readings directly. Do not use calculated results in place of direct data; however, calculated results may be recorded in the same table with the direct data. Data tables should be clearly identified and each data column labeled and headed by the proper units of measure.

7. Calculations:
Not always necessary but equations and sample calculations are often given to illustrate the treatment of the experimental data in obtaining the results.

8. Graphs:
Graphs are used to present large amounts of data in a concise visual form. Data to be presented in graphical form should be plotted in the laboratory so that any questionable data points can be checked while the experiment is still set up. The grid lines in the notebook can be used for most graphs. If special graph paper is required, affix the graph permanently into the notebook. Give all graphs a short

descriptive title. Label and scale the axes. Use units of measure. Label each curve if more than one on a graph.

9. Results:
The results should be presented in a form which makes the interpretation easy. Large amounts of numerical results are generally presented in graphical form. Tables are generally used for small amounts of results. Theoretical and experimental results should be on the same graph or arrange in the same table in a way for easy correlation of these results.

10. Conclusion:
This is your interpretation of the results of the experiment as an engineer. Be brief and specific. Give reasons for important discrepancies.

TROUBLE SHOOTING HINTS

1. Be Sure that the power is turned ON
2. Be sure the ground connections are common
3. Be sure the circuit you build is identical to your circuit diagram (Do a node by node check)
4. Be sure that the supply voltages are correct
5. Be sure that the equipment is set up correctly and you are measuring the correct parameters
6. If steps 1 through 5 are correct then you probably have used a component with the wrong value or one that doesn't work. It is also possible that the equipment does not work (although this is not probable) or the protoboard you are using may have some unwanted paths between nodes. To find your problem you must trace through the voltages in your circuit node by node and compare the signal you expect to have. Then if they are different use your engineering judgment to decide what is causing the different or ask your lab assistant.

Title: Speed Control of DC Shunt Motor

AIM: To control the speed of DC shunt motor by using.
a) Field control.
b) Armature control methods.

NAME PLATE DETAILS:

s.no	DC MOTOR	
	HP Rating(KW)	
	Voltage	
	Field Excitation	
	Current	
	Winding	
	Speed	

APPARATUS REQUIRED:

S.NO	Meter	Type	Range	Quantity
1	Ammeter	MC	(0-2A)	1
2	voltmeter	MC	(0-300V)	1
3	Tachometer	Digital	---	1
4	Rheostat	---		1
5	Rheostat	---		1

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Keep the field rheostat in the minimum resistance position and the armature resistance in the maximum resistance position.
3. Start the motor by moving the handle of the starter slowly.

Field control:

1. Vary the Armature rheostat resistance until voltmeter across the armature reads 200 Volts.
2. Increase the Field resistance in steps.
3. Note down the values of I_{sh}, the shunt field current, speed.

Armature control:

1. Keep the field rheostat at a selected field current value at the rated field current such that it shows Base speed
2. Decrease the armature resistance from the maximum position in steps keeping the field current at the set value.
3. Note down the speed for each value of armature voltage and armature current.

Observations:

Flux control:

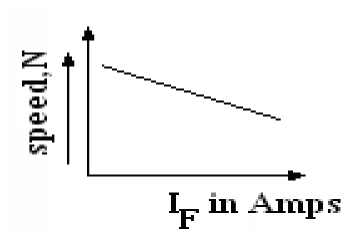
S.NO	Field current I_f (A)	Speed N (rpm)

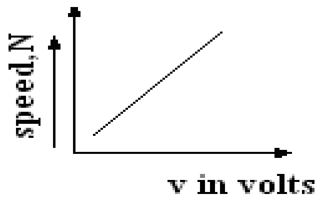
Armature control:

S.NO	Voltage V (V)	Speed N (rpm)

MODEL GRAPHS:

1. Plot **I_F** Vs speed **N** **2.** plot **voltage Va** speed **N**





PRECAUTIONS:

1. Take care while using the starter.
2. Keep the armature and field rheostats at proper positions.
3. The speed should be adjusted to rated speed.
4. There should be no loose connections.

RESULT:

The variation of speed with armature voltage and field current in case of DC shunt motor is studied.

Title: SWINBURNE'S TEST

AIM: To predetermine the efficiency of DC shunt machine by performing Swinburne's test.

NAME PLATE DETAILS:

S.NO	NAME	RATING
1	Motor rating (HP)	
2	Voltage(Volt)	
3	Current(Amp)	
4	Winding	
5	Excitation current(Amp)	
6	Speed(RPM)	

APPARATUS REQUIRED:

S.No	Meter	Type	Range	Quantity
1	Ammeter	MC	(0-5)A	1
2	Ammeter	MC	(0-2)A	1
3	Voltmeter	MC	(0-300)V	1
4	Rheostat	Wire wound		1
5	Tachometer	Digital	-----	1
6	Connecting wires			As required

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The motor is started with the help of three point starter by gradually cutting out the resistance of the starter.
3. The speed is adjusted to the rated speed (base speed) by adjusting the field rheostat (or) regulator.
4. Note down the readings of no-load current, field current, and voltage.
5. Bring the rheostat at minimum position and switch OFF the supply.

TABULAR COLUMN:

S.NO	I_{a0}(A)	I_{f0}(A)	I_{L0}(A)	V(V)	Speed (rpm)	R_a(Ω)

I_{a0} ----- No load armature current
I_{f0} ----- No load field current
I_{L0}----- No load current
Ra-----armature resistance

CALCULATIONS:

MOTOR:

Full load current I_l = _____Amps
Input Power = $V*I_o$
$Ia_0 = Io - Ish$
Cu losses in armature = $Ia_0^2 * Ra$
Constant losses = No-load input power - Cu losses
Constant losses = $V*I_0 - Ia_0^2 Ra$
Total losses = Constant losses + Cu losses
Out put = Input - total losses
Efficiency = (output / input) * 100

GENERATOR:

Full load current I_l = ______A
Full load cu losses=Ia^2Ra
$I_l + I_{sh} = I_a$
Generator output=$V*I_l$
Input = output +Total losses
Efficiency= (output/input) * 100

RESULT:

Hence the Efficiency of DC machine is calculated at different loads using Swinburne's test.

Title: Brake test on a DC Compound Motor

Aim:

To determine the performance characteristics of a DC compound motor.

Name Plate Details:

s.no	Compound Motor	
	HP rating	
	voltage	
	Excitation	
	current	
	Speed	

Apparatus Required:

S.NO	Meter	Range	Type	Quantity
1	Voltmeter	(0-300V)	MC	1
2	Ammeter	(0-2A)	MC	1
3	Ammeter	(0-20A)	MC	1
4	Tachometer	---	Digital	1
5	Rheostat		Wire wound	1
6	Connecting	----	----	required

Procedure:

1. Make the connections as per the circuit diagram.
2. Check spring balance reading and adjust them to zero initially.
3. Start the motor by moving the starter handle slowly.
4. The speed is adjusted to rated speed by adjusting the field rheostat (or) regulator.
5. The meter readings are noted at no load condition.
6. Gradually increase the load on the motor by rotating the handle of the spring balance, step by step.
7. At each step, note down the readings of Ammeter, Voltmeter, speed and spring balance readings.
8. This procedure is to be continued in steps up to rated current of the DC shunt motor.
9. Gradually remove the load till the spring balance reads zero, then switch off the supply.

TABULAR FORM:

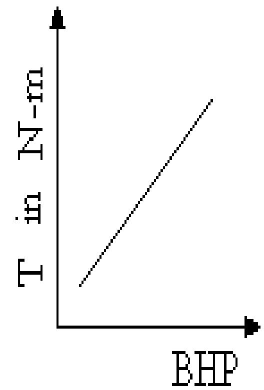
S. no	Input current (I_L)	Input voltage (V)	Speed (N)	Spring balance		Torque =(W_1-W_2) 9.81*R	i/p power =V*I_L	o/p power 2∏NT/ 60	Efficiency(η = (o/p / i/p)
				W1	W2				
1									
2									
3									
4									
5									

CALCULATIONS:

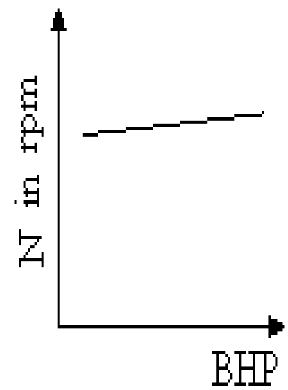
Radius of the pulley =R
Torque T= (W_1-W_2)*R*9.81 N-m
Output of the motor=2ΠNT/60 in watt
B.H.P=Output / 735.5
Input of the motor = VI watts
% Efficiency= (Output/Input)*100

Model Graphs:

1. plot BHP Vs Efficiency



2.plot BHP Vs Torque



3.plot BHP Vs Speed

Precautions:

1. Take care while using the starter.
2. The speed should be adjusted to rated speed.
3. There should be no loose connections.
4. Pour water in the brake drum for cooling purpose.

RESULT:

Hence the performance characteristics of a DC compound motor are determined by conducting brake test.

Title: Magnetization characteristics of DC shunt Generator

Aim:

To obtain the magnetization characteristics of DC shunt Generator and determination of critical field resistance.

Name plate details:

Motor		Generator	
Power Output (HP)		Power output(HP)	
Voltage		Voltage	
Current		Current	
excitation		excitation	
Speed		speed	

Apparatus required:

S.No	Meter	Type	Range	Quantity
1	Ammeter	MC	(0-2)A	1
2	Voltmeter	MC	(0-300)V	1
3	Voltmeter	MC	(0-300)V	1
4	Rheostat	Wire wound		2
5	Tachometer	Digital		1
6	Connecting wires			As required

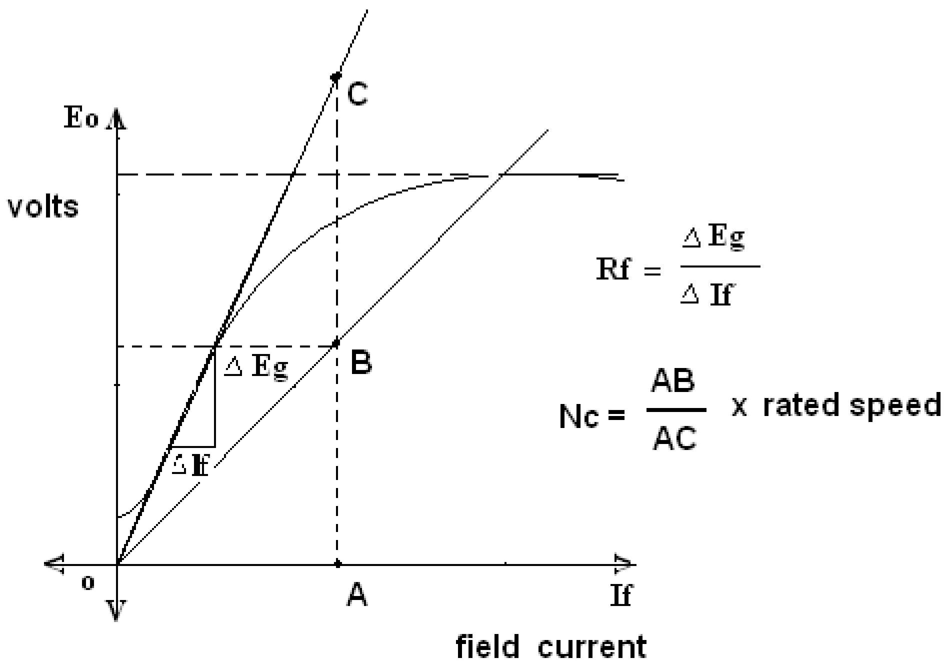
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The motor is started with the help of three point starter by gradually cutting out the resistance of the starter.
3. The speed is adjusted to the rated speed by adjusting the field rheostat (or) regulator.
4. Increase the field current of the generator by using potential divider till 125% of the rated voltage is obtained.
5. Note down the ammeter and voltmeter reading each time adjusting the speed of the machine to rated value if necessary.

Tabular column:

S.NO	E_0(V) (Open circuit voltage)	I_f (A) (Field current)	$R_f = E_0/ I_f$ (Field resistance)

MODEL GRAPH:



RESULT:
Hence the magnetization characteristics of DC shunt Generator are obtained.

Title: Load Test on DC shunt Generator

AIM:

To determine the internal and external characteristics of DC shunt generator by conducting load test.

Name Plate Details:

Motor		Generator	
Power Output (HP)		Power output(HP)	
Voltage		Voltage	
Current		Current	
excitation		excitation	
Speed		speed	

Apparatus Required:

S.NO	Meter	Type	Range	Quantity
1	Volt meter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Ammeter	MC	(0-2)A	1
4	Rheostat	400Ω/1.7A		2
5	Resistive load	230V,16A		1
6	Connecting wires	-----		required

Procedure:

1. Connect the circuit as per the circuit diagram.
2. Keep the motor field rheostat at minimum resistance position.
3. Switch on the supply and start the motor with the help of starter.
4. Adjust the speed by varying the motor field resistance slowly.
5. Now switch ON the load and for different values of load, note the ammeter and voltmeter readings.
6. After loading the generator up to the rated value gradually reduce the load in steps and switch off the supply.

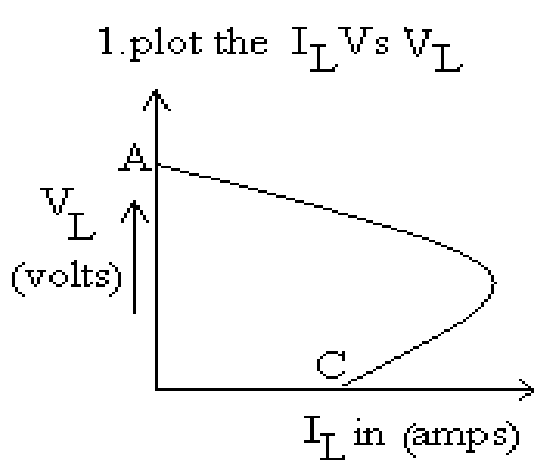
Observations:

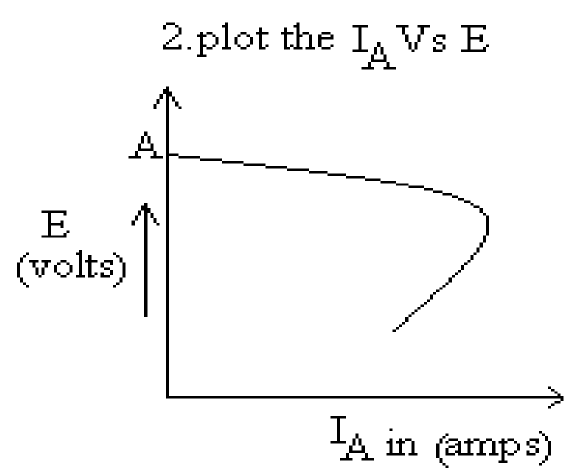
Speed N=_______rpm

Armature resistance Ra =______ohm

S.NO	I_L in Amps	V in volts	I_a=I_L+I_F	E_g= V+I_aR_a

Model Graphs:





Precautions:

1. Take care while using the starter.
2. The speed should be adjusted to rated speed.
3. There should be no loose connections.

Result:

Internal and external characteristics are plotted by conducting load test on D.C shunt Generator.

Title: Field Test on DC Series Machines

Aim:
To determine the efficiency of the two DC series machines by conducting field test.

Name Plate Details:

Motor		Generator	
Power Output (HP)		Power output(HP)	
Voltage		Voltage	
Current		Current	

excitation		excitation	
Speed		speed	

Apparatus Required:

S.NO	Meter	Type	Range	Quantity
1	Volt meter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Ammeter	MC	(0-2)A	1
4	Rheostat	400Ω/1.7A		2
5	Resistive load	230V,16A		1
6	Connecting wires	-----		required

Procedure:

1. Connections are made as per the circuit diagram.
2. Start the motor by moving the handle of the starter slowly
3. Now keep the input DC voltage constant at 220V DC.
4. Now increase the load of the generator up to the rated value of armature current and note down the readings of ammeter, voltmeters connected in the circuit.
5. Reduce the loads one by one till the motor speed does not exceed 1800rpm.
6. Note down the readings of the instruments at different loads.
7. Gradually, reduce the armature voltage of the prime mover and then switch off the Supply

Observations:

Armature resistance of the motor $\mathbf{R_{a1}}$=
Series field resistance of the motor $\mathbf{R_{se1}}$=
Armature resistance of the generator $\mathbf{R_{a2}}$=
Series field resistance of the generator $\mathbf{R_{se2}}$=

S.NO	V_1(volts)	I_1 (Amps)	V_L (volts)	I_L (amps)	N (rpm)
1					
2					
3					

Calculations:

Power input $P_{in} = V_1 I_1$
Power out put $P_{out} = V_L I_L$
Total losses of the two machines $P_L = P_{in} - P_{out}$
Field copper losses in the motor= $I_1^2 R_{se1}$
Field copper losses in the generator= $I_1^2 R_{se2}$
Armature copper losses in the motor= $I_1^2 R_{a1}$
Armature copper losses in the generator= $I_L^2 R_{a2}$
Total copper losses in the field and armature of the motor and generator is P_{cu}

$$P_{cu} = I_1^2 R_{se1} + I_1^2 R_{se2} + I_1^2 R_{a1} + I_L^2 R_{a2}$$

Stray losses per each machine $W_s = (P_L - P_{cu})/2$

Motor efficiency calculations:

Power input to the motor $P_{in} = V_1 I_1$
Total losses in the motor $P_T = I_1^2 R_{se1} + I_1^2 R_{a1} + W_s$
Motor output $P_{out} = P_{in} - P_T$
%Efficiency $\eta = P_{out} / P_{in} {}^* 100$

Generator efficiency calculations:

Generator output $P_{out}(g) = V_L I_L$
Total losses of the generator $W_{gt} = W_s + I_L^2 R_{se2} + I_L^2 R_{a2}$
Power input to the generator $P_{in} = P_{out}(g) + W_{gt}$
% Efficiency of the generator $\eta = P_{out(g)} / P_{in} {}^* 100$

Precautions:

1. Don’t switch on the supply with out any load.

2. Take care while using the starter.
3. The speed should be adjusted to rated speed.
4. There should be no loose connections.

Result:

The efficiency of the Dc series motor and series generator are determined.

Title: LOAD TEST ON D.C COMPOUND GENERATOR

Aim:
To determine the internal and external characteristics of a DC compound generator by conducting load test.

Name Plate Details:

Motor		Generator	
Power Output (HP)		Power output(HP)	
Voltage		Voltage	
Current		Current	

excitation		excitation	
Speed		speed	

Apparatus required :

S.NO	Meter	Type	Range	Quantity
1	Volt meter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Ammeter	MC	(0-2)A	1
4	Rheostat			2
5	Resistive load	230V,16A		1
6	Connecting wires	-----		required

Procedure:

1. Connect the circuit as per the circuit diagram.
2. Keep the motor field rheostat at minimum resistance position.
3. Switch on the supply and start the motor with the help of starter.
4. Adjust the speed by varying the motor field resistance slowly.
5. Now switch ON the load and for different values of load, note the ammeter and voltmeter readings.
6. After loading the generator up to the rated value gradually reduce the load in steps and switch off the supply.

Tabular column:

S.NO	$I_{L\ (Amps)}$	V (Volts)	$Eg = V_t + I_{se} R_{se}$	Speed
1				
2				
3				
4				

Precautions:

1. Don't switch on the supply with out any load.
2. Take care while using the starter.
3. The speed should be adjusted to rated speed.
4. There should be no loose connections.
5. Remove the load gradually in steps and switch off the motor.

Result:

The internal and external characteristics of DC compound generator are drawn by conducting load test.

Title: Brake Test on DC shunt Motor

AIM:

To determine the performance characteristics of DC shunt motor by conducting Brake test.

NAME PLATE DETAILS:

S.NO	NAME	RATING
1	Power outout(HP)	
2	voltage	

3	Current	
4	Excitation	
5	Speed	
6	Winding	

APPARATUS REQUIRED:

S.NO	Name of the eqyuipment	Range	Type	QUANTITY
1	Voltmeter	(0-300V)	MC	1
2	Ammeter	(0-2A)	MC	1
3	Ammeter	(0-20A)	MC	1
4	Tachometer	----	digital	1
5	Rheostat	400 Ω/1.7A	Wire wound	1
6	Connecting wires			required

Procedure:

1. Make the connections as per the circuit diagram.
2. Check spring balance reading and adjust them to zero initially.
3. Start the motor by moving the starter handle slowly.
4. The speed is adjusted to rated speed by adjusting the field rheostat (or) regulator.
5. The meter readings are noted at no load condition.
6. Gradually increase the load on the motor by rotating the handle of the spring balance, step by step.

7. At each step, note down the readings of Ammeter, Voltmeter, speed and spring balance readings. This procedure is to be continued in steps up to rated current of the DC shunt motor.
8. Gradually remove the load till the spring balance reads zero, then switch off the supply.

TABULAR FORM:

S.No	Input current (I_L)	Input voltage (V)	Speed (N)	Spring balance		Torque =(W_1-W_2) 9.81*R	i/p power =V*I_L	o/p power 2∏NT/60	Efficiency (η=o/p / i/p)
				W1	W2				

CALCULATIONS:

Radius of the pulley =R

Torque T= (W_1-W_2)*R*9.81 N-m

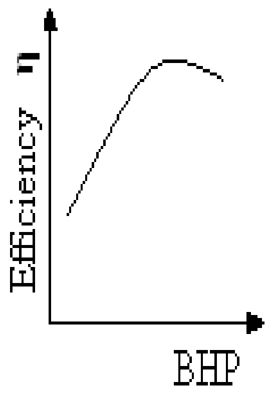
Output of the motor=2ΠNT/60 in watt

B.H.P=Output/735.5

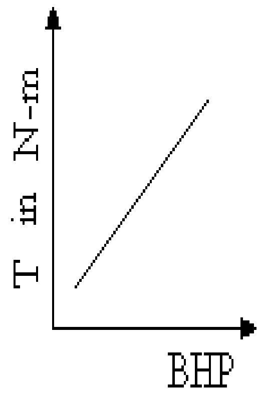
Input of the motor=VI watts

%efficiency= (Output/Input)*100

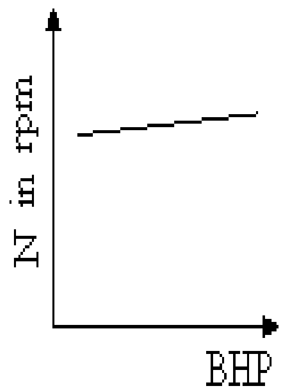
Model graphs



1. plot BHP Vs Efficiency



2.plot BHP Vs Torque



3.plot BHP Vs Speed

Precautions:

1. Take care while using the starter.
2. The speed should be adjusted to rated speed.
3. There should be no loose connections.
4. Pour water in the brake drum for cooling purpose.

RESULT:
Hence the performance characteristics of a DC shunt motor are determined by conducting brake test.

Title: RETARDATION TEST

Aim:

To determine the stray losses and efficiency of a DC shunt machine by conducting retardation test.

Name plate details:

S.NO	NAME	RATING
1	Power outout(HP)	
2	voltage	

3	Current	
4	Excitation	
5	Speed	
6	Winding	

Apparatus Required:

S.No	**Meter**	**Type**	**Range**	**Quantity**
1	Ammeter	MC	(0-10)A	1
2	Ammeter	MC	(0-2)A	1
3	Voltmeter	MC	(0-300)V	1
4	Rheostat	Wire wound	(400Ω/1.7A)	1
5	Tachometer			1
6	Connecting wires			As required

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Initially the switch S_2 is open and S_1 is closed then the motor is started with the help of three point starter.
3. The speed is adjusted to the rated speed by adjusting the field rheostat (or) regulator.
4. The voltage is noted then switch S_1 is opened and also note down the time taken to reach the armature voltage to a voltage of 25%,50%,75% less than the initial value.

5. Again S_1 is closed immediately before the motor reaches to zero speed and rheostats are adjusted until the motor reaches its rated speed.
6. Then S_1 is opened and at a time S_2 is closed at this instant record the readings of ammeter and also note down the time taken to reach the armature voltage to a voltage of 25% less than the initial voltage.

TABULAR COLUMN:

S_1 close and S_2 open

S.NO	V(Volts)	I_f(A)	Time(t1)

S_1 open at a time S_2 close

S.NO	V(Volts)	I_f(A)	Time(t1)

CALCULATIONS:

Rotational losses or stray losses $P_S=P_S^1(t_2/t_1-t_2)$

$P_S^1 = V_{avg} I_{Lavg}$

Input power = $V I_L$

I_L=full load current of the motor

Armature cu losses = $Ia^2 Ra$

$Ia = I_L-I_f$

Total losses = Armature cu losses + Stray losses

Output power=Input -Total losses

Motor efficiency ή = output/input.

Precautions:

1. Take care while using the starter.
2. The speed should be adjusted to rated speed.
3. There should be no loose connections.

Result:

Hence the stray losses and efficiency of a DC shunt machine are determined by conducting retardation test.

Title: HOPKINSON'S TEST

AIM:

To determine the efficiency of two similar DC shunt machines by conducting Hopkinson's Test

NAME PLATE DETAILS;

Motor		Generator	
Input Voltage		Rated Voltage	
Load current		Load current	

Field current		Field current	
Speed		Speed	
power		power	

APPARATUS REQUIRED:

S.NO	Meter	Type	Range	Quantity
1	Ammeter	MC	(0-15)A	2
2	Ammeter	MC	(0-2.5)A	2
3	Voltmeter	MC	(0-300)V	2
4	Rheostats		400Ω/1.7A	2
5	Tachometer			1
6	Connecting Wires			As required

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the rheostat in motor field at minimum and generator field at maximum resistance position and switch S is in open position.

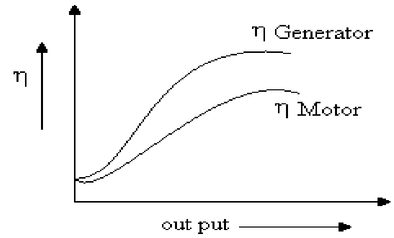
3. Start the motor slowly with three point starter and adjust the field to rated value by field rheostat of the motor.
4. The excitation of generator is adjusted such that generated EMF is equal to the rated value.
5. Under this condition voltmeter across the switch reads zero, at this instant close the switch S.
6. Load the generator in steps by decreasing the field resistance of the generator or by increasing the field resistance of the motor.
7. Take the readings of all the meters for each load.
8. Reduce the excitation of the generator by increasing the field rheostat of the generator and open the switch S.

TABULAR FORM:

S.NO	Speed N(rpm)	V(volts)	$I_1(I_{Lm})$	$I_2(I_{LG})$	$I_3(F_m)$	$I_4(I_{GF})$

S.NO	Motor i/p(watts)	Motor o/p(watts)	Motor Efficiency	Generator input	Generator output	Generator Efficiency

MODEL GRAPH:



CALCULATIONS:

Motor armature current = $(I_1+I_2-I_3)$

Motor armature Cu losses= $(I_1+I_2-I_3)^2 R_{am}$

Generator Armature current= (I_2+I_4)

Generator Armature cu losses = $(I_2+I_4)^2 R_{ag}$

Shunt field Cu loss for motor = VI_3

Shunt field Cu loss for Generator = VI_4

Input power to motor =VI_1 (watt) =Total losses of both the machines.

$VI_1 = (I_1+I_2-I_3)^2 R_{am} + (I_2+I_4)^2 R_{ag} + VI_3 + VI_4 +$ **Stray losses**

Stray losses of each machine=$VI_1/2$ watt

Motor efficiency:

Motor input power=$V(I_1+I_2)$ watt

Out put power= (input power-motor armature Cu loss-motor shunt field cu loss-stray losses)

Out put power =$V(I_1+I_2)-(I_1+I_2-I_3)^2R_{am}-VI_3-W_s/2$ watt

$\%\eta$= (Output/Input)*100

Efficiency of generator:

Generator out put power=VI_2**watts**

Input power=output generator armature Cu loss+generator field cu loss+stray loss

=$VI_2+(I_2+I_4)^2R_{ag}+VI4+Ws/2$ watts

$\%\eta$= (Output/Input)*100

PRECAUTIONS:

1. Keep the rheostat in motor and generator field circuit at proper positions while starting the motor.
2. Excessive care must be taken while closing the parallel switch **S** at which the voltmeter must read zero

RESULT:

Hence the efficiency of the motor and generator are determined by Hopkinson's test.

Title: Seperation of losses of DC Shunt Motor

Aim:

To find the separation of losses on a DC shunt motor.

Name plate details:

MOTOR	
HP	
Voltage	
Field Excitation	
Current	
Speed	

Apparatus Required:

S.NO	Meter	Type	Range	Quantity
1	Ammeter	MC	(0-2A)	1No.
2	voltmeter	MC	(0-300V	1No.
3	Tachometer	---	---	1No.
4	Rheostat	Wirewound	145Ώ/2.8A	1No.
5	Rheostat	Wirewound	145Ώ/2.8A	1No.
6	Connecting Wires	-----	-----	Required

PROCEDURE:

1. Make the connections as per the circuit diagram.

2. Keep the field rheostat in the minimum resistance position
3. Start the motor by moving the handle of the starter slowly.
4. Apply rated voltage and rated field current till the motor gets rated speed, note down the voltage voltage and armature current.
5. Keeping the field excitation constant, the speed of the can be varied by varying the armature rheostat.
6. Decrease the speed by varying armature rheostat, note down armature voltage, speed, and armature current.
7. The field current is adjusted 3/4th of normal field current, keeping it constant; again decrease the speed by varying armature rheostat, note down armature voltage, speed, and armature current.
8. The graphs for different excitations are plotted and calculate hysteresis loss and Eddy current loss.

Observations:

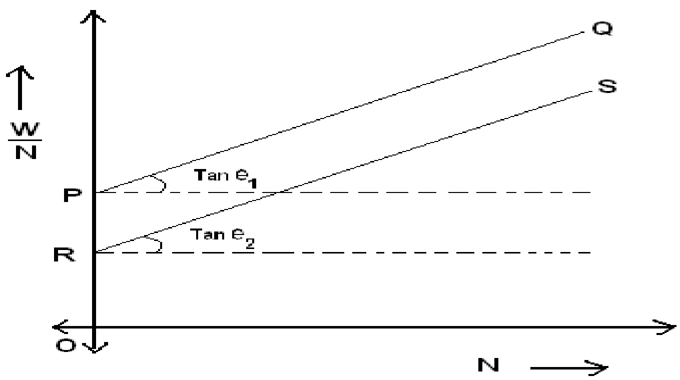
Flux control:

S.NO	Field current I_f (A)	Speed N (rpm)

Armature control:

S.NO	Voltage V (V)	Speed N (rpm)

MODEL GRAPHS:

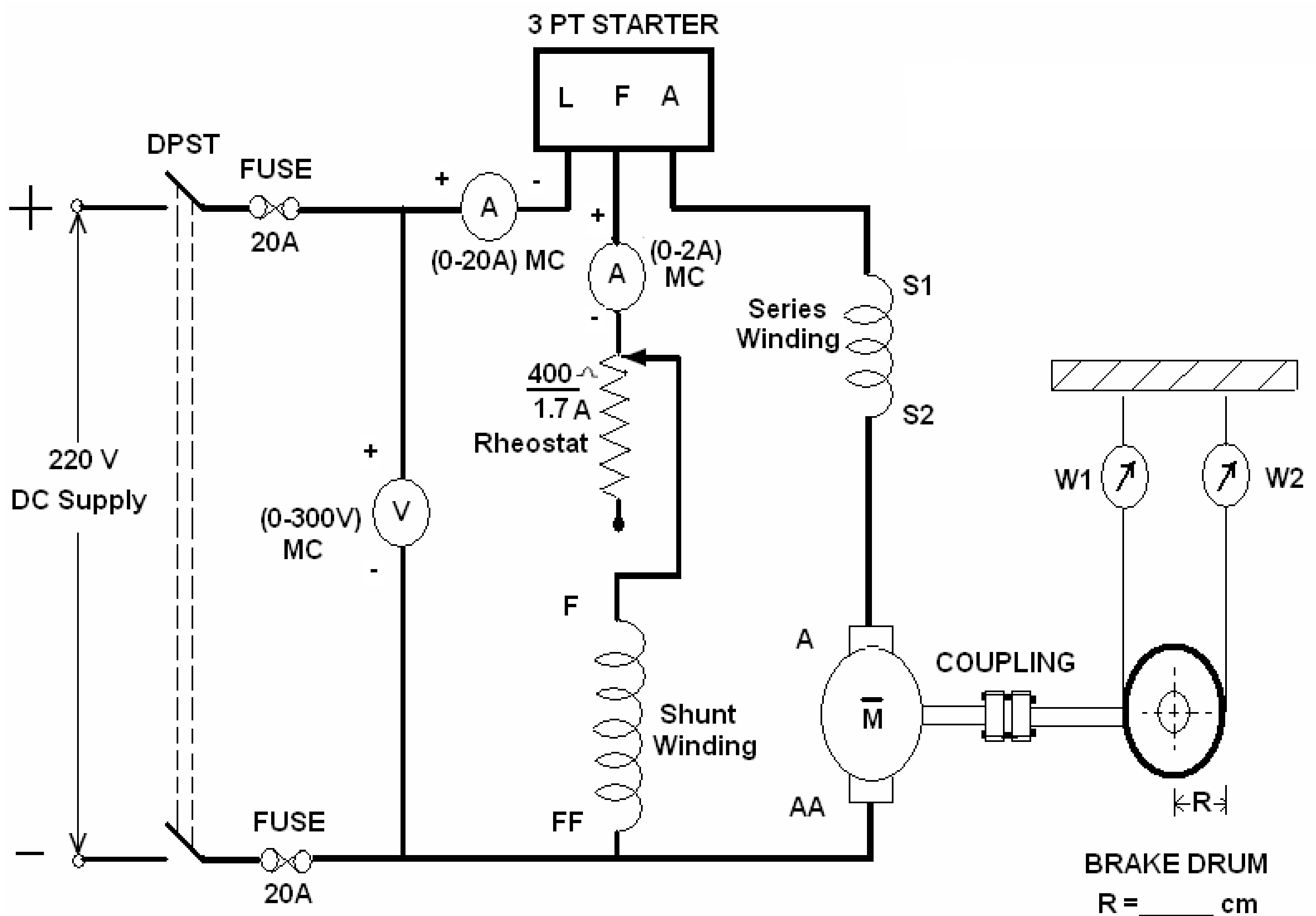


PRECAUTIONS:

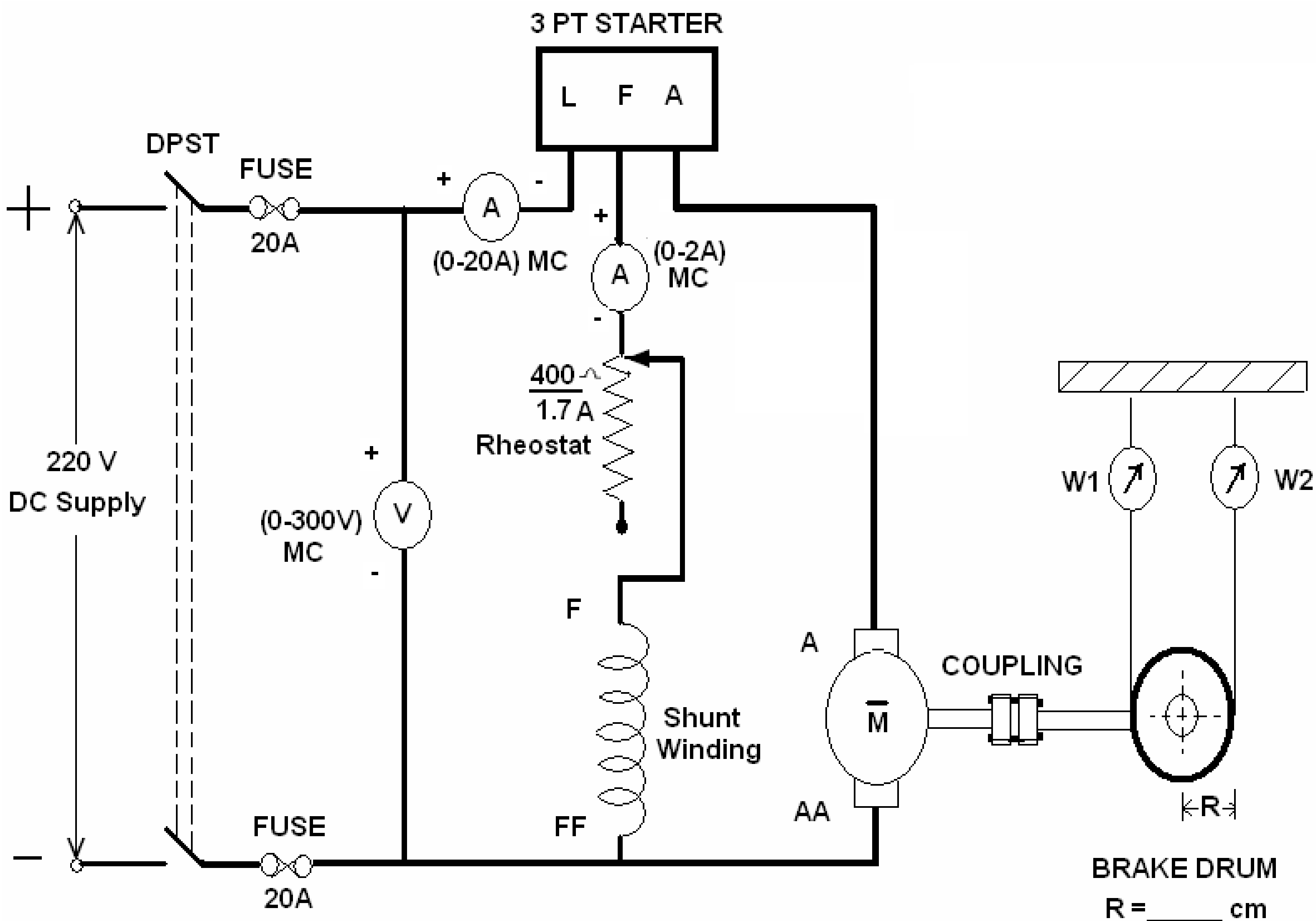
5. Take care while using the starter.
6. Keep the armature and field rheostats at proper positions.
7. The speed should be adjusted to rated speed.
8. There should be no loose connections.

RESULT:

TITLE : BRAKE TEST ON DC COMPOUND MOTOR
CIRCUIT DIAGRAM

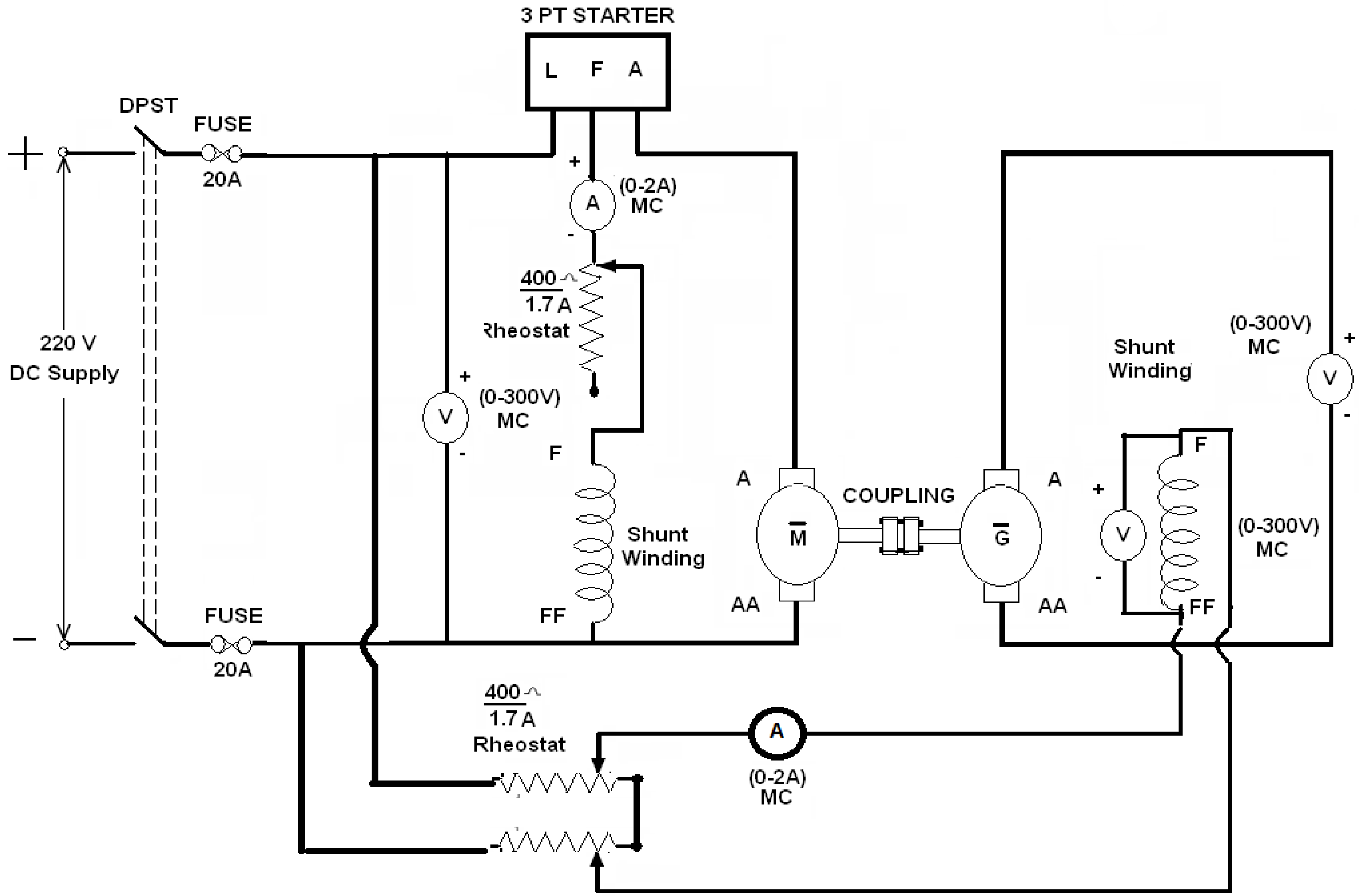


TITLE : BRAKE TEST ON DC SHUNT MOTOR
CIRCUIT DIAGRAM

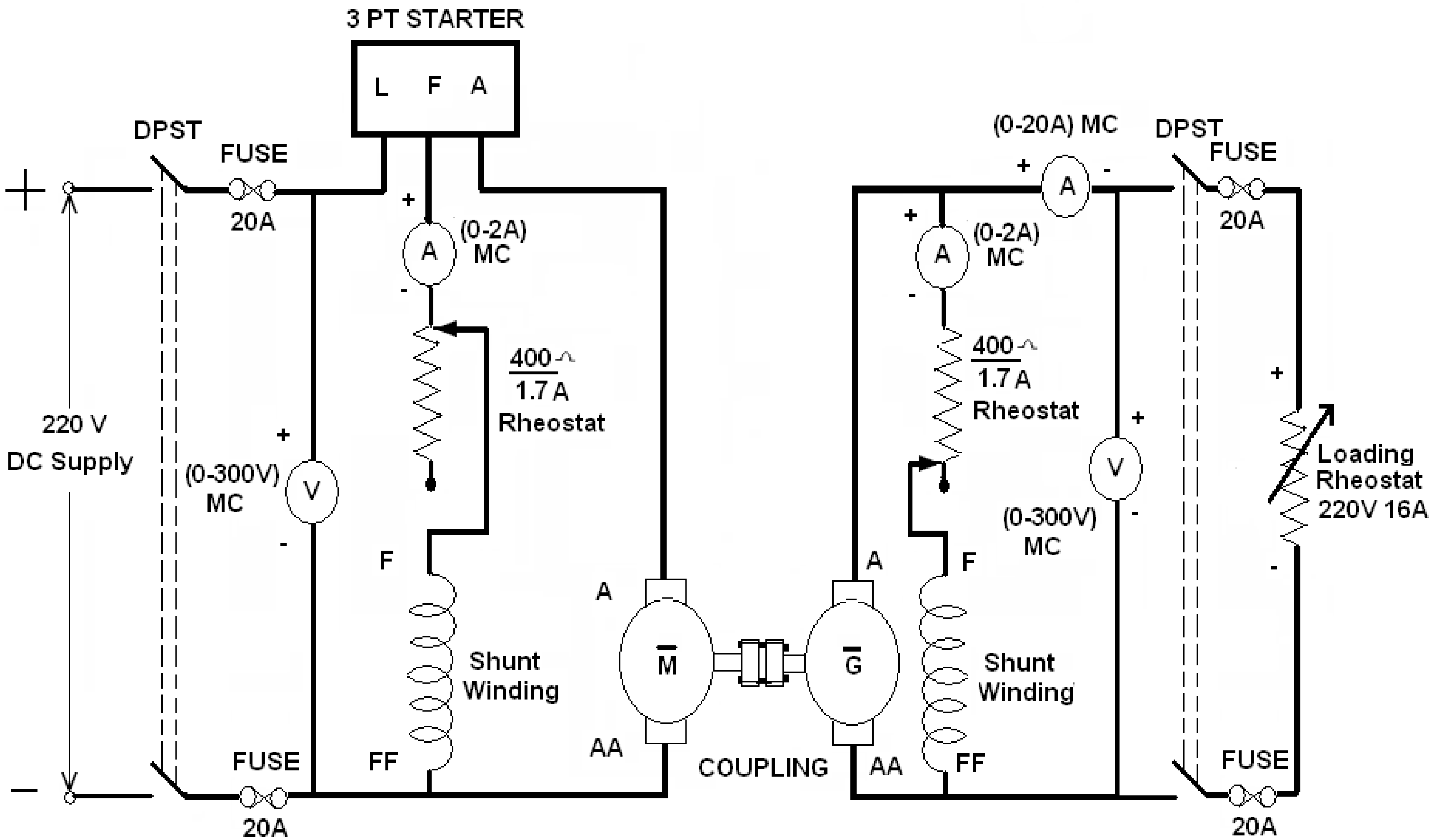


TITLE : MAGNESTISATION CHARACTERISTICS OF DC SHUNT GENERATOR

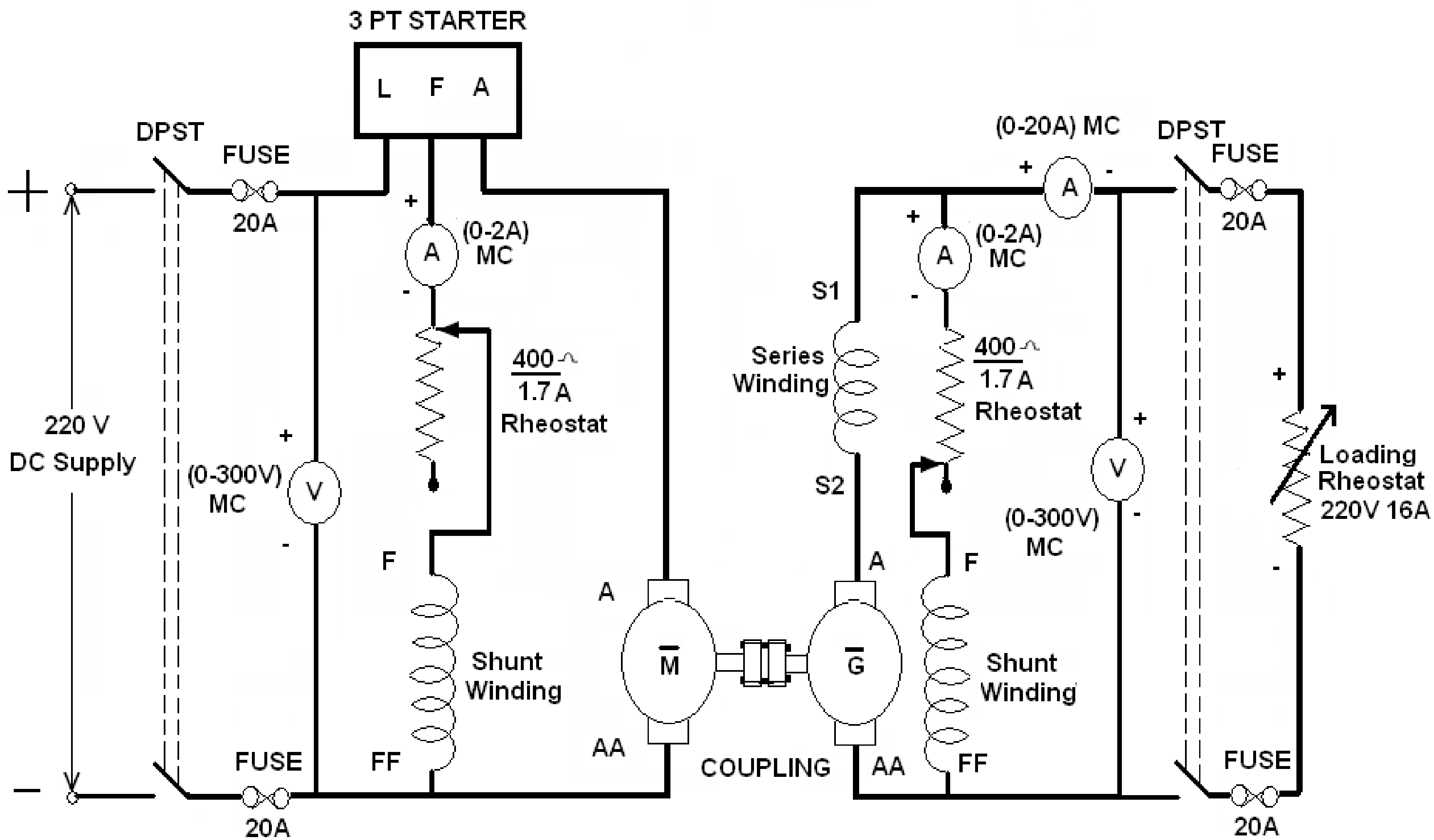
CIRCUIT DIAGRAM



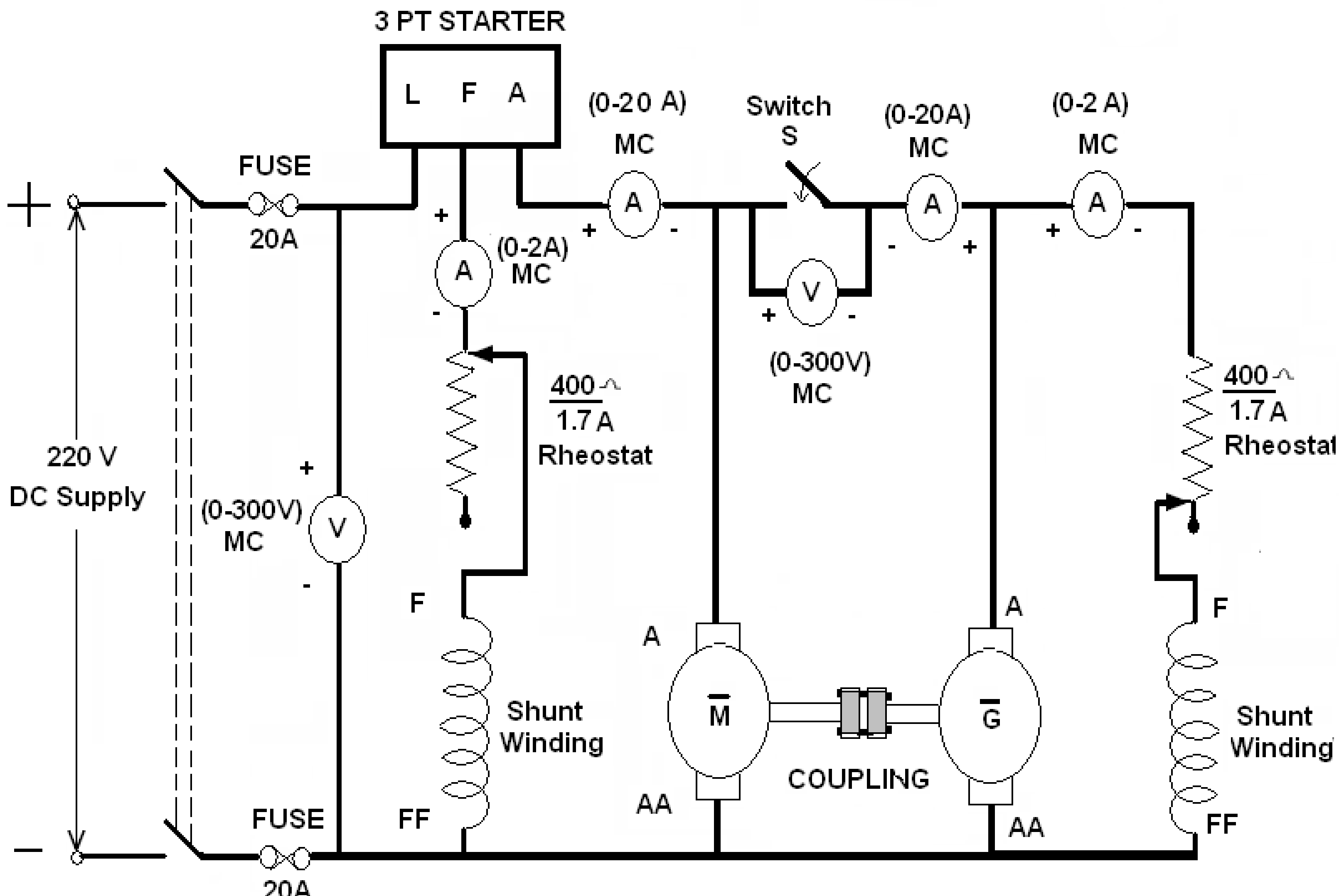
TITLE: LOAD TEST ON DC SHUNT GENERATOR
CIRCUIT DIAGRAM



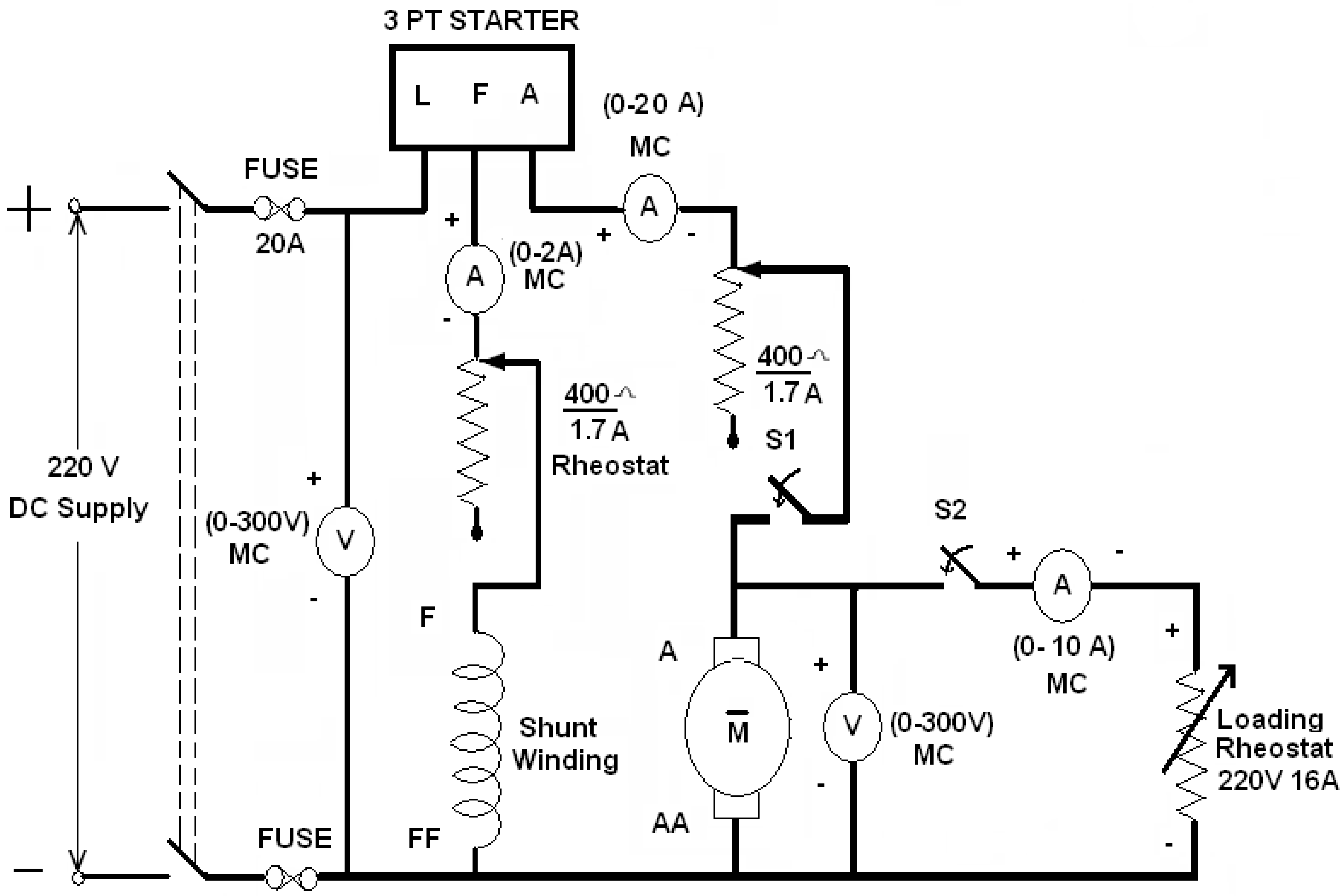
TITLE : LOAD TEST ON DC COMPOUND GENERATOR
CIRCUIT DIAGRAM



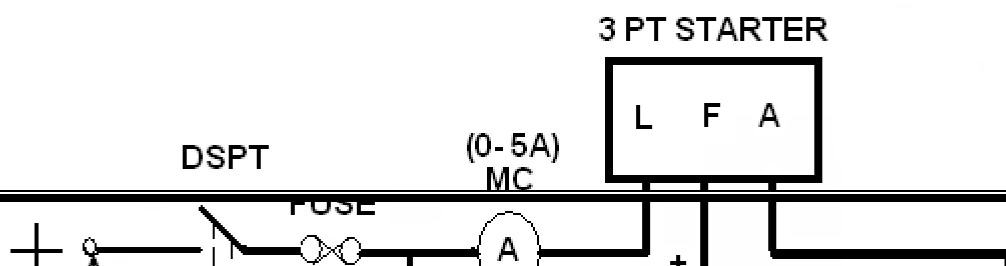
TITLE: HOPKINSON'S TEST ON TWO IDENTICAL DC MACHINES
CIRCUIT DIAGRAM



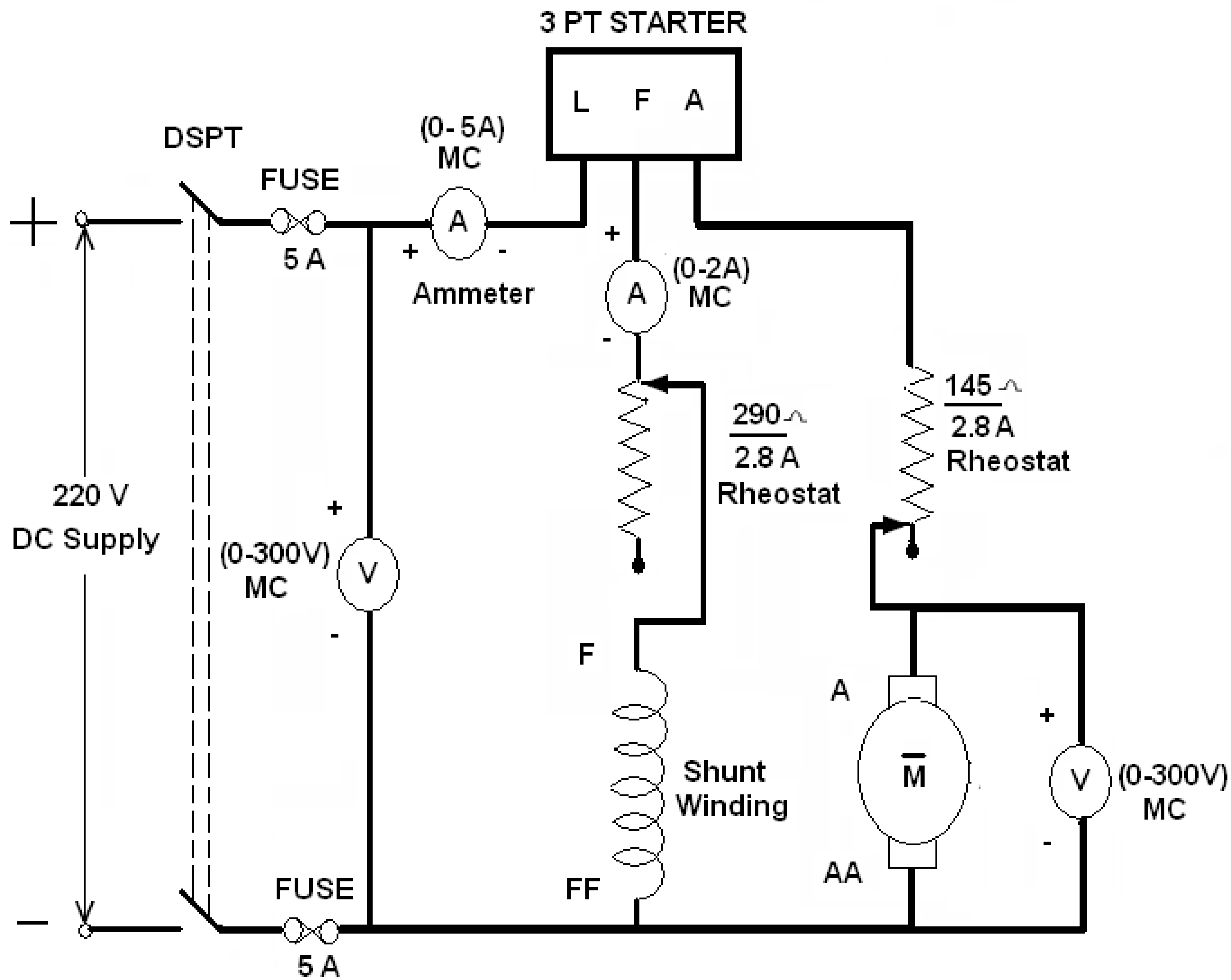
TITLE: RETARDATION TEST
CIRCUIT DIAGRAM



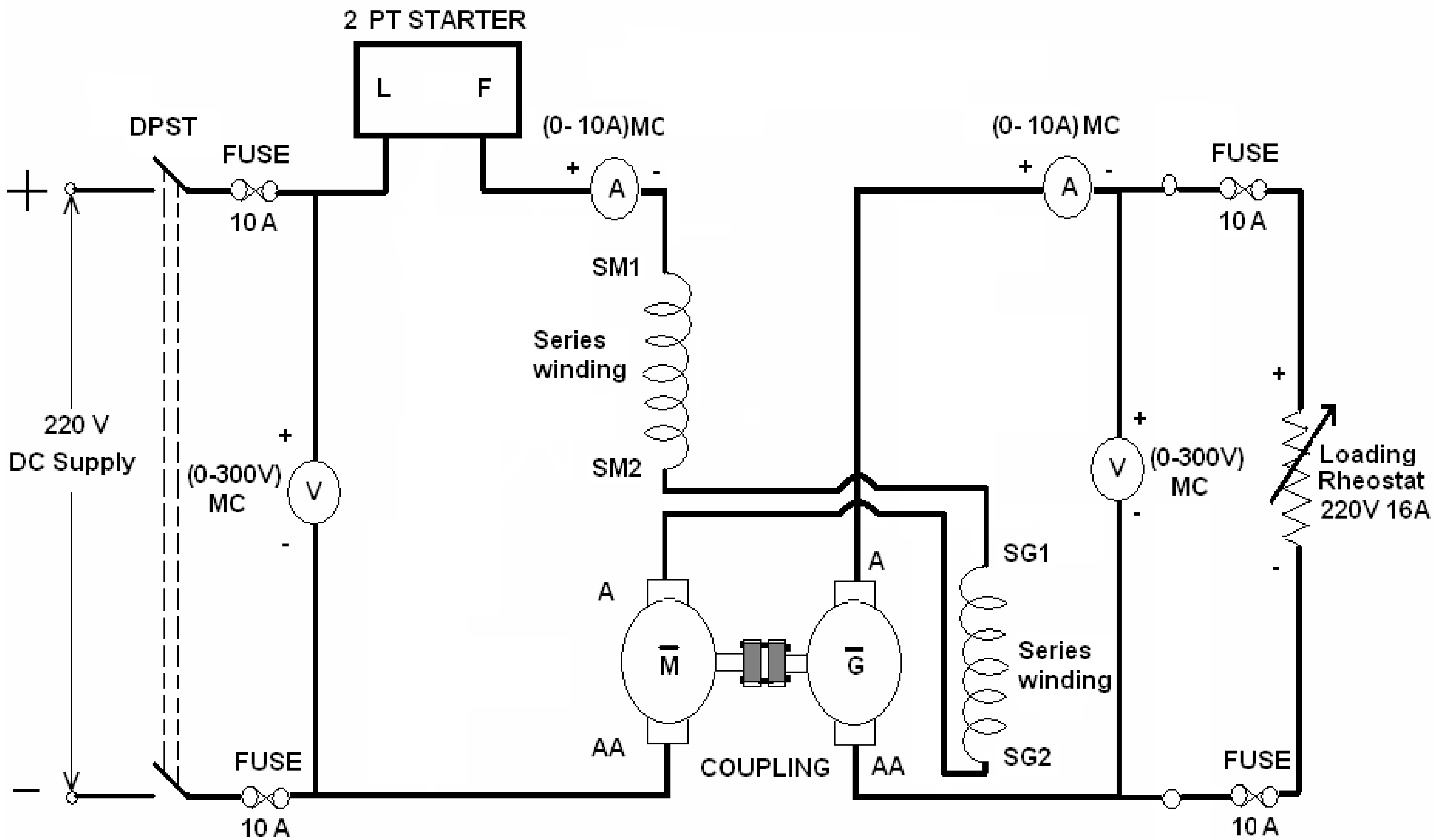
TITLE: SWINBURNE'S TEST
CRCUIT DIAGRAM



TITLE: SPEED CONTROL OF DC SHUNT MOTOR
CIRCUIT DIAGARM



TITLE: FIELD'S TEST ON TWO IDENTICAL DC SERIES MACHINES
CIRCUIT DIAGRAM



TITLE: SEPERATION OF LOSSES IN DC MACHINE
CIRCUIT DIAGRAM