NAME:               DATE:   
NUMBER:       
GROUP:       
PARTNER(S):       LABORATORY ROOM: 1816  
BENCH COLOUR: 

UTS Engineering  
48550 Electrical Energy Technology  

LABORATORY 4  

DC AND SINGLE PHASE COMMUTATOR MOTORS  

EACH STUDENT ATTENDING THIS LAB SHOULD READ CAREFULLY THE SAFETY PRECAUTIONS BELOW, SIGN THIS COVER SHEET AND RETURN IT TO YOUR LAB TUTOR  

- STUDENTS ARE WARNED OF POSSIBLE ELECTRIC SHOCK RISK AND FIRE RISK IN THE LAB AREA.  
- NO FOOD OR DRINK IS ALLOWED IN THE LAB.  
- AS THE BENCH POWER SUPPLIES HAVE 150 V AC AVAILABLE, THE TESTS COVERED IN THIS LAB CAN BE LETHAL IF A MISTAKE IS MADE.  
- FIND OUT THE LOCATION OF YOUR NEAREST EMERGENCY STOP BUTTON BEFORE STARTING.  
- DO NOT TURN ON THE SUPPLY UNTIL YOU HAVE DRAWN THE CIRCUIT DIAGRAM AND YOUR CONNECTIONS HAVE BEEN CHECKED BY YOUR TUTOR.  
- DO NOT DISCONNECT ANY LEADS WHILE THE SUPPLY IS ON.  
- ALWAYS SET THE VARIABLE VOLTAGE TO ZERO BEFORE TURNING ON THE SUPPLY.  
- RETURN THE VOLTAGE TO ZERO BEFORE SWITCHING OFF, UNLESS THERE IS AN EMERGENCY.  
- REMEMBER TO DIAL 6 FOR EMERGENCY.  
- REMEMBER TO DIAL 0000 FOR AMBULANCE.  

I have read these precautions and shall carry them out.  

SIGNED:               (PLEASE SIGN)
LAB 4 -- DC AND SINGLE PHASE COMMUTATOR MOTORS

AIM
1. Measurement of current/voltage and speed/voltage curves for separate and series excitations, DC and AC supplies.
3. Calculation of back e.m.f. and performance.

Apparatus
1. Lyb-o-tec bench with DC and three-phase AC power supplies.
2. 4-pole DC machine.
3. 3-phase, 4-pole stator, 3-phase, 4-pole salient rotor with slip-rings and AC brushgear for synchronous machine.
4. Torque measuring ring device (the effective radius of the torque ring is 150mm. The force is indicated on the dial gauge which is calibrated in ponds or in ponds and centi-Newton. 1 pond = 1grm. Wgt = 9.8 x 10^-3 Newtons).
5. 3-phase resistor set (0 - 8 ohms/phase).
6. Rectifier.
7. Metering equipment of the test bench.

EXPERIMENT
1. No-load Test
Complete the assembly of the machine by connecting it as a series motor (with 4 series field coils and the armature all in series).

Method
DC series motor
- Record the speed and current as a function of the supply voltage for the machine on no load. Take about 5 readings up to 1500 rev/min. **Do not exceed the speed rating of 1500 rev/min or the armature current rating of 20 A in any of these tests.**

AC series motor
- Using the same set-up, change the meters for AC and connect the machine to the AC supply.
- Repeat the tests above noting any distinctive features of AC operation.

DC separately excited motor
- Using the same machine rearrange the wire connections as follows:
  Connect the armature circuit directly to the DC supply.
  Disconnect the series field coils. Then connect the 4 shunt field coils in series including an ammeter and supply this circuit separately from a rectifier connected to the single phase AC supply. Set the field current to 1A.
- Repeat the tests above noting any changes as a separately excited motor.
2. **Load Test** (For separately excited DC motor only).

Couple the AC generator through the torque measuring ring for the load test and put the DC motor above the AC generator.

The AC generator stator windings (connected in delta) are connected to a load comprising the full 8 ohm resistor set connected in star. Include AC meters in one phase to measure the load voltage and current for calculating the load power.

Use a rectifier connected between two phases of the 3-phase power supply for the field excitation of the AC generator. Infinitely variable motor load control is obtained by varying the AC generator field current only.

For this test, assume the DC motor **current rating is 10 A** and **its base speed is 1000 rev/min**.

**Method**

- Maintaining the DC generator field current at 1.0 A. Adjust the AC generator excitation to give a DC motor load (armature current) of 10 A while adjust the armature voltage of DC motor to the voltage needed for 500 rev/min at 10 A. Record the DC voltage, speed, torque, AC voltage and current.
- Increase the speed of the DC motor from 500 rev/min to 1000 rev/min by adjusting the armature voltage of DC motor while adjust the AC generator excitation to maintain the DC motor load (armature current) at 10 A. Take about 5 readings over this range of DC voltages, speeds, torques, AC voltages and currents.
- When 1000 rpm is reached, hold the armature voltage constant at this value and decrease the DC field current of the DC motor in about 5 steps to 0.5 A. Adjust the AC generator excitation to maintain the DC motor load (armature current) at 10 A and take readings of DC voltages, speeds, torques, AC voltages and currents. **Do not exceed 1500 rev/min**.
- From these readings, plot the curves of torque and power against speed.

3. **Resistance test**

Measure the series field winding resistance and the armature resistance by the volt-ampere method.

**REPORT**

1. Report your results with the necessary diagrams and graphs as for the previous lab tests.
2. Explain the results of your experiments in Part 1 above and discuss the different types of behaviour observed in Part 2.
3. Determine and plot the back e.m.f. against the speed for the DC series motor.
4. From the linear part of the voltage/speed curve for the series DC motor evaluate the constant $k_f$ in the expression $$\omega_m = \frac{V_s}{\sqrt{kT_r}} - \frac{(R_a + R_f)}{k_f}$$ volts, which relates to the steady-state equivalent circuit of a series motor. Assuming the no-load torque $T_{loss}$ is constant, derive and plot the speed/torque curve for a supply voltage of 15 V.
5. Attach the signed results sheets.