OBJECTIVE:

Electrical machines course in one of the important courses of the Electrical discipline. In this course the different types of DC generators and motors which are widely used in industry are covered and their performance aspects will be studied

GROUP-I (SHORT ANSWER TYPE QUESTIONS)

S.No	QUESTION	BLOOMS TAXONOMY LEVEL	COURSE OUTCOME
	UNIT-I **Electromechanical Energy Conversion**		
1	Write the expressions of energy stored in capacitor and inductor	Remember	1
2	Define Fleming's right hand rule	Understand	1
3	On what factors, the EMF induced in a coil rotating in a magnetic field is depending?	Remember	2
4	Define the terms torque and force.	Remember	2
5	Give an expression for the energy density in an electric field.	Remember	2
6	Why energy storing capacity of electric field is much smaller than that of magnetic field?	Understand	1
7	What kind of emf (either dc or ac) is induced in a rotating coil of DC generator?	Understand	1
8	Mention the advantages of analyzing energy conversion devices by field – energy concept?	Remember	2
9	Draw the linear response of flux linkage VS current (Ψ – I) for mechanical work – done during transient movement of armature.	Understand	1
10	Predominant energy storage does not occur in the air – gap of an electromechanical energy conversion device. Is this statement correct? Give reason in support of your answer.	Understand	1
	UNIT-II **D.C. Generators & Armature Reaction**		
1	What is the necessity of laminating the armature core of a DC generator?	Understand	3
2	What do you mean by "back e.m.f" in DC Machine?	Understand	3

3	Mention the types of armature winding and their specifications.	Remember	4
4	Why electromagnets are preferred other than permanent magnets in large DC machines?	Understand	3
5	Mention the reasons, why armature of a DC machine is made of laminated silicon steel?	Understand	4
6	Write the basic equation of induced e.m.f in DC Generator.	Remember	3
7	For which kind of machines lap winding is preferred?	Understands	4
8	Define commutation Process in DC generators.	Remember	3
9	What is the main function of compensating winding?	Remember	4
10	What is the use of equalizer rings?	understand	4
	UNIT-III **Types of D.C Generators & Load Characteristics**		
1	Mention the three important characteristics of a DC generator.	Understand	5
2	What are magnetic saturation and residual magnetism in DC generators?	Remember	5
3	Draw the external characteristics of series wound DC generator.	Understand	6
4	A 1500 kw, 600V, 16-pole separately excited DC generator runs at 200 RPM. It has 2,500 lap connected conductors and full – load	Evaluate	5
5	What is meant by OCC of a DC generator and explain?	Analyze	6
6	In a DC generator, if the load increase the flux per pole decreases. Justify the statement.	Analyze	5
7	Compare separately excited DC generator with self excited DC generator.	Remember	5
8	Compare self and separately excited DC machines.	Understand	5
9	A 4-pole, 15KW, 240V DC machine is wave connected. If this machine is now lap connected, all other things remain the same, calculate the voltage and current ratings of machine.	Evaluate	5
10	What is the importance of critical field resistance?	Understand	5
	UNIT-1V **D.C. Motors & Speed Control Methods**		
1	Would you list out the types of DC generators based on field connections?	Remember	7
2	Write the expression for speed of DC motor in terms of number of conductors, supply voltage and armature current?	Apply	8
3	Show that, armature torque developed by motor is proportional to number poles and armature current.	Apply	7
4	Define shaft torque and Brake Horse Power.	Remember	7
5	How can determine the direction of rotation of a DC motor? And also explain how to change the direction of rotation?	Analyze	7
6	Explain why the EMF generated in the armature of a DC motor is called the "back emf".	Apply	7
7	What is a starter? Mention different types of starters for DC motor.	Remember	10
8	Draw the block diagram / circuit diagram of ward Leonard system and mention its applications.	Understand	9
9	On which factors speed of DC motor is depend?	Understand	8

10	Would you list out the applications series and compound motors?	Apply	7
	UNIT-V **Testing of D.C. Machines**		
1	Mention the various losses that occur in DC machines?	Remember	9
2	Write down mechanical efficiency and electrical efficiency expressions in terms of E_g & I_a, for DC generator?	Understand	9
3	What is the condition for maximum efficiency of any DC machine?	Analyze	9
4	What do you understand by Swinburne's test and what are its limitations?	Understand	9
5	On which factors Eddy current and Hysteresis losses are depends?	Understand	9
6	Does core loss occur in armature or in the poles of DC machine?	Understand	9
7	Which type of mechanical losses occurs in a DC machine?	Remember	9
8	If P_C and P_S is the full – load copper loss and stray power losses (including iron loss) of DC machine for which value of the ratio P_C/P_S will be the maximum efficiency occur at 80% of full – load?	Apply	9
9	Briefly explain with reason whether the field test on two identical DC series machines in generative method?	Understand	9
10	At which point of a conductor embedded in a slot does the maximum temperature occur?	Understand	9

GROUP-II (LONG ANSWER QUESTIONS)

UNIT-I **Electromechanical Energy Conversion**			
S.No	**QUESTION**	**BLOOMS TAXONOMY LEVEL**	**COURSE OUTCOME**
1	Draw and explain schematic diagram of flow of energy in the conversion of electrical energy into mechanical term.	Understand	1
2	With a neat schematic of electromagnetic system derive the expression for the energy absorbed by establishing flux linkages Ψ.	Remember	2
3	How the force between two parallel faces in a singly excited system calculated?	Understand	1
4	The typical saturation level flux density of a given ferromagnetic material is 1.4 T. Find the force density on iron face.	Evaluate	2
5	Derive the expression of torque developed in doubly excited magnetic system?	Remember	2
6	Discuss in brief about interaction and reluctance torques.	Understand	1
7	Briefly write and explain the energy balance equation of a motor.	Remember	2
8	Distinguish between the terms "energy" and "co energy"	Understand	1
9	Mention the examples of singly – excited and doubly – excited electromechanical energy conversion devices.	Remember	2

10	When the armature of an electromagnetic relay moves to close the air gap instantaneously, where does the energy come from for doing mechanical work?	Apply	1
	UNIT-II **D.C. Generators & Armature Reaction**		
1	Explain in detail how direct quantity is obtained as an output in dc generator with the help of neat sketches?	Understand	3
2	a) What is the effect of armature reaction at leading and trailing pole tips of a dc generator? Explain with the help of neat sketches. b) Discuss the methods to minimize the effect of armature reaction in brief.	Understand	4
3	Describe the construction of DC machine with neat diagram and also derive the EMF equation of DC generator from its first principle.	Remembre	3
4	a) Define armature reaction & state its effect. b) What is back EMF? State its significance	Understand	4
5	Explain the principle of operation in dc generator with neat sketches.	Remember	3
6	Derive the expression for cross magnetizing effect of dc generator.	Remember	4
7	Derive the expression for de-magnetizing effect of dc generator.	Remember	4
8	Explain the commutation process in dc generator and also explain the commutation improving methods?	Understand	4
9	Explain the types of windings with applications.	Understand	3
10	Compare lap and wave winding at least in 8 aspects.	Remember	3
	UNIT-III **Types of D.C Generators & Load Characteristics**		
1	Explain the condition of non building up of e.m.f. in generator and also explain the remedies.	Understand	5
2	What are the different types of self-excited dc generators?	Remember	5
3	Draw and explain the load characteristics of a separately-excited dc generator.	Analyze	5
4	Explain the no load characteristics of dc series and shunt generators	Understand	5
5	Explain the no load characteristics of dc compound generators	Understand	5
6	Explain the parallel operation and conditions for parallel operation.	Understand	5
7	Explain the load characteristics of dc shunt and series generator.	Understand	5
8	Explain the load characteristics of dc compound generators.	Understand	5
9	Explain the purpose of using equalizing bars in parallel operation.	Analyze	6

10	Derive the terminal voltage and current expressions for the self and separately excited dc generators.	Remember	5
	UNIT-IV **D.C. Motors & Speed Control Methods**		
1	i) With the help of speed torque characteristics, explain the motoring function of DC compound motor. ii) Which type of speed control techniques used in DC motor? Explain each one of them	Understand & Remember	9
2	Explain the principle of operation of dc motor with neat sketch.	Understand	7
3	Derive the expression for torque in dc motor.	Remember	7
4	Derive the terminal voltage and current expressions for the self and separately excited dc motors	Apply	7
5	Explain the applications of self and separately excited dc motors.	Understand	7
6	Explain the following speed control methods. a) Armature control b) flux control	Understand	8
7	Explain the Ward-Leonard system of speed control.	Remember	8
8	Explain the principle of operation of 3- point starter.	Understand	10
9	Explain the principle of operation of 4- point starter.	Understand	10
10	Explain the necessity of starters in dc machine and compare the 3-point and 4-point starters.	Understand	10
	UNIT-V **Testing of D.C. Machines**		
1	Explain the experimental procedure to conduct 'Retardation Test' on a dc shunt machine with the help of connection diagram. How the different losses are estimated from the test results?	Understand	9
2	i) With neat circuit diagram, explain the procedure to conduct Swinburne's test. ii) List the calculations to be made to predetermine the efficiency of DC motor by using Swinburne's test results.	Remember	9
3	Derive the expression for condition for maximum efficiency.	Understand	9
4	Explain how many losses are there in dc machine with equations.	Remember	9
5	Explain the procedure to conduct Hopkinson's test with neat sketches.	Understand	9
6	Explain the procedure separate the losses in dc machine with neat sketches.	Remember	9
7	Classify the methods of testing? And compare them.	Remember	9
8	Indirect test is superior to the direct test justify this statement with proof.	Analyze	9
9	With neat circuit diagram Calculate the efficiency by break test.	Apply	9
10	Draw and explain the internal and external characteristics of dc motor.	Understand	9

GROUP-III (ANALYTICAL QUESTIONS)

S.No	QUESTION	BLOOMS TAXONOMY LEVEL	COURSE OUTCOME
	UNIT-I **Electromechanical Energy Conversion**		
1	For a certain relay, the magnetization curves for open and closed positions of the armature are linear. If the armature of the relay moves from open to closed position at constant current shows that the electrical energy input is shared equally between field energy stored and the mechanical work done.	Analyze	1
2	Two magnetic surfaces separated by distance g have a flux density of 1.6 T in between them. This value is usually the saturation level for ferromagnetic materials. Find the force between these two surfaces for area A= $1m^2$	Analyze	2
3	Two parallel plates, each of area A=$1m^2$, are separated by a distance g. The electric field intensity between the plates is $3*10^6$ V/m, a value equal to the break down strength of air. Find force between the two plates. Use both energy and co energy methods	Apply	2
4	A solenoid of height h and radius r has N turns. For a solenoid current I, calculate a) the energy stored inside the solenoid b) the radial magnetic force tending to burst out the solenoid c) The radial pressure on the sides of solenoid d) the solenoid inductance.	Analyze	2
5	An inductor of resistance 4 Ω and inductance 2 His switched on to a voltage source which varies linearly from 0 to 8 V in 2 sec and then stays constant. Find the energy stored in inductor (a) during the 2 sec period (b) after all the transients are over.	Apply	1
6	An inductor has an inductance which varies with displacement x as L=2Lo/(1+(x/x_o)) where Lo =50mh, Xo =0.05cm, X=displacement in cm. The coil resistance is 1Ω. a) The displacement x is held constant at 0.75 cm, and the current is increased from0 to 3 amp. Find the resultant magnetic stored energy in the inductor. The current is then held constant at 4 amps and the displacement is increased to 0.5 cm. Find the corresponding change in the magnetic stored energy.	Apply	1
7	Show that the torque developed in a doubly-excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant currents.	Apply	2
	A doubly excited rotating machine has the following self and mutual inductances	Apply	1

8	Rs=40Ω , Ls =0.16 H, Rr =2 Ω, Lr =0.04+0.02cos2Ø, Msr =0.08cosØ Where Ø is the space angle between axes of rotor- coil and of stator coil. The rotor is revolving at a speed of 100 radians/sec. For i_s=10 Amp d.c, and i_r =2 Amp d.c obtain an expression for torque and corresponding electrical power.		
9	An inductor has an inductance which varies with displacement x as L=2Lo/(1+(x/x_o)) where Lo =50mh, Xo =0.05cm, X=displacement in cm. The coil resistance is 0.5Ω. b) The displacement x is held constant at 0.075 cm, and the current is increased from0 to 3 amp. Find the resultant magnetic stored energy in the inductor. c) The current is then held constant at 3 amps and the displacement is increased to 0.15 cm. Find the corresponding change in the magnetic stored energy.	Analyze	1
10	If the inductor is the previous case is connected to a voltage source which increases from 0 to 3 V and then is held constant at 3 V, repeat the problem, assuming that electrical transients are negligible.	Evaluate	1
	UNIT-II **D.C. Generators & Armature Reaction**		
1	A d.c. generator generates an e.m.f of 520 V and has 2000 armature conductors, flux per pole of 0.013 wb, speed of 1200 r.p.m and the armature winding has four parallel paths. Find the number of poles	Apply	3
2	A 4 pole machine running at 1500 r.p.m has an armature with 90 slots and 6 conductors per slot .The flux per pole is 10mwb .Determine the terminal e.m.f as d.c generator if the coils are lap connected .If the current per conductor is 100A,determine the electrical power generation.	Apply	3
3	Calculate the demagnetizing amp-turns of a 4 pole lap wound generator with 720 turns, giving 50 A ,if the brush lead is 10^0 (mechanical)	Apply	4
4	An 8 pole lap connected d.c. shunt generator delivers an output of 240 A at 500 V. The armature has 1408 conductors and 160 conductor segments. If the brushes are given a lead of 4 segments from the no-load neutral axis, estimate the de-magnetizing and cross-magnetizing AT/Pole	Apply	4
5	A 22.38 kw, 440 V, 4-pole wave wound d.c. shunt motor has 840 armature conductors and 140 commutator segments. Its full-load efficiency is 88% and the shunt field current is 1.8 A. If brushes are shifted backwards through 1.5 segments from the geometrical neutral axis, find the demagnetizing and distorting amp-turns/pole.	Analyze	4
6	Determine per pole the number (i) of cross magnetizing ampere-turns (ii) of back ampere-turns and (iii) of series turns to balance the back ampere-turns in the case of a d.c. generator having the following data 500 conductors, total current 200 A, 6 poles, 2-circuit wave winding , angle	Apply	3

	of lead=10^0, leakage coefficient=1.3		
7	A 500 kw, 500 V, 10 pole d.c. generator has a lap wound armature with 800 conductors. Calculate the number of pole face conductors in each pole of a compensating winding if the pole face covers 75 percent of pole pitch.	Analyze	4
8	Calculate the flux in a 4 pole dynamo with 722 armature conductors generating 500 V when running at 1000 r.p.m. when the armature is a) lap connected b) wave connected	Apply	3
9	A4 pole wave wound motor armature has 880 conductors and delivers 120 A. The brush has been displaced through 3 angular degrees from the geometrical axis. Calculate a) demagnetizing amp-turns/ pole b) cross magnetizing amp-turns/pole c) the additional field current for neutralizing the demagnetization if the field winding has 1100 turns/pole	Apply	4
10	Estimate the number of turns needed on each interpole of a 6-pole generator delivering 200 kw at 200 V; given: number of lap connected armature conductors =540; interpole air gap=1 cm; flux density in interpole air gap=0.3 wb/m^2. Ignore the effect of iron parts of the circuit and leakage.	Evaluate	4
	UNIT-III **Types of D.C Generators & Load Characteristics**		
1	Two shunt generators A and B operate in parallel and their load characteristics may be taken as straight lines. The voltage of A falls from 240 V at no-load to 220 V at 200 A, while that of B falls from 245 V at no-load to 220 V at 150 A. determine the current which each machine supplies to a common load of 300 A and the bus bar voltage at this load.	Analyze	6
2	Two separately-excited d.c. generators are connected in parallel and supply a load of 200 A. The machines have armature circuit resistance of 0.05 ohm and 0.1 ohm and induced e.m.fs. Of 425 V and 440 v respectively. Determine the terminal voltage, current and power output of each machine. The effect of armature reaction is to be neglected.	Evaluate	6
3	A long shunt compound generator delivers a load current of 50 A at 500 V and the resistance of armature , series field and shunt field are 0.05 ohm,0.02 ohm,250 ohm respectively. Calculate the generated electromotive force and the armature current. Allow 1 V per brush for contact drop.	Evaluate	5
4	In d.c. machine the total iron losses is 8 kw at its rated speed and excitation. If excitation remains the same, but speed is reduced by 25%, the total iron loss is found to be 5 kw. Calculate the hysteresis and eddy current losses at (i) full speed (ii) half the rated speed.	Analyze	5
5	Two compound generators A and B, field with an equalizing bar, supply a total load current of 500 A. the data regarding the machine are :- A B Armature resistance (ohm) 0.01 0.02	Evaluate	5

	Series field winding (ohm) 0.004 0.006 Generated e.m.f. (volt) 240 244 Calculate (a) current in each armature (b) current each series winding (c) the current flowing in the equalizer bar and (d) the bus bar voltage. Shunt current may be neglected.		
6	Two generators each having no load voltage of 500 V, are connected in parallel to a constant resistance load consuming 400 kw. The terminal p.d. of one machine falls linearly to 470 V as the load is increased to 850 A while that of the falls linearly to 460 V when the load is 600 A. find the load current and voltage of each generator. If the induced e.m.f. of one machine is increased to share load equally find the new current and voltage.	Analyze	6
7	Two d.c. generators are connected in parallel to supply a load of 1500 A. one generator has an armature resistance of 0.5 ohm and an e.m.f. of 400 V while the other has an armature resistance of 0.4 ohm and an e.m.f. of 440 V. The resistance of shunt fields is 100 ohm and 80 ohm respectively. Calculate the current I_1 and I_2 supplied by individual generator and terminal voltage V of the combination.	Evaluate	6
8	Two shunt generators operating in parallel have each an armature resistance of 0.02 ohm. The combined external load current is 2500 A. If the generated e.m.f. of the machines are 560 V and 550 V respectively, calculate the bus-bar voltage and output in kw of each machine	Analyze	6
9	Two shunt generators operating in parallel deliver a total current of 250 A. one of the generators rated 50 kw and 100 kw. The voltage rating of both machines is 500 V and has regulations of 6% and 8%. Assuming linear characteristics, determine (a) the current delivered by each machine (b) terminal voltage.	Apply	6
10	Find how many series turns per pole are needed on a 500 kw compound generator required to give 450V on no-load and 500 V on full load, the requisite number of ampere –turns per pole being 9000 and 6500 respectively. The shunt winding is designed to give 450 Vat no load when its temperature is 20 degree centigrade. The final temperature is 60 degree centigrade. Take α_0=1/234.5 per degree centigrade.	Evaluate	5
	UNIT-IV **D.C. Motors & Speed Control Methods**		
1	A 440 V, shunt motor has armature resistance of 0.8 ohm and field resistance of 200 ohm. Determine the back e.m.f. when giving an output of 7.46kw at 85% efficiency	Apply	7
2	A d.c. motor takes an armature current of 110 A at 480 V. the armature	Apply	7

<table>
<tr><td></td><td>circuit resistance is 0.2 ohm. The machine has 6 poles and the armature is lap connected with 864 conductors. The flux per pole is 0.05 wb. Calculate (i) the speed and (ii) the gross torque developed by the armature.</td><td></td><td></td></tr>
<tr><td>3</td><td>The armature winding of a 200 V, 4 pole, series motor is lap connected. There are 280 slots and each slot has 4 conductors. The current is 45 A and the flux per pole is 18 mwb. The field resistance is 0.3 ohm; the armature resistance 0.5 ohm and the iron and friction losses total 800 W. The pulley diameter is 0.41 m. Find the pull in Newton at the rim of the pulley</td><td>Analyze</td><td>7</td></tr>
<tr><td>4</td><td>A 460 V series motor runs at 500 r.p.m. taking a current of 40 A. Calculate the speed and percentage change in torque if the load is reduced so that the motor is taking 30 A. Total resistance of the armature and field circuits is 0.8 ohm. Assume flux is proportional to the field current</td><td>Apply</td><td>7</td></tr>
<tr><td>5</td><td>A 14.92 kw, 400V, 400 r.p.m. d.c. shunt motor draws a current of 40 A when running at full load. The moment of inertia of the rotating system is 7.5 kg-m^2. If the starting current is 1.2 times full load current, calculate
(a)Full load torque (b) the time required for the motor to attain the rated speed against full load</td><td>Analyze</td><td>7</td></tr>
<tr><td>6</td><td>A 4 pole, lap connected d.c. motor has 576 conductors and draws an armature current of 10 A. if the flux per pole is 0.02 wb. Calculate the armature torque developed</td><td>Apply</td><td>7</td></tr>
<tr><td>7</td><td>The armature current of a series motor is 60 A when on full load. If the load is adjusted to that this current are decreases to 40 A. Find the new torque expressed as a percentage of the full load torque. The flux for a current of 40 A is 70% of that when current is 60 A.</td><td>Analyze</td><td>7</td></tr>
<tr><td>8</td><td>For a ward-Leonard system, two identical 220V, 15 A d.c. machines are used. Total armature resistance of each machine is 0.4 ohm and the magnetization curve for each machine at 1500 r.p.m. is as given below
<table>
<tr><td>E_a in Volts</td><td>120</td><td>160</td><td>197</td><td>210</td><td>220</td><td>228</td><td>232</td><td>236</td><td>243</td></tr>
<tr><td>I_f in Amps</td><td>0.3</td><td>0.4</td><td>0.5</td><td>0.6</td><td>0.7</td><td>0.8</td><td>0.9</td><td>1.0</td><td>1.2</td></tr>
</table></td><td>Apply</td><td>7</td></tr>
<tr><td>9</td><td>A 4 pole d.c. series motor has flux per pole $\emptyset=4*10^{-3}I_a$ wb where Ia is the armature current. The motor drives a fan requiring 40 Nm at 1000 r.p.m. The wave connected armature has 480 conductors and its resistance is 1 ohm
Find the motor speed and armature current if it is fed from 230 V d.c. machine</td><td>Analyze</td><td>7</td></tr>
<tr><td>10</td><td>A 4 kw, 230V, 1000 r.p.m. separately excited d.c. motor is fed from 260 V a.c. source through a single phase full converter. At no load and with zero firing angle delay, the motor draws 2 A and runs at 1100 r.p.m. The armature circuit resistance is 0.5 ohm voltage drop in conducting thyristors is 2 V. For a firing angle delay of 300 and rated armature current of 20 A. Compute</td><td>Apply</td><td>8</td></tr>
</table>

	i) The motor torque and ii) motor speed.		
	UNIT-V **Testing of D.C. Machines**		
1	A 250 V, 15 kw, shunt motor has a maximum efficiency of 88% and a speed of 700 r.p.m., when delivering 80% of its rated output. The resistance of its shunt field is 100Ω. Determine the efficiency and speed when the motor draws a current of 78 A from the mains.	Analyze	8
2	A 10 kw, 250 V d.c. shunt generator has a total load rotational loss of 400 watts. The armature circuit and shunt field resistances are 0.5 ohm and 250 ohm respectively. Calculate the shaft power input and the efficiency at rated load. Also calculate the maximum efficiency and the corresponding power output.	Analyze	9
3	A 10 kw, 240 V d.c. shunt motor draws a line current of 5.2 A while running at no load speed of 1200 r.p.m. from a 240 V d.c. supply. It has an armature resistance of 0.25Ω and a field resistance of 160Ω. Estimate the efficiency of the motor when it delivers rated load	Analyze	8
4	A 400 V d.c. shunt motor takes 5A at no load. Its armature resistance is 0.5 ohm and shunt field resistance is 200 ohm. Estimate the KW output and efficiency when the motor takes 50 A on full load	Apply	9
5	Two identical d.c. shunt machines when tested by Hopkinson's method, gave the following data: Line voltage 230 V; line current excluding both the field current 30 A ; motor armature current 230 A, field currents 5 A and 4 A If the armature resistance of each machine is 0.025 ohm, calculate efficiency of both the machines.	Analyze	9
6	Hopkinson's test on two similar d.c. shunt machine gave the following data: Line voltage 230 V; line current excluding both the field currents , 40 A ; motor armature current 350 A; field currents 5 A and 4.2 A.	Apply	9
7	A 230 V d.c. shunt motor takes 5 A when running at no load. The armature resistance is 0.2 ohm and field circuit resistance is 115 ohm. For an input current of 72 A, calculate the shaft output and efficiency. Also calculate the armature current at which the efficiency is maximum	Apply	9
8	A 100 V series motor takes 45 A when running at 750 rpm. Its armature resistance is 0.22 ohm & series field resistance is 0.13 ohm, iron & friction losses amount to 750 W, find i) shaft power ii) total torque & iii) shaft torque.	Analyze	9
9	A 220 V, 3.7KW dc motor operates at full load with 90% efficiency has constant losses 180W. Find the copper loss at full load. Also find the efficiency of motor at half full load.	Analyze	9
10	The armature and field resistances of a 300 V, dc shunt motor are 0.6 Ω and 260 Ω respectively When driving a load of constant torque at 600 rpm, the armature current is 25 A. If it is required to increase the speed from 600 rpm to 750 rpm, calculate the resistance to be connected in the shunt field circuit.	Apply	9