Code No: W0221 **R07** SET - 1

II B. Tech I Semester, Supplementary Examinations, Nov – 2012
ELECTRICAL MACHINES-I
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 80

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) What are singly-excited and doubly-excited systems? Give an example for each.
   b) For a singly excited magnetic field system, derive expression for the magnetic stored energy.

2. a) Name the main parts of a d.c machine and briefly explain the functions each of them.
   b) An 8-pole, 20 kW, 220 V dc generator has a simple lap-wound armature, which has 64 coils with 16 turns per coil. Its rated speed is 1400 rpm. (i) How much flux per pole is required to produce the rated voltage in this generator at no-load condition? (ii) What is the current per path in the armature of this generator at the rated load? (iii) If the resistance of this winding is 0.01Ω per turn, what is the armature resistance of this machine?

3. a) Discuss the effect of using compensating winding in d.c. machines.
   b) A 4-pole lap-wound d.c generator has 492 conductors and 82 commutator segments. The armature current is 153 A. It is given a brush lead of 5 commutator segments from the GNA. Calculate (i) the cross and demagnetizing ampere-turns per pole and (ii) find the extra field turns required on the field magnet to compensate the demagnetization, if the field winding carries a current of 13 A.

4. a) Define the terms critical resistance and critical speed and bring out their roles in the process of self-excitation of d.c machines.
   b) A 4-pole short shunt wave-wound generator supplies 20 kW load at terminal voltage of 250 V, R_a=0.1Ω, R_{sh}=100 Ω, R_{se}=0.2 Ω and flux per pole = 0.05 Wb. Assume the total brush drop 2 V. Find (i) the e.m.f generated and (ii) number of conductors in each parallel path if the speed is 1200 rpm.
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5. a) What is the necessity of equalizer bar while paralleling compound generators?

   b) The following readings were recorded in magnetization characteristics of a separately excited generator.

Field current(A)	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2
E.M.F(V)	10	40	80	120	142	168	178	190	205

   When the machine is loaded, the readings are observed as i_a(full load)= 20 A, V = 160 V, i_f = 1.75 A, R_a = 0.5 . Find (i) no-load generated emf, (ii) drop due to armature reaction at full load and (iii) field current to overcome demagnetizing effect of armature reaction.

6. a) Explain principle of operation of a dc motor and derive the expression for torque produced.

   b) A shunt generator delivers 50 kW at 250 V when running at 400 rpm. The armature and field resistance are 0.02 Ω and 50 Ω respectively. Calculate the speed of the machine when running as a shunt motor and taking 50 kW input at 250 V. Assume 1 V per brush for contact drop.

7. a) Explain with a neat sketch, the working of a 3-point starter.

   b) A series motor, with an unsaturated magnetic circuit and 0.5 Ω total resistance, when running at a certain speed takes 60 A at 500 V. If the load torque varies as the cube of the speed, calculate the resistance required to reduce the speed by 25 %.

8. a) Explain Swinburne's test to determine no-load losses of a dc machine.

   b) The Hopkinson's test on two similar shunt machines gave the full-load data: Line voltage =110 V; Line current =48 A; Motor armature current =230 A; field currents: 3 A and 3.5 A. Armature resistance of each machine: 0.035 Ω. Calculate the efficiency of each machine assuming a brush contact drop of 1 V per brush.

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(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 80

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1. a) Explain briefly an electromechanical energy conversion device with the help of a block diagram.
   b) Define field energy and co-energy. What is the significance of co-energy in electromechanical energy conversion?

2. a) Explain the working principle of a d.c generator.
   b) A six pole lap wound d.c. machine armature has 70 slots with 20 conductors/slot. The ratio of pole arc to pole pitch is 0.68. The diameter of bore of the pole shoe is 0.46 m. The length of pole shoe is 0.3 m. If the air gap flux density is 0.3 Wb/m^2 and the e.m.f. induced in the armature is 500 V, find the speed at which it runs.

3. a) Why are interpoles provided in a dc machine? Describe their role in improving the commutation in a d.c generator.
   b) The commutator ring of a d.c machine has a diameter of 40 cm. The thickness of mica insulation is 0.3 cm and brush thickness is 1.8 cm. Calculate the time of commutation for a coil to reverse the current of 20 A in each coil if the speed of the armature is 1500 r.p.m and the reactive voltage, if the self-inductance of the coil is 0.05 mH.

4. a) Explain different methods of excitation of d.c generators with suitable diagrams.
   b) The following data pertain to the magnetization curve of a 4-pole, separately excited generator at 600 r.p.m is as follows.

I_f in Amps	1.6	3.2	4.8	6.4	8.0	9.6	11.2
E_G in Volts	148	285	390	460	520	560	590

   Calculate (i) the voltage to which the machine will excite as a shunt generator with a field circuit resistance of 60 Ω, ii) critical field resistance and iii) critical speed at this field resistance of 60 Ω.
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5. a) Explain carefully the exact procedure for connecting a shunt generator in parallel with others already supplying a load.
   b) The external characteristic of a series generator from zero to 40 V at 200 A is a straight line. The total resistance of the generator is 0.02 Ω. If it is used as a booster between a 110 V bus-bar and a feeder of 0.2 Ω resistance, determine:
   i) The voltage available to a consumer at the far end of the feeder at a load current of 100 A.
   ii) Find the power supplied by the booster.

6. a) Explain the function of commutator in a D.C. motor.
   b) A 6-pole, 230 V DC series motor has a flux per pole of 4mWb/A over the working range of the magnetization curve which is assumed to be linear. The load torque is proportional to speed squared and its value is 20 N-m at 800 rpm. There are 432 wave-connected conductors and the total resistance of motor is 1.0 Ω. Determine the motor speed and current when this motor is connected to rated supply voltage.

7. a) Explain with neat sketch how speed control of a DC shunt motor is done by Ward Leonard method.
   b) A dc series motor has the following rating: 200V, 20A and 1000 rpm. Armature and series field resistances are 0.1 Ω and 0.2 Ω respectively. Magnetic circuit can be assumed to be linear. At what speed the motor will run at rated torque if a resistance of 20 Ω is placed in parallel with the armature?

8. a) Explain how Hopkinson's test is carried out on two dc shunt machines to obtain efficiency.
   b) A retardation test is made on a separately excited dc machine as a motor. The induced emf falls from 240 V to 225 V in 25 seconds on opening the armature circuit and 6 seconds on suddenly changing the armature connection from supply to a load resistance taking 10 A (average). Find the efficiency of the machine when running as a motor and taking a current of 25 A on a supply of 250 V. The resistance of its armature is 0.4 Ω and that of its field winding is 250 Ω.

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1. a) Draw and explain the general block-diagram representation of an electromechanical energy conversion device.
   b) Derive an expression of field energy in a singly-excited electromechanical unit.

2. a) Explain the following terms as applied to a d.c. armature winding.
   i) Front pitch ii) Back pitch
   iii) Commutator pitch iv) winding pitch
   b) A 4-pole, lap wound, d.c shunt generator has a useful flux/pole 0.06 Wb. The armature winding consists of 200 turns, each turn having a resistance of 0.003 Ω. Calculate the terminal voltage when running at 1000 r.p.m if armature current is 45 A.

3. a) Enumerate the methods used for improving commutation and explain any one of them in detail.
   b) A 50 kW, 500 V, 4-pole generator has a 2 layer simplex lap winding in 36 slots with 10 conductors in each layer. If the brushes are given an actual lead of 10^0, calculate:
   i) Demagnetizing AT/pole
   ii) Cross-magnetizing AT/pole,
   iii) Number of turns per pole on the compensating winding if the pole arc to pole pitch is 0.8 and brushes are placed on geometric neutral axis.

4. a) What is meant by the saturation curve? What test must be performed to determine data for its construction?
   b) The open circuit characteristics of a separately excited DC generator driven at 1000 rpm is as follows:

Field current (A)	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6
EMF (volts)	25	50	70	85	95	105	110	115

   If the machine is connected as shunt generator and driven at 1100 rpm and has a filed resistance of 100 ohms, find (i) open circuit voltage and exciting current (ii) The critical field resistance and (iii) resistance to induce 120 V on open circuit.
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Code No: W0221 **R07** SET - 3

5. a) Explain, with appropriate diagrams, the procedure to obtain external characteristics of shunt and series generators.
   b) Two separately excited dc generators are running in parallel each supplying 500 A at 450 V. The armature resistance of each machine is 0.1 Ω. If the load current supplied by first generator is to be reduced to zero, determine:
      i) The percentage decrease in induced emf of first machine
      ii) Change in terminal voltage.
      iii) Total load current and emf of second machine remains unchanged.

6. a) Draw the characteristic curves of D.C. shunt motors. Use these curves to explain the applications of shunt motor.
   b) A 500 V, 37.3kW, 1000 rpm. DC shunt motor has on full load an efficiency of 90%. The armature circuit resistance is 0.24 Ω and there is total voltage drop of 2V at the brushes. The field current is 1.8A. Determine i) full-load line current ii) full load shaft torque in N-m and iii) Total resistance in motor starter to limit the starting current to 1.5 times the full-load current.

7. a) Make a list of different speed control methods for DC motor. Discuss merits and demerits of each method.
   b) A shunt motor takes 50 A on full load from 250 V mains. Its speed is to be raised by 40% by weakening of the field flux. If the torque at the increased speed is 20% more than that at the initial speed, find the percentage change in field flux. The armature resistance (including brushes) is 0.5 Ω.

8. a) Draw the power flow diagram for a dc compound motor and derive the condition for maximum efficiency.
   b) The Hopkinson's test on two identical shunt machines gave the following results: Input voltage = 500 V; Input current = 15 A: Output current of generator = 120 A; Field current of generator = 4 A; Field current of motor =3 A; Armature resistance of each machine = 0.06 Ω. Find the efficiency of motor and generator.

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1. a) Explain briefly an electromechanical energy conversion process with the help of a block diagram.
   b) Define the field energy and co-energy. Give the significance of co-energy in the derivation of torque or force in an electromechanical energy conversion system

2. Draw the developed diagram for a 4-pole, 17 slot, and double-layer simplex wave winding with each slot having 2 coil sides. Assume progressive winding.

3. a) What are the detrimental effects of armature reaction?
   b) What is meant by commutation and linear commutation? What are the effects of commutation on generated voltage?

4. a) What are the reasons for failure of voltage buildup in a dc shunt generator?
   b) A 250 kW, 500 V long shunt compound generator has the following data: armature resistance including brush resistance is 0.03 Ω, series field resistance is 0.012 Ω, diverter resistance is 0.036 Ω, shunt field resistance is 100 Ω and commutating field winding resistance is 0.011 Ω. Calculate the voltage and power generated by the armature when the machine is delivering full load.

5. a) Explain how internal and external characteristics are obtained for a d.c compound generator.
   b) Two dc shunt generators with emfs of 120 V and 115 V, armature resistances of 0.05 Ω and 0.04 Ω and field resistances of 20 Ω and 25 Ω respectively are in parallel supplying a total load of 25 kW. How do they share the load?

6. a) Draw the characteristics of a dc series motor and from the nature of the curves explain the application of dc series motors.
   b) The input to a 220 V D.C. shunt motor is 11 kW. The other particulars of the motor are: No load current = 5 A; No load speed= 1150 rpm; Armature resistance= 0.5 Ω; shunt field resistance=110 Ω. Calculate : i) the torque developed ii) The efficiency iii) The speed at this load.
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7. a) Draw a neat schematic of a four-point starter and explain its operation.
   b) A 230 V dc shunt motor takes an armature current of 20 A on a certain load. Resistance of armature is 0.5 Ω. Find the resistance required in series with the armature to halve the speed if i) the load torque is constant ii) the load torque is proportional to the square of the speed.

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8. a) Determine a suitable method for determining the efficiency of a series motor
   b) A 500 V shunt motor takes 4 A on no-load. The armature resistance including that of brushes is 0.2 Ω and the field current is 1 A. Estimate the output and the efficiency when the input current is 20 A.