Code No: R1621022 **R16** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, October/November - 2018
ELECTRICAL MACHINES – I
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any F**OUR** Questions from **Part-B**

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PART –A

1. a) Draw and explain the general block diagram representation of an electromechanical energy conversion device? (3M)
   b) Explain the necessity of commutating poles and compensating windings in a dc machine? (3M)
   c) Explain the significance of swinburne's test on dc machine? (2M)
   d) Define all day efficiency of a single phase transformer? (2M)
   e) Explain why OC test is performed on LV side of a single phase transformer? (2M)
   f) List the problems associated with harmonics in 3-ϕ transformers (2M)

PART –B

2. a) Derive expressions of field energy, co energy and magnetic force in a singly excited electromechanical unit? (7M)
   b) An 8 pole DC generator has per pole flux of 40 mWb and winding is connected in lap with 960 conductors. Calculate the generated EMF on open circuit when it runs at 400 rpm.If the armature is wave wound, at what speed must the machine be driven to generate the same voltage. (7M)

3. a) Discuss Armature reaction and commutation in DC motors. Explain their effects on the performance of the motor and give remedies to their effects (7M)
   b) A 6-pole DC motor has a wave connected armature with 87 slots, each slot containing 6 conductors. The flux per pole is 20 mwb and the armature has a resistance of 0.13 ohm when the motor is connected to 240V supply and the armature draws a current of 80A driving a load of 15KW. Calculate (i) Speed (ii) Armature Torque and (iii) Shaft Torque. (7M)

4. a) Compare Swinburne's test and Hopkinson's test conducted on DC machines. List the advantages limitations of both the methods. (7M)
   b) The Hopkinson's test on two similar machines gave the following data. Line Voltage =230 V; line current excluding both the field currents 40A, motor armature current=350A The field currents are 5A and 4.2A. Armature resistance of each machine is 0.02 ohms. Calculate the efficiency of each machine assuming a brush contact drop of 1V per brush. (7M)

5. a) Explain the working of single phase transformer on load? Also draw and explain the phasor diagram of single phase transformer with capacitive load? (7M)
   b) A 40 KVA single phase transformer has got maximum efficiency of 97 % at 80 % of full load at UPF. During the day, the load on the transformer is as follows. (7M)

No. of hours	Load	Power factor
9	6 KW	0.6 lag
8	25 KW	0.8 lag
7	30 KW	0.9 lag

Determine the All day efficiency of the transformer
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6. a) Following are the test figures for the 4KVA, 200/400V, 50Hz, single phase transformer. (7M)
O.C test : 200V, 0.8A, 70 W
S.C test : 17.5V, 9A, 50 W.
Calculate the parameters of equivalent circuit of a transformer

b) A 50 kVA, 2200/1100 V, single phase, 50Hz transformer has a full load efficiency of 95% and iron loss of 500 W. The transformer is connected as an auto transformer to a 3300 V supply. When it delivers a load of 50Kw at unity power factor at 1100 V, calculate the currents in the windings. Find also, the increase in output as auto-transformer. Also, calculate the copper loss as two winding transformer (7M)

7. a) Write a brief not on tap changing transformers? (7M)

b) A bank of three single phase transformers has its h.v. terminals connected to 3 wire, 3-phase, 11KV system. It's l.v. terminals are connected to a 3 wire, 3-phase load rated at 1500KVA, 2200V. Specify the voltage, current and KVA ratings of each transformer for both h.v. and l.v. windings for the following connections: (i) Y-Δ (ii)Δ-Y (iii) Y-Y (7M)

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Why the core of the machine is laminated? (3M)
   b) Draw and explain the characteristics of a dc series motor and from the nature of the curve give the applications of dc series motor? (3M)
   c) What is the necessity of starter for DC motor? (2M)
   d) Explain why SC test is to be performed on HV side of the transformer? (2M)
   e) Draw the equivalent circuit of a single phase transformer with primary quantities referred to the secondary side? (2M)
   f) List the applications of SCOTT connection of transformers? (2M)

PART –B

2. a) Show that the torque developed in a doubly excited magnetic system is equal to the rate of increase of filed energy with respect to displacement at constant currents? (7M)
   b) The open circuit characteristic for a dc shunt generator at 800 rpm is given by the following data. (7M)

I_f (A)	0	0.2	0.4	0.65	1.02	1.75	3.15	5
E_a(V)	10	40	80	120	160	200	240	260

Find the critical field resistance at 900 rpm.

3. a) What is meant by commutation in dc machine? Differentiate between good commutation and bad commutation? Enumerate the mechanical and electrical conditions leading to poor commutation in dc machine? (7M)
   b) A 250 V, 4 pole shunt motor has two circuit armature winding with 500 conductors. The armature circuit resistance is 0.25 Ω, field resistance is 125 Ω and the flux per pole is 0.02 Wb. Armature reactions is neglected. If the motor draws 14 A from the mains, then compute (7M)
      (i) Speed and the internal torque developed
      (ii) The shaft power, shaft torque and efficiency with rotational losses equal to 300 watts

4. a) Describe and compare various methods of speed control of dc motors? (7M)
   b) A DC shunt motor runs at 750 rpm from 250 V supply and is taking a full load line current of 60 A. Its armature and field resistances are 0.4 Ω and 125 Ω respectively. Assuming 2 V brush drop and negligible armature reaction effect, calculate the no load speed for a no load line current of 6 A and resistance to be added in series with armature circuit to reduce the full load speed to 600 rpm. (7M)
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5. a) Prove that EMF/Turn on both HV and LV side is equal for a single phase tranformner (7M)
   b) A 100 kVA, 2400/240 V, 50Hz single phase transformer has an exciting current of 0.64 A and a core loss of 700 W, when its high voltage side is energized at rated voltage and frequency. Calculate the two components of the exciting current. If the above transformer supplies a load current of 40 A at 0.75 p.f. lag on its l.v. side, then calculate the primary current and p.f. Ignore leakage impedance drops. (7M)

6. a) With neat diagram, explain the various tests conducted on transformer to predetermine the efficiency of the transformer without directly loading the transformer? (7M)
   b) In Sumpner's test on two identical transformer rated 500 kVA, 11/0.4 kV, 50 Hz, the wattmeter reading on HV side is 6 kW on rated voltage and on LV side is 15 kW when circulated full load current. Find the efficiency of each transformer on ¾ th load & 0.8 pf lagging. What will be the maximum efficiency of each transformer? (7M)

7. a) Explain with the help of connection and phasor diagrams, how Scott connection is used to obtain two phase supply from three phase supply mains? (7M)
   b) Two scott connected transformers are used for transforming 6600 V three phase to 400 V, 2-phase. The load on the main transformer secondary is 200 kVA at unity p.f. and the load on the secondary is 300 kVA at unity p.f. Neglecting the losses , find the currents in the transformer windings and in the primary supply lines? (7M)

Note: Graph sheet is required

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Why does the slope of OCC of a dc generator change after a certain value of field current? (2M)
b) List the applications of compound motors (3M)
c) Explain how efficiency of a dc machine can be found out without loading the machine? (3M)
d) Explain the purpose of conservator and breather in a transformer? (2M)
e) List the applications of Auto transformer? (2M)
f) Explain vector grouping of transformers. Mention its usefulness? (2M)

PART –B

2. a) Explain the constructional features of a machine with brief explanation with each part (7M)
b) A 10 kW, 240 V, 6-pole, 1200 r.p.m lap-connected d.c. generator has 500 armature conductors. At rated voltage and current, armature ohmic losses are 200 watts. Compute the useful flux per pole? Take 3 V as the brush drop at full load? (7M)

3. a) What is meant by armature reaction? Show that the effect of armature mmf on the main field is entirely cross magnetizing? Also explain the bad effects of armature reaction? (7M)
b) A 200 V d.c. shunt motor takes 5 A at no-load. R_a=0.5 Ω and R_{sh}=200 Ω. Estimate the kW output and efficiency when the motor takes 25 A on full load. (7M)

4. a) Explain the procedure to conduct retardation test on a dc machine with the help of a neat circuit diagram and hence explain how the test data is useful to calculate machine performance? (7M)
b) A 400 V d.c. shunt motor takes 5 A at no-load. R_a=0.5 Ω and R_{sh}=200 Ω. Estimate the kW output and efficiency when the motor takes 50 A on full load. (7M)

5. a) Develop the exact equivalent circuit of a single phase transformer (7M)
b) The maximum efficiency of a 500 KVA, 3300/500V, 50Hz, single phase transformer is 97% and occurs at $3/4^{th}$ full load and unity power factor. If the impedance drop is 10%, calculate the regulation at full load and 0.8 p.f lagging (7M)
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6. a) Discuss how parallel operation of two single phase transformers with equal voltage ratios is effected by un equal per unit leakage impedances but same x_e/r_e ratio. (7M)

   b) A 20 kVA, 2000/200 V, two winding transformer is to be used as an autotransformer, with constant source voltage of 2000V. At full load of unity power factor, calculate the power output, power transformed and conducted. If the efficiency of the two winding transformer at 0.7 p.f.is 95%, find the auto transformer efficiency at the same power factor (7M)

7. a) Describe the merits and demerits of a bank of three single phase transformers as compared to a three phase core type transformer? Also explain why it is necessary to have one three phase winding in delta for the transformers used in three phase systems? (7M)

   b) Two single phase transformers each rated for 200 kVA, 11/0.4 kV, 50 Hz are connected in open delta. (7M)
      (i) Determine the load kVA that can be delivered by this connection without overloading either transformer?
      (ii) This connection supplies a three phase balanced load of 200 kVA at 400 V, 0.866 p.f. lag. Find the transformer currents on h.v. side and power factors at which each transformer operates?

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Explain the classification of DC machines based on the excitation? (3M)
   b) Name the constant and variable losses in a dc machine? (3M)
   c) Compare various methods of speed control of dc motors? (2M)
   d) Explain the principle of operation of single phase transformer? (2M)
   e) List the conditions for parallel operation of single phase transformers? (2M)
   f) List the applications of tap changing transformers? (2M)

PART -B

2. a) For a singly excited magnetic system, derive the relation for the magnetic stored energy in terms of reluctance. (7M)
   b) A 4-pole, wave connected armature has 100 slots. If the flux per pole is 0.04 Wb, calculate the number of conductors required per slot to generate 220 V. Take the speed of the generator as 300 rpm. Calculate the new value of the flux due to change in the number of conductor per slot, if any. (7M)

3. a) Derive the torque equation of a DC motor? (7M)
   b) A 4 pole dc series motor has wave connected winding with 600 conductors. Total resistance of the motor is 0.8 Ω. When fed from 250 V source, dc motor supplies a load of 10 kW and takes 50 A with a flux per pole of 3 mWb. For these operating conditions calculate the developed torque and the shaft torque. (7M)

4. a) With the help of a neat sketch explain the construction and working of 4-point starter used for starting of d.c. motor? (7M)
   b) Two identical DC machines when tested by Back to back method gave the following test results: Field currents are 2.5 A and 2 A. Line voltage is 220 V. Line current including both field current is 10 A. Motor armature current is 73 A. The armature resistance of each machine is 0.05 Ω. Calculate the efficiency of both machines (7M)

5. a) Define efficiency and regulation of single phase transformer? Derive the condition for maximum efficiency of a transformer. (7M)
   b) A single phase 150 kVA transformer has efficiency of 96 % at full load, 0.8 pf and at half load, 0.8 pf lagging. Find maximum efficiency of transformer and corresponding load. (7M)
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6. a) Explain the procedure for OC & SC tests of transformer. From the test results explain how to compute equivalent circuit parameters of a single phase transformer? (7M)

   b) A 200 VA, 120/12 V two winding transformer is to be used as an auto transformer. The input voltage is 120 V. The resistances of primary & secondary windings are 1.5 Ω & 0.015 Ω respectively. Find the efficiency at full load UPF when it is used as: (i) as a two winding 120/12 V step down transformer (ii) as 120/132 V auto-transformer. Iron losses are 5 W (7M)

7. Describe in detail the four phasor groups pertaining to three phase transformers. Draw the phasor diagrams and connection schemes for each of these four groups? (14M)