



Subject Name:EM-I

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Year and Sem, Department:II-EEE SEM-I

Unit-I: (DC GENERATORS)

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

- A DC generator or direct current generator is one kind of electrical machine, and the main function of this machine is to convert mechanical energy into DC (direct current) electricity. The energy alteration process uses the principle of energetically induced electromotive force
- Armature Windings
- The armature core slots are mainly used for holding the armature windings. These are in a closed circuit winding form, and it is connected in series to parallel for enhancing the sum of produced current.
- Yoke
- The external structure of the DC generator is Yoke, and it is made with cast iron otherwise steel. It gives the necessary mechanical power for carrying the magnetic-flux given through the poles
- Poles
- These are mainly used to hold the field windings. Usually, these windings are wound on the poles, & they are connected in series otherwise parallel by the armature windings. In addition, the poles will give joint toward the yoke with the welding method otherwise by using screws.
- Pole Shoe
- The pole shoe is mainly utilized for spreading the magnetic flux as well as to avoid the field coil from falling.
- Commutator
- The working of the commutator is like a rectifier for changing AC voltage to the DC voltage within the armature winding to across the brushes. It is designed with a copper segment, and each copper segment is protected from each other with the help of mica sheets. It is located on the shaft of the machine.
- Brushes
- The electrical connections can be ensured between the commutator as well as the exterior load circuit with the help of brushes.



- O.C.C. of a dc shunt generator gives the variation of generated e.m.f (E_a) and field current (I_f), under no load condition with constant speed.
- O.C.C. helps to determine the maximum voltage that can be generated in generator.
- Critical speed and critical resistance of generator can also be determined from its O.C.C.
- The intersection of the field resistance line and the O.C.C. gives the maximum voltage that can be obtained.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. Why does saturation curve starts from some value higher than zero?(Dec-2016, R-13)
2. State the salient features of simplex winding? (Dec-2016,R-15)
3. What is GNA(Nov -2015,R-13)
4. What are the two functions of a commutator in a DC Machine? (Dec-2014,R-13)
5. Define Critical Speed and Critical Field resistance of Dc generator?(Dec-2014,R-13,Nov 2015,R-13,Nov/Dec2016,R-15)
6. Define (i) Pole pitch (ii) Back pitch (iii)Front pitch? (Dec-2014,R-13)
7. What is Armature Reaction? (Dec-2014,R-13,Dec 2016,R13)
8. Give the conditions for parallel operation of DC compound generators?(Dec - 2014,R13)
9. How a DC shunt generator builds up its voltage?(May 2013,R09)
10. What is the principle of operation of a DC generator?(May 2013,R09)

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. Explain the effects of armature reaction in a DC Shunt generator.How is its demagnetizing and cross magnetizing ampereturns calculated?(Dec-2016,R15)
2. Draw the sketches for different methods of excitation of DC Generators and write the respective generated emf equations?(Dec-2016,R15)
3. A DC Machine has 8 Poles, lap connected armature with 960 conductors and flux per pole is 40 m Wb.It is driven at 400 rpm.Calculate the generated emf.If now lap connected armature is replaced by wave connected,calculate the speed at which it should be driven to generate 400V.?(Dec-2016,R15)
4. Discuss the constructional details and working principle of 2-pole and 4-pole DC Machines?(Dec-2016,R15)



- 5. State the applications of various types of generators according to their characteristics?(Dec-2016,R15)
- 6. The open circuit characteristics of a dc shunt generator at rated speed is

I_f (A)	1	2.5	5	7	9	12	15	18
V_{oc} (V)	22	231	400	479	539	605	642	671

The field and armature resistances are 46 ohms and 0.12 ohms respectively. Determine the terminal voltage when the armature current is 360A in two cases:

- i) Armature reaction is negligible
- ii) 1 A field current is needed to counteract the effect of armature reaction. (Dec 2014-R13)
 - 7. Explain the desirable conditions and parallel operation of DC compound generators with a neat circuit diagram? (Dec 2014-R13)
 - 8. Explain the methods of improving commutation in a DC Generators with the help of neat sketches? (Dec 2014-R13)
 - 9. A 250 KW ,400 V , 4 pole dc generator has 720 lap wound conductors. It is given a brush lead of 3 angular degrees(mech.) from the geometrical neutral. Calculate the cross and demagnetizing ampere turns per pole. Neglect the shunt field current? (Dec 2014-R13)

10. A single turn coil has an inductance of 0.02 mH in the commutating zone. Find the value of compensating field required for obtaining straight line commutation for an armature

Fill in the Blanks: (Minimum 10 to 15 with Answers)

- 1. DC machine armature is laminated to reduce IRON loss.
- 2. If the back pitch is more than front pitch , the winding is said to be pole pitch
- 3. Lap winding is suitable for low current but high voltage generators.
- 4. A brush shift of 50 in a 4 pole machine means the brush shift of 60 electrical degrees.
- 5. For a P-pole machine, the relation between electrical and mechanical degrees is given by $\frac{360}{P}$
- 6. The simple energy balance equation in terms of change in electrical energy, change in mechanical energy and change in field energy can be written as MC^2
- 7. The relation between establishing flux, mmf and permeance of the magnetic circuit is $\frac{N\phi}{B}$
- 8. In a 4pole, 35 slot dc armature ,180 electrical degree coil span will be obtained when coil occupy 23 slots
- 9. In 12 pole triplex lap wound dc armature, each conductor can carry a current of 100A. the rated current of this armature is 12 ampere.
- 10. A wave winding must go at least 15 around the armature before it closes back where it started.

Choose the Best:

- 1.The DC generator works on the principle of [B]
 - a)Flemming’s left hand rule (b) flemming’s right hand rule (c) lenz’s law (d) none



2. In a dc generator, the generated EMF is directly proportional to the B []
a)Field current (b) pole flux (c) parallel paths (d)no. of dummy coils
3. The nature of current flowing in the armature of a DC machine is [C]
a)Ac (b) dc (c) pulsating (d) dc superimposed on ac
4. The EMF produced in a DC generator is-----induced EMF [B]
a)Statically (b) dynamically (c) magnetically (d) electrostatically
5. The brushes ideally should be placed along [C]
a)GNP (b) MNP (c) polar axis (d) none
6. In a separately excited DC generator the field is connected [B]
a)In series with an armature (b) across the armature (c) to an external source (d) none of these
7. The most likely cause of sparking at the brushes in a dc machine is [B]
(a)open coil in armature (b) defective inter poles
(c) incorrect brush spring pressure (d) all of the above
8. the armature of a DC machine is laminated to reduce [B]
(a) hysteresis loss (b) eddy current loss(c)mass (d)inductance
- 9.In DC machines, the armature windings are placed on the rotor because of the necessity for
(a)electromechanical energy conversion (b) generation of voltage [C]
(c)commutation (d) development of torque.
10. a 4 pole generator with 16 coils has a two layer lap winding.the pole pitch is[B]
(a)32 (b) 16 (c) 8 (d) 4

UNIT-II DC MOTORS

Important points / Definitions

- Electric Motor
- The input is electrical energy (from the supply source), and the output is mechanical energy (to the load). Electrical Electromechanical Mechanical energy energy conversion device energy Source Motor Load
- Series DC machine
- The field winding and armature winding are connected in series.
- The field winding carries the same current as the armature winding.
- DC Series Motor
- . In series motors, the series field winding is connected in series with the armature
- The torque developed in the rotor is: $T_{dev} = K \phi I_a$



- Assuming that the flux is directly proportional to field current (i.e. no magnetic saturation), DC Motor Mechanical Load (Pump, Compressor)
- $T_{load} \propto E_b + - T_{dev} I_a V_T + - \omega_m T_{dev}$
- Normal operating range Torque demanded by the load Torque developed by the motor
Final operating point 12 DC Motors $\phi \propto I_f$ Since in a series motor,
- $I_f = I_a$ $\phi = K_f I_a$ (16) where K_f is a constant that depends on the number of turns in the field winding, the geometry of the magnetic circuit and the B-H characteristics of iron.
- Therefore, the torque developed in the rotor can be expressed as: $T = K_t \phi I_a = K_t K_f I_a^2 = K I^2$
- DC Shunt Motor Power Flow • The losses and efficiency in a DC shunt motor can be calculated in a similar manner to that shown above, except that in this case Power input = $V_T I_L$ (where $I_L = I_a + I_f$). DC Series Motor Power Flow • The losses and efficiency in a DC series motor can be calculated in a similar manner to that for DC shunt motor using the equations derived earlier, except that in this case $I_f = I_a = I_L$

Short Questions

1. How does a DC motor differentiate from a DC Generator Construction? (Dec-2016-R-13)
2. What is meant by energy loss in a DC Motor?(Dec-2016, R-13)
3. Explain what would happen if the field circuit becomes open circuit with the motor running at NO Load? (Dec-2016, R-15)
4. What is the necessity of a starter?(Nov/Dec 2016, R-09)
5. Draw the characteristic curve of DC Shunt and series motors?(Nov-2015-R09)
6. State the applications of dc shunt motor, dc series motor, dc compound motor?(Dec-2014, R-13)
7. Mention their advantages and disadvantages of speed control?(Dec-2014, R-13)
8. What is the significance of back emf in a DC motor? Explain(Nov/Dec-2016,R13)
9. How does various losses occurring in a dc machine vary with the load?(Nov/Dec-2016,R13)
10. Draw the circuit model of Ward-Leonard system of speed control? (Dec 2016,R15)

Long Questions

1. Explain the conditions to be fulfilled for parallel operation of dc series motor. Explain the procedure of parallel operation? (Dec-2016, R-13)
2. Explain the principle of operation of DC Motor. Derive its torque equation? (Dec-2016, R-13)
3. Explain the various methods of speed control of DC Series motor?(Dec-2016, R-13)
4. Determine developed torque and shaft torque of a 220V, 4 Pole, dc series motor with 100 conductors wave connected supplying a load of 2 KW by taking 45 A from mains.



The flux per pole is 25mWb and its armature circuit resistance is 0.6 ohms? (Dec-2016, R-13)

5. Explain the working principle and constructional details of 4 point starter?(Dec-2016, R-13)
6. What is the necessity of starter in a DC Motor/Explain the working principle of 3-point starter write neat sketch. Also explain about protective measures in the starter? (Dec-2016. R-15)
7. A 10 KW, 250 V d.c. shunt motor takes a no load armature current of 6A at rated voltage and runs at 1250 rpm. The armature circuit resistance is 0.3Ω and the field resistance is 50Ω . At rated load and rated voltage, the motor takes a current of 20 A and the armature reaction weakens the field flux by 2%. Calculate the full load speed and the corresponding electromagnetic torque of the motor. (Dec 2014-R13)

Fill in the Blanks:

1. If a DC motor is to be selected for conveyors, which motor would be preferred?
Cumulative compound motor.
2. A 230V dc shunt motor has an armature resistance of 0.3Ω . Calculate the resistance to be connected in series with the armature to limit the armature current to 75 A at starting 2 Ω
3. A d.c series motor should always be started with load, because it at no-load will rotate at dangerously high speed
4. Which DC motor is generally preferred for cranes and hoists Cumulative compound motor
5. DC shunt motors should never be started on heavy loads because loads need zero starting torque
6. A 230V dc shunt motor has an armature resistance of 0.3Ω . Calculate the resistance to be connected in series with the armature to limit the armature current to 75 A at starting 3.0667 Ω
7. A d.c series motor should always be started with load, because it at no-load will not develop high starting torque .
8. What type of motors are used to get large starting torque blower
9. A 230V dc shunt motor has an armature resistance of 0.3Ω . Calculate the resistance to be connected in series with the armature to limit the armature current to 75 A at starting 2.7667 Ω
10. Maximum efficiency occurs when copper loss = iron loss

Fill in the blanks

1. Which DC motor is generally preferred for cranes and hoists? [B]
(a) Shunt motor (b) Series motor
(c) Cumulative compound motor (d) Differentially compound motor
2. A 3 point starter is considered as suitable for [A]
(a) All DC motors. (b) Shunt motors
(c) Shunt, compound and series motors (d) Shunt as well as compound motors

B



3. No load speed of which of the following motor will be highest[]
- (a) Cumulative compound motor (b) Differentially compound motor.
(c) Series motor (d) Shunt motor
4. A 3 point starter is considered as suitable for [D]
- (a) Shunt as well as compound motors (b) All DC motors.
(c) Shunt motors (d) Shunt, compound and series motors
5. The condition for maximum power in case of DC motor is [C]
- (a) Supply voltage = back emf (b) back emf = $1/2 \times$ supply voltage
(c) Supply voltage = $1/2 \times$ back emf (d) back emf = $2 \times$ supply voltage
6. Which type of motors are used for producing medium starting torque for conveyors? [B]
- (a) DC shunt motor (b) cumulative compound DC motor
(c) DC series motor (d) differential compound DC motor
7. A 230V dc shunt motor has an armature resistance of 0.3Ω . Calculate the resistance to be connected in series with the armature to limit the armature current to 75 A at starting[A]
- (a) 3.0667Ω (b) 2.7667Ω (c) 2Ω (d) 0Ω
8. Field winding of a DC series motor is usually provided with thick wire. [C]
- (a) As it carries large load current (b) To reduce the use of insulating materials
(c) To provide large flux (d) In order to reduce eddy current
9. While controlling the speed of a dc shunt motor, what should be done to achieve a constant torque drive? [C]
- (a) applied power should be kept constant (b) applied voltage should be maintained constant
(c) applied torque is zero (d) applied current should be kept constant
10. Which rule is used to determine the direction of rotation of DC motor? [D]
- (a) Columbus law (b) Lenz's law (c) Faradays law (d) Fleming's left-hand rule

Unit-III(TESTING OF DC MECHINES)

Important points / Definitions

Total losses

- (B) Field Cu-Loss
- (i) Shunt field Loss (ii) Series field Loss
(iii) Compensating winding Loss
(iv) Interpole winding Loss



(2) Rotational Losses

(A) Iron Loss

- (i) Hysteresis Loss (ii) Eddy current Loss

(B) Mechanical Loss

(C) Stray Load Loss

Testing of Machine

- The magnetization or open-circuit Test
- The test for Load Characteristics
- The temperature rise Test
- Efficiency Test
- Direct Method : Brake Test
- Indirect Method : Swinburne's Test
- Regenerative Method : Hopkinson's Test

DIRECT TESTING:

- By this method the efficiency and the losses of only small machines can be determined
- In this method full load is applied to the machine and the output is directly measured
- This method is not applied to large machines because large amount of power will be wasted only in testing.
- Brake Test: It is a direct method for testing dc machines
- If the brake test is to be performed on series motor, the motor should never be started at no load, otherwise due to high starting torque the motor armature will get damaged mechanically

• **INDIRECT TESTING:**

- By this method, efficiency of shunt and compound dc machines can be obtained
- Losses are determined without actually loading the machine
- The power is required only to supply losses, hence this method can be applied to large machine
- This method does not give any indication of rise of temperature
- Swinburne's Test :
- This is an indirect method of testing for dc machines
- By this test efficiency and losses at any load can be determined
- This test can't be applied to series motor

Short Questions

1. State Merits and De merits of the Swinburne's Method? (Dec-2016, R-15)
2. State Merits and De merits of the Hopkinson's Method? (Dec-2016 R-15)
3. Explain back to back Test?(Dec-2016, R-09)



4. Differentiate the indirect and direct load to be conducted on DC Machine?(Nov-2015, R13)
5. Enumerate various losses in DC machine.(Dec-2104, R-13)
6. Derive necessary condition for Back to Back Test?(Dec-2016, R-09)
7. Draw the circuit diagram for Hopkinson's test of a DC machine?(Dec-2016, R-15)
8. Explain the Brake test of a DC machine?(Dec2016, R-13)
9. Draw the circuit diagram for swineburne's test of a DC machine?(Dec2016, R-15)
10. Derive the conditions for maximum efficiency for DC Machine(Dec-2014,15, R-13)

Long Questions

1. Explain Hopkinson's test for determination Efficiency of DC Machines? (Dec-2016, R-15)
2. A200V shunt motor develops an output of 17.158 KW when taking 20.2 kw. The field resistance is 50 ohms and armature resistance is 0.06 ohms. What is the efficiency and power input when the output is 7.46 KW? (Dec-2016,R-09)
3. Explain the Brake Test to be conducted on a DC Shunt motor. How do you estimate the efficiency of the motor? (Dec-2016, R-13)
4. Explain the procedure of conducting swinburne's test in a laboratory? (Dec-2016, R-13)
5. With the help of neat circuit diagram,explainswinburne's test and derive relations for efficiency(both for generator and motor)?(Dec-2016 R-15)
6. Explain back to back test?Derive necessary condition?(Nov/Dec 2016, R-09)
7. Explain Hopkinson's Test for determination of Efficiency of DC machines?(Nov 2015-R09,Nov 2016 –R15)
8. Explain the procedure of conducting a suitable test to separate stray losses in a DC Motor?(Nov2015, R-13, Dec2014, R-13)
9. Two identical d.c.machines when tested by Hopkinson's method gave the following test results:
Field currents are 5A and 4.2 A.Line voltage is 230 V. line current excluding both field . Motor armature current is 350 A. The armature resistane of each machine is 0.02Ω Calculate the efficiency of both machines. (Dec 2014-R13,Nov 2015, R-09)

Fill in the Blanks:

1. hopkinsons test is performed on Shunt machines
2. fields test is conducted to determine the efficiency of series macine.
3. retardation test is performed to determine temperature rise in a dc shunt macine.



4. the efficiency of a generator is high when compared to a motor in swineburne's test.
5. swineburne's test is performed to determine no load losses in a large dc shunt machine.
6. iron loss are called constant losses
7. copper losses are called variable losses.
8. friction and windage losses are mechanical losses
9. expected efficiency of DC machine as a generator is 96
10. expected efficiency of DC machine as a motor is 98

Choose the Best:

1. which of the following tests need two machines [D]
(a)brake (b) swineburne's (c) retardation (d) hopkinson's
2. which one of the following is an indirect test [A]
(a)swineburne's (b) Brake test (c) retardation (d) hopkinson's
3. which one of the following is a direct test [B]
(a) swineburne's (b) Brake test (c) retardation (d) hopkinson's
4. the main disadvantage of hopkinson's test is that [B]
(a)it needs large power (b) it needs two identical machines (c)large current
5. The retardation test of a dc shunt machines is employed for determination of
(a)stray losses (b) windage losses (c)core loss(d) copperloss [A]
6. 24.To dc machines 200kw each are tested by hopkinson's test.the power input would be of the order of [B]
(a)200 kw (b)100kw(c) 35 kw (d) 10 kw.
7. The economical method for finding no load losses of a large dc shunt motor is [D]
a) Field's test b) Retardation test c) Hopkinsons test d) Swinburne's test
8. The efficiency of a traction motor is determined by [C]
a) Field's test b) Retardation test c) Hopkinsons test d) Swinburne's test
9. Retardation test is carried out to determine..... [A]
a) Frictional losses b) Iron losses c) stray losses d) copper losses
10. Which of the following tests can be conducted on other than shunt machines []
a)Swinburne's test b)Retardation test c)Field's test d)Back to back test



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