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7.6 ELECTRICAL MACHINES-I

7.6.1 OBJECTIVE AND RELEVANCE

Electricity does not occur naturally in usable form and it also can’t be stored in useful large quantities. Therefore it must be generated continuously to meet demand of power at all times. An efficient and convenient way to generate electrical power is by conversion of mechanical power into electrical form in a rotating device called “Generator”. Other than lighting and heating major use of electrical energy is made by converting it back to mechanical form to run the wheels of industry as well as tiny household appliances. In the process there may be losses existing. The basic duty of an electrical engineer should be to design more efficient machine. Therefore, it is recommended to study and understand the basic aspects of machines.

Electrical machines course is 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.

7.6.2 SCOPE

After going through this course the student gets a thorough knowledge on electromechanical energy conversion, construction operation characteristics speed control methods and testing of different types of DC Generators and DC motors, with which he/she can able to apply the above conceptual things to real-world electrical and electronics problems and applications.

7.6.3 PREREQUISITES

This course requires basic knowledge of mathematics, physics, electricity and magnetism. Introductory circuit theory, basic mechanics and elementary differential equations are mandatory requisites.

7.6.4.1 JNTU SYLLABUS

UNIT-I

OBJECTIVE

This unit explains the electromechanical energy conversion principles. It also explains magnetic force, co-energy in a single and multiexcited systems.

SYLLABUS

Electromechanical Energy Conversion: Electromechanical energy conversion, forces and torque in magnetic field systems, energy balance, energy and force in a singly excited magnetic field system, determination of magnetic force- co-energy, multiexcited magnetic field systems.

UNIT-II

OBJECTIVE

This unit explains the working principle of DC Generator and types of windings used for armature and emf equation, armature reaction effect , it’s remedies, effect of commutation and methods of improving commutation.

SYLLABUS

D.c. Generators and armature reaction: D.C.Generators, principle of operation, action of commutator, constructional features, armature windings, lap and wave windings, simplex and multiplex windings, use of laminated armature, E.M.F Equation-problems.
Armature reaction, cross magnetizing and de- magnetizing AT/pole, compensating winding, commutation, reactance voltage, methods of improving commutation.

UNIT-III
OBJECTIVE
This unit explains the different methods of excitation of DC machine and building-up of emf in DC shunt generator giving the significance of critical field resistance and critical speed the characteristic of different generators and parallel operation of generators.

SYLLABUS
Types Of D.C.Generators And Load Characteristics : Methods of excitation, separately excited and self excited generators, build of E.M.F critical field resistance and critical speed, causes for failure to self excite and remedial measures.
Load characteristics of shunt, series and compound generators, parallel operation of D.C series generators, use of equalizer bar and cross connection of field windings, load sharing

UNIT-IV
OBJECTIVE
This unit explains working principle of DC motor, back emf and torque equation. Load characteristics of all types of motors. Speed control of DC motors and necessity of starter for DC motor are explained.

SYLLABUS
D.C. Motors And Speed Control Methods : D.C. Motors, principle of operation, back E.M.F-Torque equation, characteristics and application of shunt, series and compound motors, armature reaction and commutation. Armature voltage and field flux control methods. Ward- Leonard system. Motor starters (3 point and 4 point starters)-protective devices.

UNIT-V

OBJECTIVE
This unit includes the understanding of losses , efficiency of DC machines and different methods of testing DC machines.

SYLLABUS
Testing of D.C. Machines: Losses, constant and variable losses, calculation of efficiency, condition for maximum efficiency. Methods of testing, direct, indirect and regenerative testing, brake test, Swinburne’s test, Hopkinson’s test, Field’s test, retardation test, separation of stray losses in a DC motor test.

7.6.4.2 GATE

SYLLABUS

UNIT-I
Principle of energy conversion, determination of magnetic force- co-energy.

UNIT-II
Armature windings, Lap and wave windings, simplex and multiplex windings, EMF equation

UNIT -III
Armature reaction, commutation

UNIT-IV
Methods of excitation, causes for failure to self excite and remedial measures

UNIT-V
Load characteristics of shunt, series and compound generators

7.6.4.3 IES SYLLABUS

UNIT- I
Not covered

UNIT-II
DC Generators, construction, operation and EMF equation

UNIT-III
Armature reaction, cross magnetizing and demagnetizing AT/pole, compensating windings commutation, reactance voltage, methods of improving commutation.

"There is a wonderful, mystical law of nature that the three things we crave most in life -- happiness, freedom, and peace of mind -- are always attained by giving them to someone else." - Author:Unknown

UNIT-IV
Types of DC Generators, methods of excitation, build up of EMF, causes for failure to self excite and remedial measures

UNIT-V
Load characteristics of shunt, series and compound generators

7.6.5 SUGGESTED BOOKS

TEXT BOOKS

T1 Electrical Machines, P.S. Bimbra, Khanna Publishers.
T2 Principles of Electrical Machines, V. K. Mehta, Rohit Mehta, S. Chand Publishing.

REFERENCE BOOKS

R1 Electric Machines, Mulukutla S. Sarma, Mukesh K. Pathak, Cengage Learning.
R2 Electric Machines by I.J. Nagrath & D.P. Kothari, Tata Mc Graw – Hill Publishers.
R3 Fundamentals of Electric Machines, B. R. Gupta, Vandana Singhal, New Age International Publishers.
R4 Electrical Machines, M. V. Deshpande, PHI Learning Private Limited.
R5 Electrical Machines, R. K. Srivastava, Cengage Learning.

7.6.6 WEBSITES

1. www.abii.com
2. www. ieee.org
3. www.ntpc.co.in
4. www.tce.com
5. www.powergridindia.com
6. www.iitm.ac.in
7. www.iitd.ac.in
8. www.iitk.ac.in
9. www.iitii.ac.in
10. www.iitg.ernet.in
11. www.iisc.ernet-in

7.6.7 EXPERTS' DETAILS

INTERNATIONAL

1. Prof. Ramakrishna Gokaraju
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REGIONAL

1. Prof. Dhanvanthri,
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2. Dr. S.Kamakshaiah
Electrical Engineering Department,
CVR College of Engineering,
Ibrahimpatnam,
Hyderabad
3. Dr U. k. Choudary
General Manager
BHEL R&D
Hyderabad- 500 093

7.6.8 JOURNALS

INTERNATIONAL

1. IEEE Transactions on energy conversion
2. IEEE Computer applications in power
3. IEE Proceedings : Part-C [Generation, Transmission & Distribution]
4. IEEE Transactions on Power Systems
5. IEEE Electrical Insulation magazine
6. Power Engineering Journal, IEE

NATIONAL

1. Electrical India
2. Journal of Institution of Engineers (India).
3. Electrical Engineering Update

7.6.9 FINDINGS AND DEVELOPMENTS

1. "NEW ERA" in power transmission 1200kV UHVAC Technology", IEEMA Journal, Vol. 3, No. 9, May 2012.

2. "Large storage flow batteries", IEEMA Journal, Vol. 3, No. 9, May 2012.

3. Opto electrical and structural properties of CUxO thin films gram by R.F. Spultering method, Journal of alternate energy sources and technologies, Vol. 1, Issue 1-3, 2011.

4. Thermophilic adaption of anaerobic sludge for electricity production, Journal of alternate energy sources and technologies, Vol. 1, Issue 1-3, 2011.

5. A fuzzy logic based electronics load controller for self excited induction generation, Journal of alternate energy sources and technologies, Vol. 1, Issue 1-3, 2011.

6. Novel robust control algorithm of dc motors, Ba-Hai Nguyen, The 6th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI 2009)

7. Flux Distribution in Saturated DC Machines at No-Load Erdelyi, E. A. Ahamed, S. V. Burtness, R. D.University of Colorado, Boulder, Colo.; This paper appears in: power apparatus and systems, ieee transactions on Volume: 84, Issue: 5,On page(s): 375-381,Current Version Published: 2009-01-27.

7.6.10 i. SESSION PLAN

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
		UNIT-I			
1	Electro mechanical Energy conversion, Forces and Torques in magnetic system	Energy in magnetic system Air gap description Attracted armature relay	L1	T2-Ch2, R2-Ch1 R3-Ch4	GATE
		Determination of mechanical force Significance of mechanical energy	L2	T2-Ch2, R2-Ch1 R3-Ch4	
2	Energy Balance Energy and force in a singly excited magnetic field system Determination of magnetic force, co energy Multi excited magnetic field system	Flow of energy in electro mechanical device.	L3	T2-Ch2, R2-Ch1 R3-Ch4	
		Description of electrical energy input Evaluation mechanical work done	L4	T2-Ch2, R2-Ch1 R3-Ch4	
		Magnetic field energy stored Significance of Co energy	L5	T2-Ch2, R2-Ch1 R3-Ch4	
		Determination of force Determination of energy	L6	T2-Ch2, R2-Ch1 R3-Ch4	
		Determination of Torque for multi excited system	L7	T2-Ch2, R2-Ch1 R3-Ch4	
		UNIT-II			
3	DC Generators , Principle of Operation Constructional features, Action of commutator Armature windings, lap and wave windings, Simplex and multiplex windings, Use of laminated armature EMF equation, problems	Faraday's laws of electro magnetic induction Simple loop generator Fleming's Right hand rule	L8	T2-Ch3, R2-Ch2 R7-Ch2	GATE IES
		Field system Armature Commutator Brushes, bearings and other parts	L9	T2-Ch4, R2-Ch2 R7-Ch2	
		Use of commutator Linear commutation	L10	T2-Ch4, R2-Ch2 R7-Ch3	
		Terminology in armature windings Lap and wave windings	L11	T2-Ch7, R2-Ch2 R3-Ch7	GATE
		Design of simplex lap windings Design of simplex wave windings Use of equalizer connections	L12	R2-Ch2, R3-Ch7 R7-Ch2	
		Use of laminations Introduction to Iron loss	L13	T2-Ch3, R2-Ch2 R3-Ch4	GATE IES
		Determination of generated emf Problems on generated emf	L14	T2-Ch3, R2-Ch2 R3-Ch7	

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
4	Armature reaction, Cross magnetizing and De magnetizing AT/Pole, Compensating Winding	Cross magnetizing effect Demagnetizing effect	L15	R2-Ch2, R3-Ch4 R7-Ch3	GATE IES
		Determination of Cross magnetizing AT/pole Determination of Demagnetizing AT/pole	L16	R2-Ch2, R3-Ch4 R7-Ch3	
		Use of compensating windings Determination of comp. Winding turns	L17	R2-Ch2, R3-Ch4 R7-Ch3	
5	Commutation, Reactance voltage, Methods of improving commutation	Understanding the concept of commutation	L18	R2-Ch2, R3-Ch4 R7-Ch3	
		Significance of reactance voltage	L19	T2-Ch4, R2-Ch2 R7-Ch3	
		Resistance commutation	L20	T2-Ch4, R2-Ch2 R7-Ch3	
		Brush shift method Inter poles method	L21		
UNIT-III					
6	Methods of excitation, separately excited and self excited generator Build – up of EMF	Separately excited generator	L22	T2-Ch4, R2-Ch3 R7-Ch4	GATE IES
		Circuit models and emf equation of shunt, series and compound generator	L23	T2-Ch4, R2-Ch3 R7-Ch4	
		Magnetization curve Requirements for build up of emf	L24	T2-Ch4, R2-Ch3 R7-Ch4	
7	Critical field resistance and critical speed Causes for failure to self excited and remedial measures	significance of critical field resistance Significance of critical speed	L25	T2-Ch4, R2-Ch3 R7-Ch4	
		Causes for failures to self excite . Remedial measures	L26	T2-Ch4, R2-Ch3 R7-Ch4	
UNIT-V					
8	Load Characteristics of shunt, series and compound generators Parallel operation of D.C series generators	Load Characteristics of shunt generator	L27	T2-Ch4, R2-Ch3 R7-Ch4	GATE IES
		Load Characteristics of series and compound generator	L28	T2-Ch4, R2-Ch3 R7-Ch4	
		Parallel operation of D.C series and shunt generators	L29	R2-Ch3,R7-Ch5	
9	Use of equalizer bar, Cross connection of field windings, Load Sharing and problems	Use of equalizer bars Cross-connection of field windings	L30	R2-Ch3,R7-Ch5	
		Load sharing on D.C Generators Problems	L31	R2-Ch3, R7-Ch5	

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
UNIT VI					
10	DC Motors Principle of Operations Back emf –Torque equation	Flemings left hand rule Lenz's law Motor Torque production	L32	T2-Ch4, R2-Ch4 R7-Ch6	GATE IES
		Importance of Back emf	L33	T2-Ch4, R2-Ch4 R7-Ch6	
		Derivation of Torque Problems on Back emf and Torque	L34	T2-Ch4, R2-Ch4 R7-Ch6	
11	Characteristics and application of shunt, series and compound motors Armature reaction Commutation	Characteristics of shunt motors, series motors Characteristics of Differential and cumulative compound motors	L35	R2-Ch4, R3-Ch7 R7-Ch6	
		Effects of armature reaction Demagnetizing and cross magnetizing effect	L36	T2-Ch4, R2-Ch4 R7-Ch6	
		Commutation process, Use of commutator Methods of commutation	L37	T2-Ch4, R2-Ch4 R7-Ch6	
UNIT VII					
12	Speed control of D.C Motors, Armature voltage and field flux control methods Ward – Leonard system of speed control	Armature control and field control of shunt motors	L38	R2-Ch4, R3-Ch7 R7-Ch7	GATE IES
		Speed control of series motor by diverted field , tapped field and series parallel control	L39	R2-Ch4, R3-Ch7 R7-Ch7	
		Ward Leonard method of speed control Disadvantages and advantages of the system	L40	R2-Ch4, R3-Ch7 R7-Ch7	
13	Motor starter Principles of Solid state starter	Necessity of starter 3 Pint starter circuit diagram and operation with advantages and disadvantages	L41	T2-Ch4, R2-Ch4 R7-Ch7	
		4 point starter circuit diagram, operation and application	L42	T2-Ch4, R2-Ch4 R7-Ch7	
		Solid state starter principle	L43	R7-Ch7, R8-Ch30	
UNIT VIII					
14	Losses constant and variable losses Calculation of efficiency , condition for maximum efficiency	Iron losses Copper losses Stray losses Problems on losses	L 44	R2-Ch5, R3-Ch5 R7-Ch9	GATE IES
		Condition for maximum efficiency Problems on efficiency	L 45	R2-Ch5, R3-Ch5 R7-Ch9	
15	Methods of testing, direct, Indirect and regenerative testing	Circuit connection and procedure of Brake test and Swinburnes test	L46	R2-Ch5, R3-Ch5 R7-Ch9	

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
16	Brake test, swinburne's test Hopkinson's test Fields test Retardation test, separation of stray losses in a D.C motor test	Problems on brake test and Swinburne's test advantages and disadvantages of different tests	L 47	T2-Ch4, R2-Ch5 R7-Ch9	GATE IES
		Circuit diagram and procedure of Hopkinson's test	L48	T2-Ch4, R2-Ch5 R7-Ch9	
		Circuit diagram and procedure of Fields' test	L49	T2-Ch4, R2-Ch5 R7-Ch9	
		Advantages and disadvantages of tests	L50	T2-Ch4, R2-Ch5 R7-Ch9	
		Retardation test	L51	T2-Ch4, R2-Ch5 R8-Ch31	
		Separation of stray losses	L52	T2-Ch4, R2-Ch5 R8-Ch31	
		Problems on Hopkinson's test Problems on Swinburne's test	L53	T2-Ch4, R2-Ch5 R8-Ch31	

ii. TUTORIAL PLAN

S. No	Topics scheduled	Salient topics to be discussed
1	Electromagnetics – Fundamentals, and Maxwell's Equations	Derivations and problems on Maxwell's Equations.
2	Emf generated, and self and separately excited generator circuits	Problems on Emf generated
3	Armature windings, Lap and wave winding	Problems on winding design
4	Armature reaction, demagnetizing and cross magnetizing effects.	Problems on armature reaction
5	Commutation, reactance voltage, commutation methods	Problems on commutation
6	Hysterisis loop and magnetization, OCC of shunt generator	Problems on OCC
7	Critical resistance, critical speed	Problems on Critical resistance
8	Parallel operation of shunt generators	Problems on parallel operation
9	Load sharing between two generators	Problems on load sharing
10	Back emf and significance of back emf of a DC Motor	Problems on back emf
11	Torque and Torque equation of a DC Motor	Problems on Torque
12	DC Series, Shunt, Compound motor Characteristics	Problems on DC Motor Characteristics
13	Various DC Motor Starter, 2point, 3point and 4 point starters	Problems on design of starter resistance
14	Losses in a DC Machines, Copper losses, Corelosses and mechanical losses.	Problems on losses
15	DC motor testings and efficiency	Problems on efficiency

7.6.11 STUDENT SEMINAR TOPICS

1. Heating and cooling curves of dc machines Direct current machines, RK Rajput
2. Cross field rotating machines Direct current machines, RK Rajput
3 Applying electrical motors in hazardous areas, Electricity Operators, Nov. 2003.
4. How to go for commissioning of new motor, Electricity Operators, Aug. 2003.
5. Tortional vibrations & oscillations in electrical motor, Electricity Operators, Jan. 2003.
6. Wind mill generators, Electrical India.
7. Armature Windings-Simplex and duplex" from "Electrical machine designs, A.K. Sawhany
8. Field computations of a DC machines" from "FEM in Electrical Engg., Edward.
9. Generalized theory of a DC machine - two axis model, voltage and torque model, from Generalized theory of Electrical Machine, P.S. Bimrah.

7.6.12 QUESTION BANK

UNIT-I

1 a) State the advantages of analyzing energy-conversion devices by field energy concept.
b) Explain the principle of energy conversion. **(Dec 14)**

2 a) Find an expression for the magnetic force developed in a singly excited translational magnetic system.
b) Two magnetic surfaces separated by distance g have a flux density of 1.5 T in between them. This value is usually the saturation level for ferromagnetic materials. Find the force between these two surfaces for area $A=2\ m^2$. **(Dec 14)**

3 a) Define field energy and co-energy. Give the significance of co-energy in the derivation of torque or force in an electromechanical energy conversion device.
b) Self and mutual inductances in henries of two coupled coils are
$L_1=3+1/2x$, $L_2=2+1/2x$, $M_{12}=1/2x$, over a certain displacement x in meters. The coil resistances are negligible. For constant currents of $I_1=10A$ and $I_2=-5A$.
c) Compute the mechanical work done in increasing x from 0.5 to 1m. **(Dec 14)**

1. i Derive the expression for field energy and co energy in a doubly excited system assuming constant voltage system.
   ii Two coupled coils have self and mutual inductance of $L_{11} = 2+(1/2x)$, $L_{22} = 1+(1/2x)$, $L_{21} = 1/2x$ over a certain range of linear displacement x. The first coil is excited by a constant current of 20A and the second by a constant current of -10A.Find.
   a) Mechanical work done if x changes form 0.5 ro 1m.
   b) Energy supplied by each elecrical source in part(i).
   c) Change in field energy in part(i).
   Hence verify that the nenergy supplied by the source is equal to the increase in the field energy plus the mechanical work done. **(Dec-2013)**

2. i Describe the principle of energy conversion. From the consideration of various energies include, develop the model of an electromechanical energy conversion device.
   ii Derive an expression for the energy stoted in a magnetic field system. **(Dec-2012)**

3. i. For a linear magnetic circuit, show that the magnetic stored energy density is given by $½B^2/\mu$ joules/ m^3.
   ii. A 10 KW, 1440 rpm d.c shunt generator has a time constant $L_f=R_f$ of 0.2 sec for its field winding. Under normal operating conditions, the $I_f^2r_f$ loss in the filed winding is 400 watts. Compute the energy stored in the magnetic field produced by the field winding, under normal operating conditions. **(May 11)**
4. i. What are the significances of energy and co - energy of energy conversion system?
   ii. Show how mechanical energy output can be determined in the multiple excited nonlinear systems. **(May 11)**
5. i. Draw and explain fully the general block diagram representation of an electro mechanical energy conversion device.
   ii. For a singly excited magnetic system, derive the relation for the magnetic stored energy in terms of reluctance. **(May 11)**

6. i. Describe singly excited magnetic field systems.
   ii. The magnetic Flux density on the surface of an iron face is 1.6T which is typical saturation level value for ferromagnetic material. Find the force density on the iron face. Derive the formula used. **(May 11, 05)**
7. i. Explain the principle of energy conversion of electromechanical system.
   ii. Derive an expression for the energy stored in a magnetic field. **(May 11, Mar 06)**

8. i. Define field energy and coenergy. Give the significance of coenergy in the derivation of torque or force in an electro mechanical energy conversion device.

   ii. All practical energy conversion devices use magnetic field as a coupling medium rather than electrical field. Discuss? **(Nov 10)**

9. i. Derive an expression for the energy stored in a magnetic field.

   ii. Show that the reaction of coupling magnetic field on the electrical or mechanical system is essential for the electro mechanical energy conversion process. **(Nov 10)**

10. Two windings, one on stator and the other on rotor, has the following parameters
    $R_s = 3.5\,\Omega$ $r_r = 4\,\Omega$ $L_s = 0.06\text{H}$ $L_r = 0.25$ H $M_{sr} = 0.08\cos\theta_r$

Where r is the space angle between stator and rotor winding axes. The two windings are connected in parallel and the rotor is locked at r = 900. With the currents initially zero, the windings are switched on to a voltage source of 60 volt d.c at time t=0

i. Find i_s, i_r as functions of time
ii. Find an expression for magnetic torque as a function of time **(Nov 10)**

11. i. Derive the expression for the forces developed in electro magnetic system.
ii. All energy conversion devices use magnetic field as a coupling medium rather than electrical field. Explain why? **(Nov 10, Feb 08, Mar 04)**

12. In a rectangular electro magnetic relay, the exciting coil has 1200 turns. Cross sectional area of the core is A = 6 cm × 6 cm. neglect the reluctance of the magnetic circuit and fringing effects. With coil current kept constant at 2A, derive expression for force on armature as a function of air gap of length x. Find the work done by the magnetic field when x decreases from 1 cm to 0.5 cm by integrating the force. **(June 10, Nov 08)**

13. i. Define field energy and co - energy. Give the significance of coenergy in the derivation of torque or force in an electro mechanical energy conversion device.
ii. In a rectangular electromagnetic relay the exiting coil has 900 turns of a resistance 1.5 ohm. Cross sectional area of the core is A=3 c.m^2.neglect reluctance of the magnetic circuit and fringing effects. If the coil is exited with an ac voltage of 50 Hz frequencies, having a peak to peak value of 200 V and the armature is held at a distance of 1cm, find the average force on the armature. **(June 10)**

14. i. Prove that energy and coenergy in a linear magnetic system are given by identical expressions.
ii. A 10 KW, 1500rpm d.c shunt generator has a time constant L_f/R_f of 0.5 sec for its field winding. Under normal operating conditions, the $I^2_f r_f$ loss in the filed winding is 600 watts. Compute the energy stored in the magnetic field produced by the field winding, under normal operating conditions. **(June 10, Nov 08)**

15. i. Describe the principle of energy conversion. From a consideration of the various energies involved, develop the model of an electro mechanical conversion device.
ii. Show that the torque developed in a doubly excited magnetic system is equal to the rate of increase of field energy with respect to the displacement at constant currents. **(June 10)**

16. i. Explain the significance of energy and co-energy with neat diagrams.
ii. In a rectangular electromagnetic relay, the exciting coil has 2000 turns and cross sectional area of 30cm^2. Neglect the reluctance of magnetic path, and resistance of the coil. When the coil is excited with a sinusoidal voltage source of 45V (RMS), 60Hz and armature is held at 1.5cm, find the force on the armature. **(Nov 09)**

17. i. What is energy balance equation? Explain the importance of it in electromechanical energy conversion devices.
ii. For an electromagnetic relay, calculate the maximum force on the armature if saturation flux density is 1.6T, cross sectional area is 30cm^2 and turns = 1000. Neglect the reluctance of magnetic path and calculate the current required to obtain a displacement of 0.2mm. **(Nov 09)**

18. i. Explain the mechanical energy and work done in a singly excited system when actual displacement occurs?
ii. In an electromagnetic relay, the exciting coil has 1200 turns. The cross sectional area of the core is 25cm^2. Reluctance of the magnetic path may be neglected. Find the inductance of the coil with an air gap of 1cm. Find the field energy and force on armature if current in the coil is 2 Amp. **(Nov 09)**

19. i. What is field energy? Deduce the relation between mechanical energy and field energy in a linear system.
    ii. The λ-i relationship for an electromechanical system is given by $\lambda=3.5i^{2/3}$ lg, where lg is the length of air gap. Determine the mechanical force on moving part if the current in the exciting coil is 11 Amp and lg=1mm. **(Nov 09)**

20. Describe the principle of energy conversion. From the consideration of variousenergies included, develop the model of an electromechanical energy conversion device. **(Nov 08, Mar 06, 03)**

21. Show that torque developed in a doubly excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant current? **(Nov 08)**

22. i. What are the significances of energy and co-energy of Energy Conversion system?
    ii. Derive expression for the magnetic force developed in linear electro magnetic system. **(Feb 08, Nov 07, May 05, Mar 04, 02)**

23. i. Derive the force in a singly excited relay in the linear case.
    ii. The magnetizing curve of the iron portion of a cylindrical ironclad solenoid magnet is given in the following table. The exciting coil has 1100 turns and carries a steady current of 2.5 A. Find direction and magnitude of electrical energy flow if plunger is made to move from a gap of 0.2 to 1 cm.

Flux,Wb	0.001	0.00175	0.0023	0.0025	0.0026	0.00265
MMF,AT	60	120	210	300	390	510

(Feb 08)

24. i. Derive the force in a doubly excited system in the linear magnetic system.
    ii. The magnetizing curve of the iron portion of a cylindrical ironclad solenoid magnet is given in the following table. The exciting coil has 1200 turns and carries a steady current of 2.25 A. Calaculate magnetic field energy and co-energy for an air-gap of 0.3 cm for the linear case.

Flux,Wb	0.001	0.00175	0.0023	0.0025	0.0026	0.00265
MMF,AT	60	120	210	300	390	510

(Feb 08)

25. i. Show how mechanical energy output can be determined in the doubly excited system in the linear magnetic system.
    ii. A doubly excited magnetic field system has coil self and mutual inductances of $L_{11} = L_{22} = 2$, $L_{12} = L_{21} = \cos 2\theta$, where θ is the angle between the axes of the coils. If coil 2 is shorted while coil 1 carries a current of $i = I_m \sin wt$, derive expressions for instantaneous and time average torques. Find time average torque when $\theta = \pi/4$ and $I_m = \sqrt{2}$ sin 314t. **(Nov 07)**

26. ii. Derive the force in a singly excited relay in the linear magnetic system..
    ii. In a rectangular electromagnetic relay excited from a voltage source, the current and flux linkages are related as $i = \lambda (\lambda + 2 (1 ? x)^2)$; $x < 1$. Find force on the armature as a function of λ. **(Nov 07)**

27. i. What is field energy? What is the relation of mechanical energy and field energy? Relate them in a linear system.
    ii. The magnetic flux density on the surface of an iron face is 1.45 T, find the force density on the iron face. **(Feb 07, Nov 06)**

28. i. With the help of energy balance theory, explain the concept of coenergy and mechanical energy.
    ii. Two coupled coils have self and mutual inductances of $L_{11} = L_{22} = \frac{2}{1+2x}$ and $L_{12} = 1 - 2x$. If $I_1 = 5$Amp and $I_2 = -2$ Amp, find the input energy required to increase x from 0 to 0.5 m. **(Feb 07)**

29. With the help of neat diagram obtain the expression for the energy stored in a magnetic system for a simple attracted armature type relay. Explain the operation of system. **(Feb 07, Nov 06)**

30. i. Show how torque can be determined in the multiply excited linear system.
    ii. In a rectangular electromagnetic relay, the exciting coil has 1300 turns. Crosssectional area of thecore is A = 5cm × 5cm. If the i-ë curve representing themovement of the armature is a straight line, findexpression for the mechanical energy output and calculate its value when currents ia= 2 A, ib = 1.5 A,corresponding to gaps xa = 1 cm and xb = 0.5 cm respectively. **(Mar 06)**

31. i. Derive expression for the energy stored in a magnetic field system.
    ii. What is the expression for electromagnetic torque developed in a linear electromagnetic system. **(Mar 06)**

32. i. What is the torque produced by reluctance motor.
    ii. Define energy and co-energy in a linear magnetic system. **(May 05)**

33. Derive force in a singly excited relay in the non linear case? **(May 03)**

34. i. Show how mechanical energy output can be determined in the singly excited relay in non linear case?
    ii. A doubly excited magnetic field system has coil self and mutual inductances of $L_{11}= L_{22}=2$, $L_{12}=L_{21}=\cos2q$, where q is angle between axes of coils. If coil 2 is shorted while coil 1 carries a current of I_m = Ö 2 sin 314t, derive expressions for instantaneous and time average torques. If the rotor is allowed to move, at what angle will it come to rest? Plot the average torque variation with respect to q and explain your result? **(May 03)**

35. Explain clearly about singly excited systems and develop expressions for force produced in the system? **(Mar 02)**

36. i. What are advantages of analyzing energy conversion devices by field energy concept?
    ii. Prove that energy and co energy in a linear magnetic system are given by identical expressions? **(Mar 02)**

37. i. State and briefly explain various phenomenon useful for electromechanical energy conversion in rotating mechanisms?
    ii. Energy conversion devices make use of magnetic field as a coupling medium rather than an electric field .discuss? **(Mar 02)**

UNIT-II

1. a) What are the two functions of a commutator in D.C machines ?
   b) Explain the following terms with reference to armature windings of D.C machines:
   (i) Pole pitch (ii) Back pitch (iii) Front pitch **(Dec 14)**

2. a) Explain the methods of improving commutation in D.C generators with the help of neat sketches.
b) A 250kW, 400V, 4 pole d.c generator has 720 lap wound conductors.It is given a brush lead of 3 angular degrees (mech) from the geometric neutral.Calculate the cross and demagnetizing ampere turns per pole. Neglect the shunt field current. **(Dec 14)**

3. a) What is armature reaction ? What are the effects of armature reaction? How the armature reaction is minimized?
b) A single turn coil has an inductance of 0.02mH in the commutating zone. Find the value of compensating field required for obtaining straight line commutation for an armature current of 120A for 4-pole lap wound d.c machine. **(Dec 14)**

1. i Derive the EMF equation of DC generator.
   ii A separately excited generator with constant excitation is connected to a constant load. When the speed is 1200rpm it delivers 120A at 500V. At what sp[eed will the current be reduced to 60A? Armature resistance is 0.1 ohm. Armature reaction may be ignored. **(Dec 13)**

2. i With neat diagram give the constructional features of a d.c. Machjines.

   ii The armature of a 6 pole generator has a wave winding containing 664 conductors. Calculate the generated e.m.f when flux per pole is 60mWb and the speed is 250 rpm. find speed at which the armature must be driven to generated an e.m.f of 550V if the flux per is reduced to 58m Wb. **(Dec 12)**

3. Explain the constructional features of dc machine and principle of operation? **(Dec 11)**

4. A 6-pole d.c generator runs at 850 r.p.m and each pole has a flux of 12mwb. If there are 150 conductors in series between each pair of brushes, what is the value of generated e.m.f? **(Dec 11)**

5. Draw a neat sketch of a d.c generator. State the function of each part and explain the principle of operation as a motor and generator? **(Dec 11)**

6. A 4-pole lap-wound dc armature has a bore diameter of 0.7metre. It has 560 conductors and the ratio of pole [illegible]^2. Determine the induced emf in the armature if effective length of armature conductor is 20cm. **(Dec 11)**

7. i. Discuss the principle of operation of d.c machine as a motor and as a generator?
   ii. Derive the expression of emf generated in case of generator from the first principles? **(Dec 11)**

8. An 8-pole lap-wound d.c generator armature has 960 conductors, a flux of 40mwb and a speed of 400 r.p.m. Calculate the e.m.f generated on open circuit. If the same armature is wave wound, at what speed must it be driven to generate 400V? **(Dec 11)**

9. i. Explain how ac voltage is converted to dc voltage in a generator?
   ii. Explain clearly the necessities of commutator arrangement in dc generators?
   iii. Derive the expression of emf generated in case of dc machine. **(Dec 11)**

10. A 4-pole generator has an induced emf of 262V when driven at a speed of 400rpm. The armature is lap wound and has 652 conductors, its resistance being 0.15Ω. The bore of the pole shoe is 42cm diameter; the pole subtends an angle of 60^0 and is 20cm long. Calculate the flux density in the air gap. **(Dec 11)**

11 i. Give the materials and functions of the following parts of a DC machine:
   a. Field poles
   b. Yoke
   c. Commutator
   d. Commutating poles
   e. Armature
   ii. The armature of a 6 - pole generator has a wave winding containing 664 conductors. Calculate the generated e.m.f when flux per pole is 60 mWb and the speed is 250 rpm. Find the speed at which the armature must be driven to generate an e.m.f. of 550 V if the flux per pole is reduced to 58 mWb. **(May 11)**

12. i. What is the principle of operation of a dc generator? Why is a commutator and brush arrangement necessary for the operation of a dc generator?
   ii. A 4 pole dc armature winding having 40 slots and 120 coils is to be provided with a simplex lap winding. Work out with a suitable arrangement so that split winding is not used. **(May 11)**

13. The armature winding of a 4-pole. 250V dc shunt motor is lap connected. There are 120 slots, each slot containing 8 conductors. The flux per pole is 20mWb and current taken by the motor is 25A. The resistance of armature and field circuit is 0.1Ω and 125Ω respectively. If the rotational losses amount to be 810W find.
   i. gross torque
   ii. usefull torque and
   iii. efficiency.
   (May 11)

14. i. What are the similarities and dissimilarities between lap and wave windings in a D.C machine
   ii. A 4 pole lap wound dc armature has a bore diameter of 0.7 metre. It has 560 conductors and the ratio of pole arc/pole pitch is 0.63. if the armature is running at 600 rpm and the flux density in the air gap is 1.2 Wb/m^2. Determine the induced emf in the armature if e”ective length of the armature conductor

is 20cm. **(May 11)**

15. Explain the following:
    i. How can induced emf in the armature conductors of a dc generator be made unidirectional?
    ii. Do we use laminations for all iron parts of electrical machines? If not why?
    iii. Why are the carbon or graphite brushes preferred over copper brushes for use in dc machines?
    iv. What is dummy coil and where and why it is used?

(May 11, Nov 10)

16. i. How will you distinguish between series and shunt windings of a dc compound machine?
    ii. In a model of a dc machine, the field winding and its armature circuit are always drawn at 900 with respect to each other. Why? **(May 11)**

17. Design a lap winding for 32 conductors, 4 pole d.c machine. Show also the brush position.

(May 11, 05, Feb 08, Nov 07, 05, Mar 06)

18. i. What are the factors on which the choice of type of armature winding of a dc machine will depend?
    ii. A 4 pole dc machine armature with lap connected coils has 72 slots and 6 coil sides per slots. Determine the winding pitches and connections to 9 equally spaced equalizer rings. **(Nov 10)**

19. i. Explain the construction and working of an elementary generator.
    ii. An 8 pole wave connected DC generator has 900 armature conductors and flux/pole of 0.04 wb. At what speed it must be driven to generate 500V. **(Nov 10)**

20. The resistance of the field circuit of a dc shunt generator is 200Ω. When the output of the generator is 100 KW, the terminal voltage is 500 V and the generated emf is 525 V. Calculate
    i. The armature resistance and
    ii. The value of the generated emf when the output is 60 KW and terminal voltage is 520 V. **(Nov 10)**

21. Explain with neat sketches, the difference between progressive and retrogressive windings of a d.c machine. **(Nov 10, May 04)**

22. The armature core of a 4 pole DC machine has 31 slots each designed to accommodate 4 coil sides of a simplex wave winding. The winding has total of 496 conductors. Find **(Nov 10, May 05)**
    i. Total number of coils
    ii. Turns per coil
    iii. Commutator pitch
    iv. Back, front and total pitches and
    v. Number of commutator segments

23. Explain the space distribution of main pole flux and armature flux in a dc motor? A 6 pole dc motor has 300 conductors each carrying 80A. flux per pole is 0.015Wb and speed is 1800 rpm. Compute the e.m.f, power developed in armature and electromagnetic torque if the armature conductors are lap connected.

(June 10)

24. Draw the developed diagram of simple two layer progressive lap winding for 4 pole generator with 12 slots. Each slot containing two coil sides. Indicate the position of brushes. Determine
    i. Front pitch
    ii. Back pitch
    iii. Resultant pitch
    iv. The number of brushes
    v. The number of commutator segments for the machine. **(June 10)**

25. Work out the winding details of 4 pole simplex wave wound dc armature having 21 slots and 4 coil sides per slot. Draw the sequence diagram for the winding. **(June 10)**

26. i. Explain what you understand by
a. lap and wave windings
b. duplex windings
ii. A 4 pole generator has an induced emf of 262 V when driven at a speed of 400 rpm. The armature is lap wound and has 652 conductors, its resistance being 0.15 ohm. The bore of the pole shoe is 42cm diameter, the pole subtends an angle of 60^0 and is 20 cm long. Calculate the flux density in the air gap. **(June 10)**

27. Explain the following
i. How can induced emf in the armature conductors of a dc generator be made unidirectional.
ii. Do we use laminations for all iron parts of electrical machines? If not why?
iii. Why is commutator used in dc generator?
iv. What is an equalizer ring? When and why such rings are to be used? **(June 10)**

28. i. Discuss about the various losses taking place in a DC generator. How can they be minimized?
ii. A 12 pole, DC generator has total flux of 0.3 wb and the armature conductors are lap wound with 600conductors. Calculate the generated emf on open circuit when it runs at 500rpm. If the armature is wave wound, at what speed it must be driven to generate the same voltage. **(Nov 09)**

29. i. Explain the role of brushes and commutator in a DC machine. Mention the materials used for them.
ii. A 6 pole, DC generator is wave wound. There are 66 slots on the armature surface and 10 conductors per slot. The current carrying capacity of each conductor is 25A. Find the power developed by the armature, if the flux per pole is 50m wb and rotated at 500 rpm. **(Nov 09)**

30. i. Obtain the EMF equation of a DC generator. How the generated EMF of a DC generator can be varied?
ii. The armature of a DC generator is wound with 4 poles. There are 560 conductors wounded in double layer. The resistance of each conductor is 10 milliohm. Find the resistance of armature and emf generated, if the flux per pole is 45m wb and the generator is rotated at 350rpm. **(Nov 09)**

31. i. Distinguish between lap and wave windings? Explain their limitations and suitability?
ii. A DC generator is supplying a load of 700 amperes at a terminal voltage of 300 volts. Find the resistance of armature conductor when the EMF induced is 320 volts. The machine is with 8 poles, wave wounded with 48 slots and 6 conductors per slot. **(Nov 09)**

32. i. In which type of d. c. armature windings do you need equalizer rings? Why?
ii. Derive from first principles the E. M. F. equation of a d. c. generator. **(Nov 08, 07)**

33. Describe the various parts of a dc machine. Explain fucntion of commutator. Show how the flux flows in these parts. Enumerate the conditions essential to build up voltage in a dc shunt generator. what do you understand by the following terms.
i. armature
ii. commutation. **(Nov 08)**

34. The lap wound armature of a 4 - pole generator armature has 51 slots. Each slot contains 20 conductors. What will be the e.m.f generated in machine when driven at 1500 r.p.m. If useful flux per pole is 0.01Wb? **(Nov 08)**

35. i. Distinguish between lap and wave windings.
    ii. The armature of a 2 pole, 200V generator has 400 conductors and runs at 300 rpm. Calculate the useful flux or pole. If the number of turns in each field coil is 1200, what is the average value of the emf induced in each coil on breaking the field, if the flux dies away completely in 0.1s. **(Nov 08)**

36. What are the ordinary types of armature winding for dc machine? Explain the essential difference between them and give relative merits and the applications of the two types windings. **(Nov 08)**

37. An 6 pole lap wound generator armature has 720 conductors, a flux of 30 mwb and a speed of 600 r.p.m. Calculate the e.m.f generated on open circuit. If the same armature is wave wound, at what speed it be driven to generate 600 volts? **(Nov 08)**

38. Give the developed view of a 13 slot, 2 coil sides/slot, 4-pole, D.C. wave winding. **(Feb 08)**

39. A 4-pole wave connected armature has 51 slots. Draw a developed winding diagram and show the brush positions. Assume any other data required. **(Feb 08, May 05)**

40. A 4-pole 32-conductor d. c. machine is to lap wound. Develop the simplex progressive lap winding and show the windings with brush positions. **(Nov 07)**

41. i. Explain the principle of action of commutator in a d. c. generator.
    ii. Define
    a. front pitch
    b. back pitch
    c. coil span and
    d. commutator pitch as applied to d. c. armature windings and indicate the above on the diagram of a wave winding. **(Nov 07)**

42. An 8 pole DC generator has per pole flux of 40mWb 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. **(Feb 07, Nov 06)**

43. i. A DC generator is connected with lap winding. The numbers of poles in machine are 6. If the resistance of each conductor is 2 milliohm and if there are 60 slots with 4 conductors in each slot, find the resistance of armature.Repeat the calculation if the winding is wave winding.
    ii. Explain the terms equalizer rings and dummy coils? With which windings they are related? **(Feb 07)**

44. The armature of a DC generator is wave wound with 6 poles. There are 56 slots on the armature surface and 6 turns per coil. The armature winding is double layer winding. The current carrying capacity of each conductor is 45 Amp, find the power developed by the armature, if flux per pole is 45mwb and generator is rotated at 350 rpm. Find the resistance of armature, if resistance of each conductor is 3 milliohm and hence find the output power and electrical eciency of machine. Repeat the calculation for lap winding. Compare the out put power and comment on result. **(Nov 06)**

45. The armature core of a 4-pole d. c. machine has 31 slots each designed to accommodate 4 coil sides of a simplex wave winding. The winding has total of 496 conductors. Findi. Total number of coils ii. Turns per coiliii. Commutator pitch(iv. Back, front and total pitches and(v. Number of commutator segments. **(Mar 06)**

46. Explain with sketches, the difference between a progressive and retrogressive winding. Also, explain why progressive windings are used with lap windings. **(Mar 06, Nov 05, May 04)**

47. Determine a suitable winding scheme for a 2-circuit, 4-pole winding of a D. C.machine. The armature slots are 17 and the commutator bars are 51. Give the winding table and use retrogressive type winding. **(Mar 06)**

48. Draw the winding diagram in radial for a 4-pole 13-slot simplex wave connected d. c. generator with commutator having 13 segments. The no.of coil sides per slot is 2. Indicate the position of brushes. (**Nov 05)**

49. Give lay out (winding tablv. of a simplex lap progressive winding used for a 44 slot, 4-pole d. c. armature with 44 commutator segments **(Nov 05)**

50. Derive from first principles, the emf equation of dc generator? **(May 04)**

51. A 4 pole , wave wound armature has 230 conductors , 23 commutator segments. Give table of winding connections, choose retrogressive winding? **(May 03)**

52. i. A 10kw, 6-pole, dc generator develops an emf of 200V at 1500rpm. The armature has a lap connected winding. The average flux density over a pole pitch is 0.9T. The length and diameter of armature are 0.25m and 0.2m. calculate
   ii. Flux per pole
   iii. Total number of active conductors in armature
   iv. Torque developed by machine when armature supplies a current of 50A. **(GATE 91)**

53. A 200V, 10kw lap wound dc generator has 10 poles and 500 conductors on its armature. If the pole face covers 80% of pole pitch, the pole face conductors required to fully compensate for armature reaction will be how many conductors/ pole? **(GATE 97)**

UNIT-III

1. a) Define critical field resistance and critical speed of D.C generator.
   b) Draw the external characterestics of a D.C series generator. **(Dec 14)**

2. a) Explain the desirable conditions and parallel operation of D.C compound generators with aneat circuit diagram.
   b) Two d.c shunt generators are rated 230 kW and 150kW, 400 V. Their full load drops are 3% and 6% respectively. They are excited to no load voltages of 410V and 420V respectively. How will they share load of 1000A and the corresponding bus voltage? **(Dec 14)**

3. a) How O.C.C charecterestics of d.c separately excited generator is drawn?
   b) The open circuit charecterestics of a d.c 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 46Ω band 0.12Ω respectively. Determine the terminal voltage when the armature current is 360A in two cases:
i) Armature reaction is negligible
ii) 1A field current is needed to counteract the effect of armature reaction.. **(Dec 14)**

1. Illustrate the effect of armature reaction with neat diagrams.
   ii 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 1.8A. If brushes are shifted backward through 1.5 segments form the geometrical neutral axis, find the demagnetizing and distorting amp-turn/pole. **(Dec-13)**

2. i Develop an expression for the demagnetizing and cross magnetizing armature ampere- turns in a d.c. generator.
   ~~ii Estimate the number of turns needed on each interpole of a 6 pole generator deliverinng 200kW at~~ 200V given number of lap conncted armature conductors are 540, interpole air gap is 1.0cm, flux ~~density in interpole air gap is~~ $0.3 wb/m^2$. ~~ignore the effect of iron parts of the circuit leakage.~~ **~~(Dec-12)~~**

4. Explain the process of commutation in d.c machine and describe the methods to improve it?

(Dec 11)

(Dec 11)

"A candle loses none of its light by lighting another candle."

- Author:Unknow

5. Explain the following
    i. period of commutation
    ii. reactance voltage during commutation
    iii. emf commutation
    iv. resistance commutation.

6. i. What do you understand by demagnetizing and cross magnetizing effects of armature reaction in a d.c machine?
   ii. Define commutation. Explain the process of commutation in d.c generators with neat sketches? **(Dec 11)**

7. What is armature reaction? Describe the effects of armature reaction on the operation of d.c machine. How armature reaction is minimized? **(Dec 11)**

8. i. What do you understand by armature reaction? Explain the concept of demagnetizing and cross magnetizing armature ampere turns?
   ii. A 4 pole dc generator supplies a current of 148A. It has 492 armature conductors lap connected. The brushes are given lead of 10^0 when the machines delivers full load. Calculate the demagnetising ATs per pole. If the shunt field winding takes 6 A. Determine the number of extra shunt field turns necessary to neutralize this demagnetization. **(May 11)**

9. i. What is the difference between resistance commutation and E.M.F commutation?
   ii. A 2000 kw, 500 V, 16 - pole generator has a lap wound armature with 2360 conductor. Calculate the number of pole face conductors in each of the compensating winding. Assume that pole faces cover 66 percent of the entire circumstances. **(May 11)**

10. i. Explain the effects of armature reaction.
    ii. A 4 pole series motor has 944 wave connected armature conductors. At a certain load, the flux per pole is 34.6 mwb and the total mechanical torque developed is 209 NM. Calculate the line current taken by the motor and the speed at which it will run when the voltage of 500V is applied. Total motor resistance is 3Ω. **(May 11)**

11. i. Explain the following methods of improving commutation
    a. Resistance commutation
    b. E.M.F commutation
    ii. A 75kw, 4-pole wave wound dc generator has 72 armature conductors. The brushes are given an actual lead of 90 at full load. Calculate
    a. Cross magnetizing AT/pole
    b. Demagnetizing AT/pole and
    c. Series turns required to neutralize the demagnetizing effect. **(May 11)**

12. A 480V, 20 kW shunt motor took 2.5A when running light. For an armature resistance to be 0.6Ω field resistance of 800Ω and brush drop of 2V. Find the full load efficiency. **(Nov 10)**

13. i. Explain the action of compensating windings in certain dc machines. Show schematically how they are connected .
    ii. A 500 V, wave wound, 750 rpm dc shunt generator supplies a load of 195 A. The armature has 720 conductors and shunt field resistances is 100 ohms. Find the demagnetising ampere turns/pole if the brushes are advanced through 3 commutator segments at this load. Also calculate the extra field turns required to neutralize this demagnetization. **(Nov, June 10)**

14. A 600V dc motor drives a 60 kW load at 900 rpm. The shunt field resistance is 100Ω and the armature resistance is 0.16Ω . If the motor efficiency is 85%, determine:
    i. the speed at no-load and the sped regulation.
    ii. the rotational loss. **(Nov 10)**

15. i. How are demagnetizing and cross magnetizing ampere-turns/pole in a D.C Machines calculated?
    ii. Determine AT/pole for each interpole of a 4 pole generator with 88 slots each containing 900 amp - conductors. The interpole air gap is 0.01 m and flux density in the interpole air gap is 0.3 T. The effects of iron parts of iron parts of the circuits and leakage may neglected. **(Nov 10, 08)**

16. i. Explain the methods of improving commutation with relevant figures.
    ii. A commutator segment having a diameter of 0.7 m rotates at 600 rpm. Determine the approximate time of commutation. The brush width is 15mm. **(Nov 10)**

17. i. With the help of neat sketches, explain the effect of armature reaction on the air gap flux in a D.C. generator.
    ii. A 300 KW, 500V,6 - pole lap wound DC generator has 70 slots with 12 conductors/slot. The brushes are advanced through 3.33 mechanical degrees. Find the number of demagnetizing and cross magnetizing AT/pole. Ignore shunt filed current. **(Nov 10)**

18. A 50 Kw, 500V, 4 pole generator has a 2 layer simplex lap winding in 48 slots with 12 conductors in each layer. If the brushes are given an actual lead of 150, calculate
    i. Cross magnetizing AT/pole
    ii. Demagnetizing AT/pole and
    iii. Number of turns per pole on the compensating winding if the pole arc to pitch is 0.7 and brushes are placed on geometric neutral plane. **(Nov, June 10)**

19. i. A dc shunt generator gives an open circuit voltage of 240V. when loaded the terminal voltage drops to 220V.determine the load current in case armature and field resistances are 0.1 and 50 ohms. neglect the effect of armature reaction.
    ii. Why is the resistance of the field winding of a dc shunt generator kept below critical field resistance. **(June 10)**

20. i. Define the terms critical resistance and critical speed and bring out their roles in the process of self excitation of D.C machines.
    ii. A separately excited generator has no load voltage of 120V at a field current of 2A, when driven at 1500 rpm. Assuming that it is operating on the straight line portion of its saturation curve, calculate
    a. the generated voltage when the field resistance is increased to 2.5A
    b. the generated voltage when the speed is reduce to 1400 rpm and the field current is increased to 2.84A **(June 10)**

21. A 6 pole lap connected DC generator having a commutator ring of diameter 40cm runs at 900 r.p.m the brush width is 1.7. cm and thickness of mica insulation is 0.2 cm .the load current delivered by the generator is 116A and the shunt field current is 4A .The self - inductance of each coils is 0.09mH.Determine the reactance voltage if the commutation is:
    i. Linear
    ii. Sinusoidal. **(June 10)**

22. A 4-pole lap wound dc generator delivers a full load current of 400A. It has shunt field current of 12A and 123 commutator segments in the commutator ring of the machine. If the brushes are advanced by 3 commutator segments on full load, calculate
    i. Cross magnetizing AT/pole.
    ii. Demagnetizing AT/pole. **(June 10, Feb 08, May 05)**

23. i. What is commutation? How can it be improved?
    ii. A 4 pole generator supplies a current of 286A. It has 984 lap wound armature conductors. When delivering full load, the brushes are given an actual lead of. Calculate the demagnetizating and cross magnetizing ampere turns per pole. **(Nov 09)**

24. i. Discuss and derive the cross magnetizing ampere turn per pole. Mention how that effect can be nullified?
    ii. A 8 pole, wave wound, DC generator has 480 armature conductors. The armature current is 250A. Find the demagnetizing and cross magnetizing ampere turns per pole if the brushes are shifted by 6^0 electrical from geometrical neutral axis. **(Nov 09)**

25. i. Discuss about armature reaction and its effect on the performance of a DC machine.
    ii. Calculate the armature demagnetizing and cross-magnetizing ampere turns per pole of an 8-pole generator having an output of 200A at 500V, the lap-connected armature has 1280 conductors, 160 commutator segments, when the brushes are advanced by 3 segments from the no-load neutral axis. **(Nov 09)**

26. i. Discuss and derive the Demagntezing ampere turns per pole. Mention how that effect can be nullified?
    ii. What are the causes of sparking in a DC machine? Explain how it can be avoided? **(Nov 09)**

27. i. Explain the armature reaction in a D.C generator on no-load. Enumerate and explain the method to overcome the adverse effects of the armature reaction.
    ii. A 4-pole 50 KW, 250v wave wound, shunt generator has 400 armature conductors. Brushes are given a lead of 4 commutator segments. Calculate the demagnetizing ampere turns/pole if shunt field resistance is 50 ohms. Also calculate extra shunt filed turns/pole to neutralize the demagnetization. **(Nov 08)**

28. A 4-pole generator supplies a current of 143A. It has 492 armature conductors
    i. wave wound
    ii. lap wound connected. When delivering full load, the brushes are given an actual lead of 10^0. Calculate the demagnetizing ampere turns/pole. This field winding is shunt connected and takes 10A. Find the number of extra shunt filed turns necessary to neutralize this demagnetization. **(Nov 08)**

29. i. How demagnetizing and cross magnetizing ampere turns per pole are calculated in a DC machine?
    ii. Determine per pole, the number of
    a. across magnetizing ampere turns
    b. demagnetising ampere turns
    c. series field turns to balance the back ampere turns in the case of a dc generator having the following data 6000 conductors, total current 100A, 6 pole wave wound, angle of lead is 10^0, leakage coefficient=1.3 **(Nov 08)**

30. i. Explain the purpose of laminating the armature core of a d. c. machine.
    ii. The diameter of a commutator ring of a lap wound d. c. motor is 25 cms. The brush width is 1.8 cm and width of mica insulation is 0.2 cm. If the speed of the motor is 200 rpm, determine the time of commutation. **(Feb 08, Nov 07)**

31. i. When are dummy coils used and which type of D.C. armature winding these will occur?
    ii. Calculate the ampere turns for each commutating pole of an 8-pole generator with 107 slots, each containing 1000 ampere conductors. The interpole air-gap is 1.2 cm. The flux density in the air gap is to be 0.32 T. Neglect iron parts and leakage. **(Nov 07)**

32. Explain the importance of series field, interpole and compensating windings in d.c. compound machine. **(Nov 07, Mar 06, May 05)**

33. i. With relevant diagrams, explain the phenomena of commutations in a d.c.machine
    ii. Explain what is meant by 'straight line commutation,' 'Accelerated' & 'Retarded commutation'. Discuss the role of interpoles in improving commutation. **(Nov 07, 05, May 04)**

34. i. Explain about demagnetizing Ampere turn per pole and Cross magnetizing Ampere Turn per pole.
    ii. What is the purpose of compensating winding? Explain in detail. **(Feb 07, Nov 06)**

35. i. Explain the effects of armature reaction in a d. c. generator.
    ii. Determine per pole the number
    a. Of cross-magnetizing ampere-turns
    b. Of back ampere-turns and
    c. 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 100A, 4 poles, 2-circuit wave winding, angle of lead = 10^0, leakage coecient=1.3.
    (Nov 06)

36. i. What are the causes of sparking in a d. c. machine? Explain how commutation is improved by use of inter poles.
    ii. A 22.38 kW, 400-V, 2-pole wave-wound d.c., shunt motor has 840 armature conductors and 140 commutator segments. Its full-load eciency is 88% and the shunt field current is 1.57A. If brushes are shifted backward through 1.5 segments from the geometrical neutral axis, find the demagnetizing and distorting amp-turn / pole. **(Nov 06)**

37. i. Explain the effects of armature reaction in a d. c. generator and discuss briefly the methods to minimize these effects.
    ii. With a neat sketch explain the function of commutator in a d.c. mechine. **(Mar 06, Nov 05, May 05)**

38. i. With neat sketches, explain the commutation process in d. c. generator.
    ii. With the help of neat sketches, explain the effect of armature reaction on the air gap flux in a d. c. generator. **(Mar06)**

39. Estimate the number of series turns/pole for a 500KW compound generator required to develop 500V on load, and 550V at full load, the required ampere-turns per pole being 7900 and 11200 at no load and full load respectively. The shunt winding is designed to give 500V on load where its temperature is 200C. Its final temperature on load is 600C. **(Mar06)**

40. i. Explain the effects of armature reaction in a d. c. generator.
    ii. What are the causes of sparking in a d. c. machine? Explain how commutation is improved by use of interpoles **(Nov 05, May 05)**

41. A belt driven dc shunt generator runs at 1500 rpm delivering 10kohm at 220V busbars. The belt breaks, following which the machine operates as a motor drawing 2kw power. What will be its speed as motor? Armature and field resistances are 0.25 and 55 ohms respectively. Contact drop is 1V/brush?
    (GATE 00)

42. Explain effect of armature reaction on main field flux by using developed view of armature current sheet and poles of dc machine? Hence outline bad effects of armature reaction?
    Discuss resultant flux density waveform obtained above gets modified with the use of interpoles?
    (IES 01)

43. Why compensating winding and interpole winding is used in dc machines? **(IES 96)**

UNIT-IV

1. i. State the applications of d.c shunt motor.
   ii. A 240V series motor takes a 40 A and gives its rated output at 1500rpm. Its resistance is 0.3Ω. Find what resistance must be added to obtain rated torque.
   a) at starting b) at 1000rpm. **(Dec 14)**
2. i. Derive an expression for the electromagnetic torque produced by d.c motor.
   ii. A 10 kW, 250V d.c shunt motor takes a no load armaturte current of 6A at rated voltage and runs at 1250rpm The armature circuit resistance is o.3Ω and the field resistance is 50Ω. At rated load and rated voltage, the motor takes a current of 20A and armature reaction weakens the field flux by 2%. Calculate the full load speed and the corresponding electromagnetic torque of the motor. **(Dec 14)**
3. I.Explain different speed control methods of d.c motor. Mention their advantages and disadvantages.
   ii. A d.c series motor is driving a fan load where the load torque is proportional to the cube of speed. The resistance of the armature and field in series is 0.1Ω and the motor Tks 10A and runs at 1000rpm when operating from a 200V supply. Calculate the value of resistance to be inserted in series with the armature to reduce the operating speed to 800 rpm. **(Dec 14)**

1. i Explain experimental determination of critical field resistance for a self excited generator.
   ii What are the causes and indication of over load generated? **(Dec-13)**

2. i What is critical field resistance? How di you calculate the critical field resistance practically?
   ii A 20kW,200V shunt generetor has an armature resistance of 0.05Ω and a shunt field resistance of 200Ω .Calculate the power developed in the armature when it deliver rated output. **(Dec-12)**

3. i. Explain the process of building up of voltage in a d.c shunt generators and give conditions to be satisfied for voltage build up?
   ii. What are various possible causes for d.c shunt generator not building up voltage? **(Dec 11)**

4. A short shunt compound d.c generator delivers 100A to a load at 250V. The generator delivers 100A to a load at 250V. The generator has shunt field, series field and armature resistance of 130Ω, 0.1Ω and 0.1Ω respectively. Calculate the voltage generated in armature winding. Assume 1V drop per brush.
   (Dec 11)
5. i. What are the different types of d.c generators according to the ways in which fields are excited? Show the connection diagram of each type?
   ii. Explain the process of building up of voltage in a d.c shunt generators and give conditions to be satisfied for voltage build up? **(Dec 11)**

6. Explain the process of building up of voltage in d.c shunt generator? What is its significance? How O.C.C. is being drawn for shunt generator? **(Dec 11)**

7. Distinguish between self excited and separately excited d.c generators. How is self-excited d.c generators classified? Give their connection diagram? **(Dec 11)**

8. A shunt generator gives a full-load output of 30kw at a terminal voltage of 200V. The armature and shunt field resistance are 0.05Ω and 50Ω respectively. The iron and friction losses are 1000w. Calculate
   i. generated e.m.f
   ii. copper losses
   iii. efficiency **(Dec 11)**

9. i. Give reason why a shunt generator may fail to build up.
   ii. Compute the emf generated in 8 - pole dc shunt generator having a lap wound armature with 120 slots and 8 conductors per slot. The flux per pole is 0.05 Wb and the speed of rotation is 200 rpm. The above generator supplies 40 no's of 60W lamps, a terminal voltage of 160 V if the armature and field

resistances are 0.25 Ω and 160Ω respectively, and the voltage drop at each brush is 2 V. Find the new speed at which the machine must run. Neglect armature reaction. **(May 11)**

10. In a 110 V compound generator, the resistance of the armature, shunt and series windings are 0.06, 25, and 0.04 ohms respectively. The load consists of 200 lamps each rated at 55 w, 110 V. Find the e.m.f generated and armature current when the machine is connected:
    i. long shunt
    ii. short shunt
    iii. How will the ampere-turns of series winding be changed if in (i), a diverter of resistance 0.1 ohm be connected in parallel with the series winding? Ignore armature reaction and brush contact drop.

(May 11)

11. i. A separately excited generator when running at 1200 rpm supplies a current of 150A at 125 V to circuit of constant resistance. What will be the current when the speed drops to 800 rpm if the field current is unaltered? Armature resistance is 0.05 ohm and the total voltage drop at the brushes is 2V. Ignore the change in armature reaction.

    ii. A short shunt compound generator delivers a load current of 20 A at 220 V and has armature, series field and shunt field resistance of 0.03, 0.01, and 250 Ω respectively. Calculate the induced emf and the armature current. Allow 1.0 V per brush contact drop. **(May 11)**

12. What features of a dc series generator distinguish it from other types of dc generators explain. **(May 11)**

13. A 10 kW, 250V dc shunt generator has total no load rotational loss of 400W. The armature circuit (including brushes) and shunt field resistance are 0.5Ω and 250Ω respectively. Calculate the shaft power input and the efficiency at rated loa. Also calculate the maximum efficiency and the corresponding power output. **(May 11)**

14. i. How are the series and shunt windings arranged on the pole of a dc compound machine.

    ii. The magnetization curve of a dc shunt generator running at 1000 rpm is as follows:

Field amperes :	0.25	0.5	1.0	1.5	2	2.5	3
EMF (V) :	36	72	138	188	225	250	270

    Find

    a. The value of field resistance to give 240 volts on load .

    b. The speed at which generator fails to build up. **(May 11)**

15. i. Explain in detail how a dc shunt generator builds up its voltage. What limits the voltage to which can build up?

    ii. A series generator delivers 100A at 250V and the resistance of the series field and armature resistance are 0.055 Ω and 0.1 Ω respectively. Calculate the armature current and generated emf. **(May 11, 10)**

16. Draw the connection diagrams for the shunt , series and compound generators and Discuss their load characterstics. **(Nov 10)**

17. i. Explain the various possible causes for the failure of build up of voltage in dc generators.

    ii. A 6 pole lap wound shunt generator supplies to 100 lamps of 100 watts, 200V each. The field and armature resistances are 500 ohms and 0.2 ohm respectively. Allowing a brush drop of 1V each brush, calculate the following

    a. armature current

    b. current per path

    c. generated emf

    d. power output of D.C generator **(Nov 10)**

18. i. How O.C.C charecteristics of a series generator can be obtained

    ii. Draw the load charecteristics of a cumulative compound D.C. generator (at, under excited and over excited). **(Nov 10)**

19. i. Explain the voltage regulationof a D.C generator

    ii. A 25 kw, 250V shunt generator delivers rated current at rated voltage on n removal of load the terminal voltage rises to 275 V. Determine the voltage regulation. **(Nov 10)**

20. i. Explain the applications of different types of dc generators.
    ii. A long shunt generator supplies a load current of 180A at a terminal voltage of 400V. The series field, shunt field and armature resistances are 0.03Ω, 200Ω and 0.04Ω respectively. Contact drop per brush = 1V. Armature reaction may be ignored. Determine the EMF generated. **(Nov, June 10)**

21. i. Draw OCC of a dc shunt generator and define critical speed and critical resistance.
    ii. A dc shunt generator has the following open circuit magnetization curve at its rated speed

Field current (A) :	0.5	1.0	1.5	2	3	4
EMF (V) :	180	340	450	500	550	570

The resistance of the field circuit is 200 Ω. The generator is driven at its rated speed. Find the terminal voltage on open circuit. (Use graph paper) **(Nov 10, 08)**

22. i. Explain how voltage will build up in a shunt generator.
    ii. Explain the charectristics of D.C. series generator and mark the stable region. **(Nov 10)**

23. i. Explain with suitable characteristics, the concept of critical resistance and critical speed in a DC machine.
    ii. A series generator having combine armature and field resistance of 0.4 ohm is running at 100rpm and delivering 5.5KW at a terminal voltage of 110V. If the speed is raised to 1500 rpm and load is adjusted to 10KW, find the new current and terminal voltage. Assume the machine is working on the straight line portion of the magnetizing characteristics. **(June 10)**

24. A 50 Kw, 440 V shunt generator having an armature circuit resistance including inter-pole winding of 0.15 ohm at normal working temperature was run as a shunt motor on no-load at rated voltage and speed. The total current drawn by the motor was 5 A including shunt field current of 1.5 A. Calculate the efficiency of the shunt generator at $3/4^{th}$ full-load. **(June 10)**

25. i. Write about "build-up of EMF" in self excited generator. Mention the reasons for failure of "voltage-buildup".
    ii. A 20KW compound generator works on full load with a terminal voltage of 230V. The armature, series field and shunt field resistances are 0.1Ω, 0.05Ω and 115Ω respectively. Calculate the generated emf, when the generator is connected as short shunt. **(Nov 09)**

26. i. Illustrate how DC generators are classified based on the "methods of excitation" using neat schematic diagrams.
    ii. A short shunt compound generator delivers a load of 15KW at 200V and through a pair of conductors of total resistance of 0.1Ω and armature; series field and shunt field resistances of 0.04Ω, 0.03Ω and 80Ω respectively. What is the emf generated? Allow 1.0V per brush contact drop. **(Nov 09)**

27. i. Define the terms critical resistance and critical speed. Explain their significance in DC generators.
    ii. A 100KW, 250V DC shunt generator has 4-pole, lap connected armature with 280 conductors. The generator is rewound to form two armature circuits with wave connected armature for the same number of conductors. Calculate the new rating of the machine for voltage, output current and power if the speed and flux per pole remain as before neglecting shunt field current. **(Nov 09)**

28. i. What is critical field resistance? How can b it e determined experimentally?
    ii. A long shunt compound generator delivers a load current of 40A at 220V and has armature, series field and shunt field resistance of 0.04Ω, 0.03Ω and 220Ω respectively. Calculate the induced emf and the armature current. Allow 1.0V per brush contact drop. **(Nov 09)**

29. i. How do you determine the magnetization characteristics of a DC generator.
    ii. A separately excited generator when running at 1200 rpm supplies a current of 200A at 125 V to circuit of constant resistance. What will be the current when the speed drops to 1000 rpm if the field current is unaltered? Armature resistance is 0.04 ohm and the total voltage drop at the brushes is 2V. Ignore the change in armature reaction. **(Nov 08)**

30. i. List the conditions for building up of a dc shunt generator.
    ii. A d.c. shunt generator is supplying load connected to a bus - bar voltage of 220 V. It has an armature resistance of 0.025 ohm and field resistance of 110 ohm. Calculate the value of load current and load power when it generates an emf of 230 V. Neglect the effect of armature reaction. Draw circuit diagram. **(Nov 08)**

31. i. How are the series and shunt windings arranged on the pole of a dc compound machine?
    ii. How will you distinguish between series and shunt windings of a dc compound machine? **(Nov 08)**

32. i. What is critical field resistance? How do you calculate it practically?
    ii. When a shunt generator failed to build up voltage, how to rectify fault? **(Feb 08, Nov 07, May 03)**

33. i. How the emf is generated in a shunt generator.
    ii. The open-circuit characteristic of a D.C shunt generator for a speed of 1000 rpm is given by the following table:

Field current I_f(A)	2	3	4	5	6	7
Generated emf (V)	102	150	185	215	232	245

The shunt circuit has resistance of 37 ohms. Find the speed at which the excitation may be expected to build up. The armature resistance is 0.04 ohm. Neglecting the effect of brush drop and armature reaction, estimate the terminal voltage when the speed is 1000 rpm and the armature delivers a current of 100 A. **(Nov 07)**

34. i. What is critical speed? How do you calculate the critical speed in the laboratory?
    ii. What are the conditions to build up of emf in a shunt generator? **(Nov 07, 05, May 03)**

35. i. Draw the neat graph to show open circuit characteristic of a separately excited DC generator? Why is a field regulator necessary for this machine.
    ii. What is critical speed? Explain the significance of critical speed. **(Feb 07)**

36. What is critical speed? How do you draw magnetization characteristics in laboratory. **(Feb 07, Nov 06)**

37. i. Explain experimental determination of critical field resistance for a self excited generator? **(Nov 06)**

38. i. Explain magnetization characteristic of a DC generator?
    ii. What are the advantages and disadvantages of separately excited generators? **(Nov 06)**

37. i. How do you determine the critical resistance and critical speed in the laboratory.
    ii. How do you determine the internal and external characteristics of D.C component generators. **(Mar 06)**

39. i. How do you classify the compound generators.
    ii. What are the various characteristics of compound generators. Explain them briefly? **(Mar 06, May 03)**

40. i What are conditions to build up of emf in shunt generator?
    ii. A separately excited generator when running at 1200 rpm supplies a current of 200A at 125V to a circuit of constant resistance. What will be the current when the speed drops to 1000rpm if the field current is un altered? Armature resistance is 0.04ohm and total voltage drop at brushes is 2V. ignore change in armature reaction? **(May 04)**

41. i. Clearly explain process of voltage build up in a self excited generator?
    ii. Discuss applications of shunt, series, compound generators considering their load characteristics. **(May 02)**

42. i. Clearly explain terms critical field resistance and critical speed?
    ii. A 500V dc shunt generator is supplying a 20KW load and has an armature, field resistances are 0.2 and 250 ohms respectively. Determine the armature current , emf if contact brush drop is 1V/ brush? **(May 02)**

UNIT-V

1. i. Enumerate the various losses in a d.c machine.
   ii. Derive the condition for maximum efficiency of a D.C motor. **(Dec 14)**
2. I.Explain the procedure of conducting a suitable test to separate stray losses in a d.c motor.
   ii. A 200V, 41.92kW D.C shunt motor when tested by Swinburne's method gave the following results.
   Running light: Armature current was 6.5A and field current was 2.2A
   With armature locked: The current was 70A when a potential difference of 3V was applied to the brushes.
   Estimate the efficiency of the motor when working under full load conditions. **(Dec 14)**
3. a) Discuss the effect of speed and size on the efficiency of D.C machines.
   b) Two identical d.c machines when tested by Hopkinson's method gave the following test results:
   Field currents are 5A and 4.2A. Line voltage is 230V. Line current excluding both the field currents is 40A. Motor armature current is 350A. The armature resistance of each machine is 0.02Ω. Calculate the efficiency of both machines. **(Dec 14)**

1. i Sketch and explain the load characteristics of DC generators. Also give their fields of application.
   ii Two shunt generator operating at parallel deliver a total current of 250A. One of the generated is rated 50kW and the other is 100kW. he voltage rating of both machine is 500V and have regulations of 6%(smaller one) and 4% Assuming linear characteristics determine (i) the current delivered by each machine and (ii) terminal voltage. **(Dec-13)**

2. i Explain the procedure of parallel operation of generators.
   ii What are the applications of different types of d.c generators?
   iii Two generators A and B are connected to the common load Generator A has a constant e.m.f of 400V and internal resistance of 0.25 Ω. Generator B has an e.m.f of 410V with 0.4Ω internal resistance. Calculate the current and power output from each generator when the load voltage is 390V. **(Dec-12)**

3. A 25kw, 250V dc shunt generator has armature and field resistance of 0.06Ù and 100Ù respectively. Determine the total armature power developed when working
   i. as generator delivering 25kw output
   ii. as motor taking 25kw input. **(Dec 11)**

4. Explain what is meant by back e.m.f. Explain the principle of torque production in d.c motor and also derive the expression of torque? **(Dec 11)**

5. Draw the connection diagrams for the shunt, series and compound generators and Discuss their load characterstics. **(May 11)**

6. i. What is the function of inter poles in DC machines.
   ii. A 6-pole 120 kW, 500v DC shunt generator has 756 armature conductors wave wound. The shunt field

resistance is 50 ohms. When delivering full load the brushes are displaced from the geometrical neutral axis by 24 electrical degrees. Find the demagnetizing ampere turns/pole and cross magnetizing ampere turns/pole. Also find the number of additional shunt field turns required to neutralize the magnetizing effect. **(May 11)**

7. Explain the importance of series field, interpole and compensating windings in dc machine. **(May 11)**

8. Write short notes on the following: **(May 11, 10)**
   i. Parallel operation of DC generators

Every quotation contributes something to the stability or enlargement of the language.

- Samuel Johnson

ii. Cross connection of field windings.

9. Two 220 V d.c. generators operate in parallel. One machine has a terminal voltage of 270 V on no-load and 220 V at al load current of 35 A. The other has a voltage of 280 V on no-load and 220 V at 50 A. The external characteristics are linear. Calculate the bus-bars voltage and the output current of each machine when the total load is: **(May 11)**
 i. 60 A
 ii. 20 A.

10. i. How will you distinguish between series and shunt windings of a dc compound machine.
 ii. A short shunt compound generator delivers a load current of 30 A at 220 V and has armature, series field and shunt field resistance of 0.05, 0.03, and 200 Ω respectively. Calculate the induced emf and the armature current. Allow 1.0 V per brush contact drop. **(Nov 10)**

11. Two short-shunt compound generators A and B running in parallel supply a load current of 140A at a terminal voltage 100 V. An equalizig bar connects the two machines. The data regarding the machines are:
 Generator A: Ra=0.02 ohm; Rsh=80ohm; Rse=0.02 ohm.
 Generator B: Ra=0.05 ohm; Rsh=100 ohm; Rse=0.05 ohm; e.m.f generator B, 105 V.
 Calculate:
 i. current in series windings
 ii. armature currents
 iii. current in equalizer
 iv. e.m.f generated by generator A. **(Nov 10, 08)**

12. i. Explain the advantages of operating generators in parallel?
 ii. Two shunt generators operating in parallel deliver a total current of 250A. One of the generator is rated at 50kW and the other 100kw. The voltage rating of both machines is 500V and have regulations 6%(smaller) and 4%. Assuming linear characteristics, determine:
 a. the current delivered by each machine
 b. terminal voltage. **(June 10)**

13. i. What is an equalizer ring? explain its function.
 ii. A shunt generator has external characteristic such that the terminal voltage falls uniformly from 450 V on no-load to 440 V when delivering 100 A. It is in parallel with a battery of 224 cells each of e.m.f 2V and internal resistance of 0.02 ohm. Find how a load of 400 A would be shared. **(June 10)**

14. i. Draw the internal and external characteristics of DC shunt generators and Explain.
 ii. Two DC generators operating in parallel supply a total load current of 150A. The terminal voltage of one machine falls uniformly from 240V on open circuit to 225V when delivering 80A. The terminal voltage of second machine falls uniformly from 230V to 220V when delivering 80A. Find the current output of each generator and the bus-bar voltage. **(Nov 09)**

15. Two DC shunt generators operating in parallel supply a total load current of 200A. The terminal voltage of one generator falls uniformly from 240V to 225V when delivering 120A. The terminal voltage of second generator falls uniformly from 230V to 220V when delivering 100A. Find the load current shared by each generator and the bus-bar voltage. **(Nov 09)**

16. i. Explain the exact procedure for connecting a shunt generator in parallel with others already supplying a load.
 ii. A shunt generator has external characteristic such that the terminal voltage falls uniformly from 450V on no-load to 440V when delivering 120A. It is in parallel with a battery of 224 cells each of emf 2V and internal resistance of 0.02ohm. Find how a load of 400A would be shared.

(Nov 09)

17. i. Explain the necessity of parallel operation of DC generators. Discuss the conditions necessary for parallel operation of DC shunt generators.
 ii. A 100KW, 200V, long-shunt, cumulatively compounded DC generator has equivalent armature resistance of 0.03ohms, a series field resistance of 0.004 ohms. There are 1200 shunt field turns per pole and 5 series field turns per pole. The data of magnetization curve at armature speed of 1000 rpm is given below.

I_f(A)	0	1	2.2	3.3	42	5.3	7.1
E_e(A)	11	33	100	167	200	215	222

Calculate the terminal voltage at the rated current output for the shunt field current of 5A and a speed of 950rpm. The armature reaction may be ignored. **(Nov 09)**

18. i. Explain the drooping charectoristics of a D.C shunt generator.
 ii. A d.c series generator having an reternal charectristics which is a straight line through zero to 50V at 200A is connected as a booster between a station busbar and a seeder of 0.3Ω resistance. Calculate the voltage different between the station busbar and the far end ohm the seeder at a curent of a. 1200A and b. 50A. **(Nov 08)**

19. i. What are the reasons for failure of voltage build up in a self excited D.C generator
 ii. A shunt generator is to be converted into a level compounded generator by the addition of a series field winding. From a test on the machine with shunt excitation only, it to give 400V on no-load and 4.8A to give the same voltage when the machine is supplying its full load of 200A. the shunt winding has 1200 turns/pole. find the noos series turns required per pole. **(Nov 08)**

20. Draw the load charectristics of all the D.C generators. **(Nov 08)**

21. i. Enumerate the principal losses that occur in a DC generator and where appropriate, state the general form of the physical law upon which each loss depends?
 ii. Calculate the efficiency of a self excited DC shunt generator from the following data.
 Rating : 10 KW, 250 V, 1000 rpm. Armature resistance = 0.35Ω, voltage drop at brushes = 2V. Winding and frictional losses = 150 W, Iron loss at 250 V = 180 W Open circuit characteristic:

EMF (V) :	11	140	227	285	300	312
Field current (A) :	0	1.0	1.5	2.0	2.2	2.4

(Feb 08)

22. The load characteristics of two shunt generators are as follows:

Machine: IArmature current In amperes	0	283	566	850
Machine: IIArmature current In amperes	0	200	400	600
Terminal voltage	500	490	480	470

If the above machine works in parallel to supply a total load of 400 KW, determine
 i. The load taken by each machine and
 ii. The amount by which the open circuit emf of the machine must be raised by field regulation so that the two machines share the 400 KW load equally? **(Feb 08)**

23. A 250V, 50KW shunt generator has 1000 turns on each pole of its field winding. On no load a current of 3.5A in the field winding produces a terminal voltage of 250V, but on full load the shunt current has to be increased to 5A for the same terminal voltage at the same speed. Calculate number of series field turns per pole required for level compounding. **(Nov 07)**

24. What is the procedure to connect two series generators parallel? **(Feb 08, Mar 06)**

25. What is an equalizer connection? What is necessity of equalizer connection? **(Feb 07, Nov 06)**

26. i. Sketch the internal and external characteristics of DC shunt and series generators. What are their fields of application? **(Feb 07, Nov 06)**
    ii. Discuss the need for parallel operation of generators. Explain the load sharing of DC Shunt generators operating in parallel. **(Feb 07)**

27. i. What are the reasons for the parallel operation of DC generators?
    ii. What are the conditions necessary for parallel operation of DC shunt generators?
    iii. Explain the conditions under which two shunt generators operating in parallel do not share the total load in exact proportion to the machine ratings. **(Feb 07)**

28. i. Explain clearly why an equilizer connection makes it possible for two compound generators to operate in parallel in stable equilibrium.
    ii. Discuss the necessity for parallel operation of generators. Explain the parallel operation of DC Series generators. **(Feb 07, Nov 06)**

29. Six DC generators are running in parallel, each having an armature resistance of 0.15 ohm, running at the same speed and excited to give equal induce e.m.f(s). All generators share load equally at a terminal voltage of 500V. The total load is 360KW. If the field current of one generator is raised by 5% and the speed remains constant, Calculate
    i. New Terminal Voltage
    ii. Output of each machine. **(Nov 06)**

30. i. Distinguish between:
    a. DC shunt generator and
    b. DC compound generator.
    Show and explain the nature of external characteristic of each of them. Also give applications of each of them.
    ii. Eight DC Shunt Generators are running in parallel. Each generator supplies a load current o f 400A at 210V. The shunt field current of each generator is 4A and the armature resistance of each generator is 0.04 ohm. If one generator is suddenly switched o, determine the % change in terminal voltage, the total load current being kept unchanged. **(Nov 06)**

31. A separately excited generator with constant excitation is connected to a constant load. When the speed is 1200 rpm, it delivers 120A at 500V. At what speed will the current be reduced to 60A ? Armature resistance is 0.1 ohm. Armature reaction may be ignored. **(Nov 06)**

32. Two d.c. compound generators, A and B with an equilising bar, supply a total loadof 500A. The data relating to the machine are as follows. Armature resistance, RA = 0.05 ohm, RB =0.03 ohm Series field winding RSA = 0.02 ohm, RSB = 0.01 ohm Generated emf EA = 463V, EB = 470X. Calculate
    i. The current in each armature.
    ii. The current in each series winding.
    iii. The current in the equilising bar and
    iv. The bus-bar voltage. Neglect the shunt currents and state thenecessary assumptions made, if any. **(Mar 06)**

33. i. How do you classify the compound generators.
    ii. What are the various characteristics of compound generators. Explain them briefly? **(Mar 06)**

34. What is parallel operation? How do you connect the two shunt generators in parallel.Explain briefly? **(Nov 05)**

35. Two d.c. compound generators, A and B with an equilising bar, supply a total load of 500A. The ata relating to the machine are as follows. Armature resistance, RA = 0.05 ohm, RB = 0.03 ohm Series field winding RSA = 0.02 ohm, RSB = 0.01 ohm Generated emf EA = 463V, EB = 470X. Calculate i. The current in each armature. ii. The current in each series winding. iii. The current in the equilising bar and (iv. The bus-bar voltage. Neglect the shunt currents and state the necessary assumptions made, if any. **(Nov 05)**

36. i. Explain the procedure of parallel operation of generators.
    ii. Two separately-excited d.c generators are connected in parallel and supply a load of 200A. The machines have armature circuit resistances of 0.05 ohm and 0.1 ohm and induced emfs of 425V and 440V respectively. Determine the terminal voltage, current and power output of each machine. The effect of armature reaction is to be neglected. **(Nov 05)**

37. i. Draw the load characteristics of dc series, shunt and cumulative compound generators and give an application of each generator?
    ii. A long shunt compound generator delivers a load current of 400A at a terminal voltage of 250V. armature, series and shunt field resistances are 0.04,0.01 and 125ohm respectively. Calculate, generated emf and power developed in armature? **(May 02)**

38. i. Shunt generator having drooping characteristics are best suitable for parallel operation. Discuss
    ii. Two dc shunt generators with following data are running in parallel emfs: 120V, 115VArmature resistances: 0.05 and 0.04 ohms Common load: 25kwHow do they share the load? **(May 02)**

39. What are no load rotational losses in rotating electrical machines? How can these be determined? **(IES 01)**

40. Why does the external characteristics of a dc shunt generator turn back as it is overloaded? **(IES 01)**

41. Two dc generators having rectilinear characteristics operate in parallel. One machine has terminal voltage of 270V on no load and 220V at the load current of 30A. the other has a voltage of 280V at no load and 220v at the load current of 30A. calculate output current and bus voltage of each machine when (i) Total load current is 50A (ii) The load resistance is 10ohm. **(IES 00)**

42. Find the resistance of the load which takes a power 0.5 KW from a dc shunt generator whose external characteristic is given by the equation: $V = 250 - 2.5\, I_L$ **(IES 95)**

UNIT-VI

1. i Derive the torque equation of a d c. motor.
   ii Explain the significance of back e.m.f in a b c motor.
   iii Explain the application of d.c. motors. **(Dec-13)**

2. i Explain the how unidirectional torque is a d.c motor. Mention the performance of d.c series motor when it is started without a load on it.
   ii Discuss armature reaction and commutatikon in d.cmotors.
   iii A 440V shunt motor has armature resistance of 0.8Ω and field resistance is $220\ \Omega$ runs at 1000 rpm. If iron and friction losses amount to 1500W. Find the armature torque and shaft torque when takes a total current of 200A. **(Dec 12)**

3. Sketch the speed-load characteristics of a d.c
   i. Shunt motor
   ii. Series motor
   iii. Cumulatively compound motor.
   Account for the shape of the above characteristics curves? **(Dec 11)**

4. A 250V shunt motor runs at 1,000 rpm at no load and takes 8A. The total armature and shunt field resistance are respectively 0.2Ω and 250Ω. Calculate the speed when loaded and taking 50A. Assume the flux to be constant. **(Dec 11)**

5. Discuss the different methods of speed control of d.c motor with neat circuit diagram. **(Dec 11)**

6. A d.c shunt machine, connected to 250V, has an armature resistance of $0.12\ \Omega$ and resistance of the field circuit is 100Ω. Find the ratio of the speed as a generator to the speed as a motor, the line current in each case being 80A. **(Dec 11)**

7. Derive an expression for the emf generated in a dc motor? The counter emf of a shunt motor is 227 V, the field resistance is 160 ohm and field current is 1.5A. If the line current is 39.5 A, find the armature resistance. Also find the armature current when the motor is stationary. **(May 11, 10)**

8. The following data apply to dc shunt motor.
   Supply voltage=460V, armature current=28A, speed=1000 rpm, armature resistance=0.72Ω.
   Calculate:
   i. the armature current
   ii. the speed when the
   flux per pole is increased to 120% of the initial value, given that the total torque developed by the armature is unchanged. **(May 11)**

9. A 230V, 1000 rpm dc shunt motor has field resistance of 115Ω and armature circuit resistance of 0.5Ω. At no load, the motor runs at 1000 rpm with armature current of 4A and with full field flux.:
   i. For a load requiring 80Nm, compute armature current and speed of the motor
   ii. If it is desired that motor develops 8kW at 1250 rpm determine the value of external resistance that must be inserted in series with the field winding. Saturation and armature reaction are neglected.
   (May 11)

10. i. Explain the operating characteristics of dc series motors?

ii. A250 V shunt motor has an armature current of 20A when running at 1000 rpm against full-load torque. The armature resistance is 0.5 ohm. What resistance must be inserted in series with the armature to reduce the speed to 500 rpm at the same torque, and what would be the speed if the load torque is halved with this resistance in the circuit. Assume the flux to remain constant throughout and neglect brush contact drop. **(May 11)**

11. A 7.46 kW, 250V shunt motor takes a line current of 5A when running light. Calculate the efficiency as a motor when delivering full load output, if the armature and field resistance are 0.5 Ω and 250Ω respectively. At what output power will the efficiency be maximum? Is it possible to obtain this output from these machine? **(May 11)**

12. A 10kW 900 rpm, 400V dc shunt motor has armature circuit resistance (including brushes) of 1Ω and shunt field resistance of 400Ω. If efficiency at rated load is 85%, then calculate:

i. The no-laoad armature current,

ii. The speed when motor draws 20A from the mains and

iii. The armature current when the total(or internal) torque developed is 98.5 Nm.
Assume the flux and remain constant. **(May 11)**

13. i. Draw and explain the dc Series motor characterstics.

ii. The magnetization characteristic of a 4-pole dc series motor may be taken as proportional to current over a part of the working range; on this basis the flux per pole is 4.5 mwb/A. The load requires a gross torque proportional to the square of the speed equal to 30 Nm at 1000 rev/min. The armature is wave-wound and has 492 active conductors. Determine the speed at which the motor will run and the current it will draw when connected to a 220 V supply, the total resistance of the motor being 2.0 ohm. **(Nov 10, 08)**

14. i. Explain the operating characteristics of dc compound motors?

ii. A 250 V dc Series motor has a linear open charactersitc curve with a slope of 12V/A at 1220 rpm. Find its speed when developing a torque of 40 N-m if $R_a+R_f=0.6$ ohms. **(Nov 10)**

15. A dc series motor drives a fan at 800 rpm and takes 20A. When fed from rated voltage of 230V. The motor resistance is 0.4Ω. The motor speed is to be raised to 1000 rpm by voltage control. Find the voltage and current in case magnetic circuit is:

i. saturated and

ii. unsaturated. **(Nov 10)**

16. Shunt motor connected to a constant d.c. voltage source, drives a load requiring constant electromagnetic torque. Prove that, if counter e.m.f. $E_a > (1/2)V_t$, the speed decreases with an increase in flux (or vice-versa) and if $E_a < (1/2)V_t$ the speed increases with an increase in flux. Here Vt is the armature terminal voltage. **(Nov 10)**

17. A 10 kW, 240V dc shunt motor draws a line current of 5.2A while running at noload speed of 1200 rpm from a 240V dc 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. **(Nov 10)**

18. i. Draw and explain the Torque-current characteristics of various types of dc motors.
    ii. A 220V shunt motor with an armature resistance of 0.5ohms is excited to give constant main field. At full load the motor runs at 500 rpm and takes an armature current of 30A.If a resistance of 1.0ohm is placed in the armature circuit, find the speed at:
    a. full-load torque and
    b. double full-load torque. **(June 10)**

19. i. Derive the expression for torque developed in the armature of a DC motor. State the factors on which the torque depends.
    ii. A 4 pole, DC series motor has lap connected armature winding with 600 conductors. When fed from 250V, the motor supplies a load of 10KW and takes a line current of 50A. The flux per pole is 0.03 wb and runs at 3000rpm. The friction and iron losses are 500W. Calculate the armature torque and shaft torque developed by the motor. **(Nov 09)**

20. i. Distinguish between motor and generator action. Derive the voltage equation of the DC motor.
    ii. A 12 pole, lap wound, 240V motor has 740 armature conductors. The armature resistance is 0.33ohms and the useful flux per pole is 0.03wb. If the total torque developed by the motor is 150Nm. find the armature current taken and the speed of operation. **(Nov 09)**

21. i. Explain the operating principle of a DC motor? Mention how unidirectional torque can be developed?
    ii. A 6 pole, lap wound, 240V motor has 740 armature conductors. The armature resistance is 0.2ohms and the useful flux/per pole is 0.035wb. If the total torque developed by the motor is 130Nm. find the armature current taken and the speed of operation. **(Nov 09)**

22. i. List out various types of DC motors. Mention their applications.
    ii. A 45 KW, 250V, 4-pole, lap-connected DC shunt motor has 320 conductors. The armature and shunt field resistances are 0.05 ohm and 125 ohms respectively. The flux/pole is 0.03 wb. If the full load efficiency is 75%. Find the
    a. Shaft torque.
    b. Speed **(Nov 09)**

23. A 20 KW,250 V dc shunt motor has a full-load armature current of 85 A at 1100 rpm.The armature resistance is 0.18 ohm.
    Determine:
    i. the initial torque developed;
    ii. the internal torque of the field current is suddenly reduced to 80% of its original value;
    iii. The steady motor speed in part assuming the load torque to have remained constant. **(Nov 08)**

24. i. Explain the basic performance equations for a dc motor.
    ii. A 4-pole, 250 V series motor has a wave-connected armature with 1254 conductors. The flux per pole is 22 mWb when the motor is taking 50 A. Iron and friction losses amount to 1.0 Kw. Armature resistance is 0.2 ohm and series field resistance is 0.2 ohm. Calculate:
    a. the speed
    b. the BHP
    c. the shaft torque and
    d. the efficiency at this load. **(Nov 08)**

25. A 250v 4 pole shunt motor has two circuit armature winding with 500 conductors.The armature circuit resistance is 0.25 ohms field resstance is 125 ohm and the flux per pole is 0.02wb.neglect armature reaction.find the sped and torque developed if the motor draws 14 A from the mains. **(Nov 08)**

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26. i. Develop the general expression for the speed of a motor in terms of supply voltage, armature resistance and flux per pole.
    ii. Discuss the applications of series motors and compound motors. **(Feb 08)**

27. i. Discuss about ward-Leonard system method of Speed Control of D.C. machines in detail.
    ii. In a shunt machine, running at 500 rpm, the hysteresis and eddy current losses are 250W and 150W respectively. Find the speed at which the total core losses are reduced by 30%. **(Nov 07)**

28. A 4-pole 250V DC shunt motor has lap connected 960 conductors. The flux per pole is 20mWii. Determine the torque developed by the armature and the useful torque in Nm when current drawn by the motor is 32A. The armature resistance is 0.1 and shunt field resistance is 125. The rotational losses of the machine amount to 825W. Derive the formula used **(Feb 08, Nov 07, Mar 06, May 05)**

29. i. Derive an expression for the torque of a DC motor.
    ii. Explain the armature reaction in dc motors. **(Feb 08, Mar 06)**

30. i. How does a DC motor automatically adjust input to match the mechanical load on the motor?
    ii. Explain armature reaction in DC shunt motors, indicating also a few remedies to its adverse effects. **(Feb 08, Nov 06)**

31. i. Differentiate between generator action and motor action of a DC machine.
    ii. Explain the applications of DC shunt and series motors with the help of their characteristics and equations. **(Feb 07, Nov 06)**

32. i. Define torque. Derive the expression for torque developed by a D.C. motor from fundamentals.
    ii. Determine the torque developed when a current of 30A passes through the armature of a motor with the following particulars: lap winding, 310 conductors, 4-pole, pole-shoes 16.2 cm long subtending an angle of 600 at the centre, bore radius 16.2 cm, flux density in air gap 0.7 tesla. **(Feb 07)**

33. i. What is the significance of back e.m.f in a DC motor?
    ii. Deduce the condition for maximum power of a DC motor.
    iii. A 12-pole lap connected 230V shunt motor has 410 conductors. It takes 41A on full-load. The flux per pole is 0.05 Wb. The armature and field resistances are 0.1 ohm and 230 ohms respectively. Contact drop per brush is 1V. Determine the speed of motor at full-load. **(Feb 07)**

34. i. Discuss armature reaction and commutation in DC motors.
    ii. A 220v DC Shunt Motor takes 22A at rated voltage and runs at 1000 rpm. Its field and armature circuit resistances are 110 ohms and 0.1 ohm respectively. Compute the value of additional resistance required in the armature circuit to reduce the speed to 800 rpm when the load torque is proportional to speed. **(Nov 06)**

35. i. Distinguish between motor and generator action. Derive the equation for the back e.m.f induced in a DC motor.
    ii. A 6-pole DC motor has a wave connected armature with 87 slots, each slot containing 6 conductors. The flux per pole is 20 m.wb 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 16KW. Calculate
    a. Speed
    b. Armature Torque and
    c. Shaft Torque. **(Nov 06)**

36. i. Distinguish between generator and motor action. Derive the equation for the back emf of a DCmotor.
    ii. What are the different types of DC motors and give their applications. **(Mar 06, May 05)**

37. i. Explain how the performance characteristics of a d.c. shunt motor can be determined by conducting actual load test. Draw the model curves.
    ii. In a Hopkinson's test on 200V machines, the line current excluding the field currents was 15 A and motor armature current 115A. The field currents were 5A and 4.2A and armature resistance of each machine was 0.04 . Calculate the efficiency of each machine allowing 1 V drop at each rush.**(Mar 06)**

38. A 220V shunt motor takes 60A when running at 800rpm. It has an armature resistance of 0.1. Find the speed and armature current if the magnetic flux is weakened by 20%, contact drop per brush = 1V. Total torque developed remains constant. **(Mar 06)**

39. i. Discuss armature reaction and commutation in a dc motor
    ii. A 230V DC shunt motor takes 32A at full load. Find the back emf on full load if Ra = 0.2 and Rf = 115 respectively. **(Mar 06)**

40. i. How can you control the speed of D.C. Shunt Motor by using Ward-Leonard system.
    ii. A 220V series motor runs at 800 rpm when taking a current of 15A. The motor has an armature resistance of 0.3 and series field resistance of 0.2. Find the resistance to be connected in series with the armature if it has to take the same current at the same voltage at 600 rpm. Assume flux is proportional to current. **(Mar 06)**

41. i. A 6 pole, 500 V, wave connected shunt motor has 1200 armature conductors and useful flux/ pole of 20 mwii. The armature and field resistances are 0.5 and 250 respectively. What will be the speed and torque developed by the motor when it draws 20 A from the supply mains? Neglect armature reaction. If magnetic and mechanical losses amount to 900 W, find
    a. useful torque b. output in KW & c. efficiency at this load.
    ii. A 230V, 10 H.P. shunt motor takes a full load line current of 40A. The armature and the field resistances are 0.25 and 230 respectively. The total brush drop is 2V, and the core and friction losses are 380W, Calculate the effciency of the motor. Assume that the stray load loss is 1% of the rated output.
    (Nov 05)

42. i. What is the power flow diagram of DC motor? And explain about losses involved in each stage?
    ii. A 4-pole 120KW, 240V, 800rpm wave wound generator has shunt field current of 4A at rated voltage. The generator has the following data. Armature winding single turn coils Length of conductors (including over hang) = 0.48 m Number of conductors = 480 : Voltage drop/brush = 1 volt Cross sectional area of conductors = 25 mm2 Full load temperature = 600C : Commutator diameter = 0.6 m Specific resistance of copper at 200C = 1.725 × 10-2 /m/mm2 Find
    a. Full - load armature copper loss
    b. Shunt field copper loss, and
    c. Brush contact loss **(Nov 05)**

43. i. Explain the principle of operation of a DC motor . Derive the equation for the torque developed by a DC motor.
    ii. Determine the torque developed when a current of 30 A passes through the armature of a motor with lap winding of 310 conductors, 4 pole , pole shoes 16.2 cm long subtending an angle of 60 deg at the center, borre radius 16.2 cm , flux density in air gap 0.7tesla. **(May 05)**

44. A separately excited dc motor has armature resistance of 0.5ohm. it runs off a 250V supply drawing an Ia=20A at 1500rpm. The torque developed for Ia of 10A will be how much for same field current?
    (GATE 92)

45. A 10kw, 240V dc shunt motor draws a load current of 5.2A while running at no load speed of 1200 rpm from a 240V dc supply. It has an armature and shunt field resistance of 0.25 and 160 ohms respectively. Estimate efficiency of motor when it delivers rated load? **(GATE 93)**

46. A 440V, dc shunt motor has a no load speed of 2000rpm. It is running at 1000rpm at full load torque, reduced armature voltage and full field. If load torque is reduced to 50% of rated value with armature voltage and field voltage held constant at previous values, the speed increases to 1050rpm. Find the armature voltage drop at full load? **(GATE 94)**

47. A 220V, 1.5KW, 859 RPM, separately excited dc motor has an armature resistance of 2.5ohm and it draws a current of 8A at rated load condition. If field current and armature voltage are fixed at value of rated speed at rated load, what will be the no load speed of motor? **(GATE 95)**

48. A 5 KW, 200V DC shunt motor has armature and shunt field resistance of 1 and 100 Ohm respectively. At no load, the motor draws 6A from 200V supply and runs at 1000 rpm. Find
    i. Rotational losses
    ii. No load torque **(GATE 95)**

49. What is the terms air gap power, internal mechanical power, developed and shaft power? How are these terms related with each other? **(IES 01)**

50. Explain characteristics of speed-current, torque-current and speed-torque characteristics of dc shunt motor? **(IES 94)**

51. Explain speed-current, torque- current and speed- torque characteristics of dc series motor? **(IES 92)**

UNIT-VII

1. i Explain the flux control and armature control methods of speed control of DC shunt motors.
   ii A 220 V d.c shunt motor has an armature resistance of 01.5 ohm and takes an armature current of 40 A on a certain load. By how much the main flux be reduced to raised speed by 50% if the developed speed is constant? Neglect saturation and armature reaction. **(Dec-13)**

2. i What are the diffrent methodss of speed control of a d.c motor? Explain.
   ii Explain the operation of a three points starter with a neat sketch. (**Dec-12**)

3. A shunt generator delivers 50kw at 250V when running at 400 r.p.m. The armature and field resistance are 0.2Ω and 50Ω respectively. Calculate the speed of the machine when running as a shunt motor and taking 50kw input at 250V. Allow 1V per brush for contact drop? **(Dec 11)**

4. What are the general methods of speed control of d.c motors and explain them briefly? **(Dec 11)**

5. A 220-V, d.c series motor is running at a speed of 800 r.p.m and draws 100A. Calculate at what speed the motor will run when developing half the rated torque. Total resistance of the armature and field is 0.1Ω. Assume that the magnetic circuit is unsaturated. **(Dec 11)**

6. What are the drawbacks of three-point starter? Describe a four-point starter with a neat sketch? **(Dec 11)**

7. Describe the Swinburne's test with the help of a neat diagram to find out the efficiency of d.c machine. What are the main advantages and disadvantages of this test? **(Dec 11)**

8. Explain Hopkinson's test and corresponding circuit diagram and procedure for efficiency calculation as motor and generator? **(Dec 11)**

9. i. Compare the speed-torque characteristics of dc shunt, series and compound motors.
   ii. A 200 V dc shunt motor with armature resistance 0.1 ohm runs at 1000 rpm taking an armature current of 50A. If the flux is suddenly reduced by 10% obtain maximum current at this instant and the corresponding torque. **(May 11)**

10. A 200V d.c shunt motor, with an armature resistance of 0.1Ω, is running at 1000 r.p.m. and takes an armature current of 50A. If the field flux is suddenly reduced by 10% obtain:
    i. the maximum value of current at this instant and the corresponding torque and
    ii. ultimate speed and armature current after the transients are over. Assume constant load torque and negligible armature inductance. **(May 11)**

11. A shunt motor fed from a 400 V direct current supply takes an armature current of 100 A when running at 800 rpm. If the total torque developed remains unchanged, find the speed at which the motor will run if the flux is increased to 120% of its original value and a resistance of 0.8 ohm is connected in series with the armature. The armature resistance is 0.2 ohm. **(May 11)**

12. A shunt wound motor has a field resistance of 400 Ω and an armature resistance of 0.1 Ω and runs off 240V supply. The armature current is 60A and the motor speed is 900 rpm. Assuming a straight line magnetization curve calculate
    i. the additional resistance in the field to increase the speed to 1000 rpm for the same armature current
    ii. the speed with which the original field current of 200A. **(May 11)**

13. i. Describe the methods for speed control of dc series motors.
    ii. A dc series motor, running a fan at 1000 r.p.m., takes 50A from 250V mains. The armature plus field resistance is 0.6Ω. If an additional resistance of 4.4Ω is inserted in series with the armature circuit, find the motor speed in case the field flux is proportional to the armature current. **(Nov 10)**

14. Why is a dc series motor used to start heavy loads? A 250 V dc series motor runs at 500 rpm. The shaft torque is 130 N-m and the efficiency at this load is 88%. Find the current taken by the motor. **(Nov 10)**

15. A dc shunt motor, with armature circuit resistance of 0.1Ω, runs at 1600 rpm while taking an armature current of 100A from 230V dc source. The friction and windage loss is 300W, no-load core losses are 1200W and the total I^2R loss is 2500W. Stray loss equals 1% of the output. Find the shaft torque of the motor and its efficiency. **(Nov 10)**

16. A 10 KW, 250 V, dc shunt motor has an armature resistance of 0.5 ohm and a field resistance of 200 ohm. At no load and rated voltage, the speed is 1200 rpm and the armature current is 3 A. At full load and rated voltage, the line current is 47 A and because of armature reaction, the flux is 4% less than its no-load value:
    i. What is its full-load speed?
    ii. What is the developed torque at full load? **(Nov 10)**

17. A 50 KW, 230 V dc shunt motor has an armature resistance of 0.1ohm and a field resistance of 200 ohm. It runs on no-load at a speed of 1400 rpm, drawing a current of 10 A from the mains. When delivering a certain load, the motor draws a current of 200 A from the mains. Find the speed at which it will run at this load and the torque developed. Assume that the armature reaction causes a reduction in the flux/pole of 4% of its no-load value. **(Nov 10)**

18. A 200V dc shunt motor takes 22 amperes at rated voltage and runs at 1000 rpm. Its field resistance is 100Ω and armature circuit resistance (including brushes) is 0.1Ω . Compute the value of additional resistance required in the armature circuit to reduce the speed to 800 rpm: When:
    i. the load torque is independent of speed (as in a reciprocating pump).
    ii. The load torque is proportional to speed. **(June 10)**

19. i. With the help of neat sketches, explain torque-speed characterstics of the following DC motors:
    a. Series connected
    b. Shunt wound.
    ii. What are the operating characteristics of dc motors? **(June 10)**

20. Explain the need and necessity of starters in dc machines. Explain the working of a 3-point starter with neat diagram. **(June 10)**

21. i. What are the advantages and disadvantages of different types of speed control methods of DC motors.
    ii. A 500V shunt motor runs at its normal speed of 250rpm. When the armature curent is 200A, the resistance of armature is 0.12Ω. Calculate the speed when a resistance is inserted in the field which reduces the shunt field to 80. **(June 10)**

22. i. Discuss any two methods for speed control of a DC shunt motor in detail.
    ii. A DC series motor running a fan at 1000 rpm, takes 50A from 250V mains. The combined armature and field resistance is 0.6Ω. If an additional resistance of 4Ω is inserted in series with the armature circuit, find the motor speed if the field flux is proportional to the armature current. **(Nov 09)**

23. i. What is the difficulty in starting DC series motors at no load? Explain this with torque-speed relation of DC series motor.
    ii. A 220V, DC shunt motor has an armature resistance of 0.5Ω and field circuit resistance of 220Ω. It takes a line current of 41A, when delivering full load torque. If it is desired to raise the speed by 50% with the load torque remaining constant, find the additional resistance to be inserted in the field circuit. **(Nov 09)**

24. i. Discuss how the speed of a DC series motor can be controlled.
    ii. A DC shunt motor runs at 800rpm from 250V supply and takes a full load line current of 60A. Its armature and field resistances are 0.4Ω and 125Ω respectively. Allow a brush contact drop of 2.0V. Calculate
    a. No-load speed for a no-load line current of 6A.
    b. The value of resistance to be added in series with armature to reduce full load speed to 600 rpm. **(Nov 09)**

25. i. What is the necessity of a starter? Explain in detail about 3-point starter.
    ii. A 400V, DC shunt motor has 0.18Ω and 200Ω of armature and field resistances respectively. The no-load current is 5.6A. On full-load, it draws 68.3A and the field is weakened by 3%. Calculate the ratio of full-load speed to no-load speed, allowing a brush contact drop of 2.0V. **(Nov 09)**

26. The speed of a 50 h.p series motor working on 500V supply is 750 rpm at full load and at 90 % efficiency. If the load torque is made 350Nm and a 5 ohm resistance is connected in series with the machine, calculate the speed at which the machine will run. Assume the magnetic circuit to be unsaturated and the armature and field resistance to be 0.5ohm. **(Nov 08)**

27. A 240V, 50A,800 rpm dc shunt motor has armature circuit resistance of 0.2 ohm. If load torque is reduced to 60% of its full-load value and a resistance of 2 ohm is inserted in series with armature circuit, find the motor speed. Armature reaction weakens the field flux by 4% at full load and by 2% at 60% of full load. **(Nov 08)**

28. A 250V dc series motor has armature and series field resistance of 0.25 and 0.15ohms respectively.
    i. Calculate the current for developing a torque of 80Nm at 1200 rpm.
    ii. Calculate the percentage reduction in flux when the motor runs at 1800 rpm at half the current obtained in part (i). **(Nov 08)**

29. i. What are the factors effecting the speed of dc motors.
    ii. State one advantage and one disadvantage in the application of each of the three basic types of dc motors. **(Nov 08)**

30. i. Explain about series-parallel method of Speed Control of D.C. Series Motors.
    ii. A 500V, d.c. shunt motor takes a current of 5 A on no-load. The resistances of the armature and the field circuits are 0.22 ohm and 250 ohm respectively. Find
    a. The efficiency when loaded and taking a current of 100A.
    b. The percentage change of speed. State precisely the assumptions made. **(Feb 08, Nov 07)**

31. i. What are the different methods of speed control of DC motor? Explain.
    ii. A 220V DC shunt motor draws a no load armature current of 2.5A when running at 1400rpm. Determine its speed when taking an armature current of 60A if armature reaction weakens the flux by 3%. (Assume Ra = 0.2) **(Feb 08, Nov 05)**

32. i. A 220V shunt motor takes 60A when running at 800rpm. It has an armature resistance of 0.1. Find the speed and armature current if the magnetic flux is weakened by 20%, contact drop per brush = 1V. Total torque developed remains constant.
    ii. A 220V series motor runs at 800 rpm, when taking a current of 15A. The motor has Ra = 0.3 and Rf = 0.2. Find the resistance to be connected in series with armature if it has to take the same current at the same voltage at 600 rpm. Assume flux is proportional to current. **(Feb 08, Nov 07, 05, Mar 06)**

33. i. What is a starter necessary for a DC motor / Explain the working of a 3-point starter with the help of a neat diagram.
    ii. Develop the general expression for the speed of a motor in terms of supply voltage, armature resistance and flux per pole. **(Nov 07, May 05)**

34. i. A 250V DC shunt motor has a rated current of 120A and an armature resistance of 0.08 ohms. It is to accelerate a load whose torque is constant and of rated value. The peak current is not to exceed twice the rated value. Calculate the value of starting resistance and the manner in which it is divided among several sections.
    ii. Explain the design of a starter for a dc shunt motor. **(Nov 07)**

35. i. The following readings were obtained in a brake test conducted on a DC shunt motor, supply volts = 240V, armature current = 35A, shunt field current = 4A, load on one band = 60 Kgf and load on the other band is 15 Kgf. Diameter of brake pulley = 0.35m, speed = 1000 rpm. Determine
    a. Output torque
    b. Horse power output
    c. Efficiency
    ii. A 200V shunt motor has a 5-step starter. The maximum current during starting should not exceed 40A. Armature resistance is 0.5ohms. Find the resistance of different steps. **(Nov 07)**

36. i. Discuss about ward-Leonard system method of Speed Control of D.C. machines in detail.
    ii. In a shunt machine, running at 500 rpm, the hysteresis and eddy current losses are 250W and 150W respectively. Find the speed at which the total core losses are reduced by 30%. **(Nov 07)**

37. i. With Neat diagram Explain the construction and working of 4-point starter
    ii. A DC shunt motor runs at 750 RPM from 250 V supply and is taking a full load line current of 60 Amps. Its armature and field resistances are 0.4 and 125 respectively and brush voltage drop is 2V, calculate,
    a. The no load speed, for a no load line current of 6 Amp.
    b. The value of resistance to be added in series with armature to reduce full load speed to 600 RPM. **(Feb 07)**

38. For a Ward-Leonard system two identical 220 V, 15 A DC machines are used. Total armature resistance of each machine is 0.4 and the magnetization curve for each machine at 1500 RPM is as given below:

E_a	120	160	197	210	220	228	232	236	243	248
I_f	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.2	1.45

The generator of Ward-Leonard system is driven at a constant speed of 1500 RPM.
    i. The generator field current is varied from 0.115 Amp to 1.4 Amp, while the motor field current is maintained constant at 0.6 Amp. Find the speed range for full load armature current of 15 Amp and at no load (neglect no load current).
    ii. The maximum speed, at full load, in above part is to be doubled. If the generator field current is not allowed to exceed 1 Amp., find the minimum motor field current. **(Feb 07)**

39. i. Compare armature voltage control and flux control methods of speed control of DC motor. Enumerate the advantage and disadvantage of each method.
    ii. A 400 V DC shunt motor takes a current of 5.6 A on no-load and 68.3 A on full load. The load current weakens the field by 3 %. Calculate the ratio of full-load speed to no-load speed, if Ra = 0.18 , brush voltage drop = 2 V, Rf = 200 . Also calculate the resistance to be added in series with armature to reduce speed to 50% of no load speed in gross torque remains unchanged. **(Feb 07)**

40. i. A 220 V DC shunt motor, with an armature resistance of 0.1 is running at 1000 RPM and takes an armature current of 50 A. If the field flux is suddenly reduced by 10%, obtain
    a. The maximum value of current at this instant and the corresponding torque.
    b. Ultimate speed and armature current after the transients are over. Assume constant load.
    ii. Explain the use of diverters in speed control of DC series motors. **(Feb 07)**

41. i. Explain the 'above normal speed', speed control of DC motor. How this control is achieved? Explain why speed is above normal?
    ii. A 220 V series motor runs at 700 RPM when operating at full load current of 20 Amp. The motor resistance is 0.5 . Assume magnetic path is un-saturable. What will be the speed if:
    a. Load torque is increased by 44%
    b. Motor current = 10 Amp. **(Nov 06)**

42. i. With Neat diagram Explain the construction and working of 3-point starter
    ii. A 2 ? pole lap wound DC shunt motor with 360 conductors operates at a constant flux level of 50mWb. The motor armature has a resistance of 0.12 and is designed to operate at 240 V, taking a current of 60 A at full load.
    iii. Determine the value of external resistance to be inserted in the armature circuit so that armature current does not exceed twice its full load value at starting. **(Nov 06)**

If you have no enemies you are apt to be in the same predicament in regard to friends.
- Elbert Hubbard

43. i. With neat diagram explain the construction of mechanical starter used for starting of DC shunt motor.
    ii. A 4 kW DC series motor has four field coils. The motor runs at 900 RPM and takes 20 Amp from a 230 V DC source, when field coils are in series under normal operation. Estimate the speed and current taken by the motor, if field coils are reconnected in two parallel groups of two in series. **(Nov 06)**

44. Deduce the expression for the number of steps, No. of studs, and resistance for each step of a 3-point starter. **(Nov 06)**

45. i. How can you control the speed of D.C. Shunt Motor by using Ward-Leonard system.
    ii. A 220V series motor runs at 800 rpm when taking a current of 15A. The motor has an armature Resistance of 0.3 and series field resistance of 0.2. Find the resistance to be connected in series with the armature if it has to take the same current at the same voltage at 600 rpm. Assume flux is proportional to current. **(Mar 06, Nov 05)**

46. i. Explain clearly how the direction of rotation of a DC motor can be reversed.
    ii. What are the various power stages of D.C.Motor.
    iii. One of the two-similar 500-V shunt machines A&B running light and takes 3A. When A is mechanically coupled to B, the input to A is 3.5 A with B unexcited and 4.5 A. When B is seperately excited to generate 500 V. Calculate the friction and windage loss and core loss of each machine. **(Mar 06)**

47. i. What is the power flow diagram of DC motor? And explain about losses involved in each stage?
    ii. A 4-pole 120KW, 240V, 800rpm wave wound generator has shunt field current of 4A at rated voltage. The generator has the following data. Armature winding single turn coils Length of conductors (including over hang) = 0.48 m Number of conductors = 480 : Voltage drop/brush = 1volt Cross sectional area of conductors = 25 mm2 Full load temperature = 600C : Commutator diameter = 0.6 m Specific resistance of copper at 200C = 1.725 × 10-2 /m/mm2 Find i. Full - load armature copper loss ii. Shunt field copper loss, and iii. Brush contact loss **(Mar 06)**

48. i. Write a note on series-parallel Speed Control method of D.C. Series Motors.
    ii. A 4 pole, 250V, d.c. series motor has a wave wound armature with 496 conductors. Calculate: i. The gross torque ii. The speed iii. The output torque iv. The efficiency, if the motor current is 50A v. The value of flux per pole under these conditions is 22 mwb and the corresponding iron, action and vintage losses totaling 810 w. Armature resistane = 0.19 field resistance = 0.14 **(Mar 06)**

49. i. Why is a starter necessary for a dc motor? What is the difference between 3&4 point starters?
    ii. Calculate the values of resistance elements for a 6-stud starter. The maximum current at starting is not to exceed 20A for a 200V shunt motor. The armature resistance is 0.5. What is the value of minimum current? **(Mar 06)**

50. i. What is the effect of excitation, speed and load on the losses of a DC machine?
    ii. A 230V, DC shunt motor is taking 5A when running light (i.e at no loaiv.. The armature resistance (including brushes) is 0.2 and field circuit resistance is 115. For an input current of 72A, calculate the shaft output and efficiency. Also calculate the armature current at which the efficiency is maximum. **(Nov 05)**

51. A 220 V shunt motor takes 60 A when running at 800 rpm. It has an armature resistance of 0.1 ohm. Find the speed and armature current if the magnetic flux is weakened by 20%, contact drop per brush=1V. Total torque developed remains constant. **(May 05)**

52. A 220 V series motor runs at 800 rpm, when taking a curren of 15 A. the motor has jRa=0.3 ohm and Rf= 0.2 ohm . Find the resistance to be connected in series with armature if it has to take the same current at the same voltage a t 600 rpm. Assume flux is proportional to current **(May 05)**

53. A dc series motor draws a load current of 100A from the mains while running at 1000rpm. Its armature and shunt field resistance are 0.15 and 0.1ohm respectively. Assuming that the flux is corresponding to a current of 25A is 40% of that corresponding to 100A, find speed of motor whenit is drawing 25A from 230V supply? **(GATE 96)**

54. A 200V dc shunt motor takes 20A at rated voltage and runs at 1000rpm. If field and armature resistances are 100 and 0.1 ohms respectively. Compute the value of additional resistance required in the armature circuit to reduce the speed ot 800rpm. When **(IES 99)**

55. A 220V, shunt motor takes 22A at rated voltage and runs at 1000rpm. Its field and armature resistances of 100 and 0.1 Ohms respectively. Compute the value of additional resistance required in the armature circuit to reduce the speed to 800rpm. When **(IES 93)**
   i. The load torque is proportional to speed
   ii. The load torque is proportional to square of speed

UNIT-VIII

1. i A DC shunt motor, with armature circuits resistance of 0.1 ohm, runs at 1600 rpm while taking an armature current of 100A form 230V DC source. The friction and windage loss is 300W, no-load losses are 1200W and the total I^2R loss is 2500W.
   Stray loss equals 1% of the output. Find the shaft torque of the motor and its efficiency.
   ii Derive the condition for maximum efficiency of a d.c. machine. **(Dec-13)**

2. i State the expressoions for eddy current hystersis losses in a b c. machine.
   ii The no load test of a 45kW, 230V shunt motor gave the following results:
   input current = 14A; field current = 2.55A; Resistance of armature at $75^0C \Rightarrow 0.032\Omega$; Brush drop =2V; Estimate the full load current and efficiency. **(Dec-2012)**

3. i. Draw the power flow diagram of a d.c generator and d.c motor?
   ii. Derive the condition for maximum efficiency? **(Dec 11)**

4. A 4-pole, 250-V, wave-connected shunt motor gives 10kw when running at 1000 r.p.m and drawing armature and field currents of 60A and 1A respectively. It has 560 conductors. Its armature resistance is 0.2Ω. Assuming a drop of 1V per brush. Determine
   a) total torque b) useful torque c) useful flux per pole d) rotational losses e) efficiency **(Dec 11)**

5. i. Explain with neat diagram how field's test can be conducted on pair of identical series machines.
   ii. A field's test on two identical machines gave the following data: Motor armature current=60A, Motor armature voltage=500V, Motor field voltage=40V, Generator armature current=46A, Generator terminal voltage=450V, Generator field voltage=40V. Armature resistance including brushes is 0.25 ohm for each machine. Find the efficiency of the machines. **(May 11)**

6. i. What are the advantages and disadvantages of different types of speed control methods of DC motors?
   ii. A 500V shunt motor runs at its normal speed of 250rpm. When the armature current is 200A, the resistance of armature is 0.12Ω. Calculate the speed when a resistance is inserted in the field reducing the shunt field to 80% of normal value and the armature current is 100A. **(May 11)**

7. Two windings, one on stator and the other on rotor, has the following parameters
$R_s = 2.5\ \Omega$ $r_r = 3\Omega$ $L_s = 0.03H$ $L_r = 0.12\ H$ $M_{sr} = 0.06\cos\theta_r$
Where r is the space angle between stator and rotor winding axes. The two windings are connected in parallel and the rotor is locked at $\theta_r = 90^0$. With the currents initially zero, the windings are switched on to a voltage source of 30 volt d.c at time t = 0
   i. Find is, ir as functions of time.
   ii. Find an expression for magnetic torque as a function of time. **(Nov 10)**

8. i. Derive the condition for maximum efficiency in D.C motors.
   ii. A 500V dc shunt machine draws 4A as a motor on no load. If R_a=0.2 ohms and R_f=500 ohms find:
   a. the constant losses
   b. efficiency when running as a generator supplying a 50A load at 500V. **(Nov 10)**

9. Explain how efficiency is calculated using no-load test. Draw the relevant circuit diagram for the above test. **(June 10)**

10. A dc shunt machine while running as generator develops a voltage of 250V at 1000 rpm on no-load. It has armature resistance of 0.5Ω and field resistance of 250Ω. When the machine runs as motor, input to it at no load is 4A at 250V. Calculate the speed and efficiency of the machine when it runs as a motor taking 40A at 250V. Armature reaction weakens the field by 4%. **(June 10)**

11. A 10 kW, 240V dc shunt motor draws a line current of 5.2A while running at noload speed of 1200 rpm from a 240V dc 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. **(June 10)**

12. i. Explain how brake test is done on a DC shunt motor.
   ii. A 480V, 20KW, shunt motor takes 2.5A when running light. The armature resistance and field resistances are 0.3Ω and 800Ω respectively. Allow a brush drop of 2V. Find the full load efficiency. **(Nov 09)**

13. Two identical DC machines when tested by Back-to-Back method gave the following test results.
Field currents are 2.5A and 2.0A.
Line voltage is 220V.
Line current including both field currents is 10A.
Motor armature current is 73A.
The armature resistance of each machine is 0.05Ω.
Calculate the efficiency of both machines. Also mention the merits and demerits of this method. **(Nov 09)**

14. i. Explain how swinburne's test is done on a DC shunt motor. What are its advantages and disadvantages?
   ii. A 440 DC shunt motor takes a current of 3A on no-load. The armature resistance including brushes is 0.3Ω and the field current is 1A. Calculate the output and efficiency when the input current is 30A. **(Nov 09)**

15. i. Derive the condition for maximum efficiency in a DC machine.
   ii. A brake test on a DC shunt motor gave the following results.
   Weight on the brake drum = 4.5 kg and 0.5 kg.
   Radius of the pulley = 12cm.
   Speed of the motor = 1200 rpm.
   Line current = 3.7 A
   Supply voltage = 200 V.
   Find the output torque and efficiency of the motor. **(Nov 09)**

16. The Hopkinson's test on two similar machines gave the following full load results.
Line current =48A
Line voltage =110V
Motor armature current=230A
The field currents are 3A an 3.5A. Armature resistance of each machine is 0.035 ohms.Calculate the efficiency of each machine assuming a brush contact drop of 1V per brush. **(Nov 08)**

17. A 10kW 900 rpm, 400V dc shunt motor has armature circuit resistance (including brushes) of 1ohm and shunt field resistance of 400 ohm. If efficiency at rated load is 85%, then calculate:
   i. The no-laoad armature current,
   ii. The speed when motor draws 20A from the mains and
   iii. The armature, eurrent, when the total(or internal) torque developed is 98.5 Nm.
   Assume the flux remain constant. **(Nov 08)**

18. A 50 Kw, 440 V shunt generator having an armature circuit resistance including inter-pole winding of 0.15 ohm at normal working temperature was run as a shunt motor on no-load at rated voltage and speed. The total current drawn by the motor was 5 A including shunt field current of 1.5 A. Calculate the efficiency of the shunt generator at $3/4^{th}$ full-load. **(Nov 08)**

19. A 200V shunt motor has Ra=0.1ohm, Rf=240 ohm and rotational loss=236W. On full load the line current is 9.8A with the motor running at 1450 rpm. Determine:
   i. the mechanical power developed
   ii. the power output
   iii. the load torque
   iv. the full load efficiency. **(Nov 08)**

20. i. The following readings were obtained in a brake test conducted on a DC shunt motor, supply volts = 240V, armature current = 35A, shunt field current = 4A, load on one band = 60 Kgf and load on the other band is 15 Kgf. Diameter of brake pulley = 0.35m, speed = 1000 rpm. Determine
   a. Output torque
   b. Horse power output
   c. Efficiency
   ii. A 200V shunt motor has a 5-step starter. The maximum current during starting should not exceed 40A. Armature resistance is 0.5ohms. Find the resistance of different steps. **(Feb 08, Nov 07)**

21. i. Outline the steps to estimate the efficiency of given two d.c. machines by conducting Hopkinson's test. Draw schematic diagram to illustrate the method.
   ii. In a Hopkinson's test on a pair of 500V, 100KW, shunt generators, the following data was obtained.
   Auxiliary supply 30A at 500V
   Generator output Current 200 A
   Field currents 3.5 A and 1.8A
   Armature circuit resistances of each machine 0.075 ohms
   Voltage drop at brushes (each machine) : 2 V
   Calculate the efficiency of each machine acting as a generator. **(Feb 08, Nov 07)**

22. i. What are the various methods of finding inertia of a motor? Explain any one method to calculate inertia experimentally?
   ii. A retardation test is carried out on a 1000 rpm DC machine. The time taken for the speed to fall from 1030 rpm to 970 rpm is

a. 36 seconds with no excitation.
b. 15 seconds with full excitation and
c. 9 seconds with full excitation and armature supplying an extra load of 10A at 219 V.

(Feb 08, Nov 07, May 03)

23. i. How are large series machines tested, explain?
    ii. The Hopkinson's test on two DC shunt machines gave the following results for full load. Line voltage 250V, line current 45A excluding field currents; motor armature current 385A; field current 5A and 4A. Calculate the efficiency of each machine. Armature resistance of each machine is 0.015.

(Feb 08, Mar 06).

24. i. Explain, with a neat circuit diagram, why no load test is considered convenient and economical for testing d.c. shunt machines. Is it possible to conduct the same on series machines? Why?
    ii. In a brake test, on a shunt motor, the tensions of the two sides of the brake were 3.1 and 0.2. The radius of the pulley was 8 cm. The input current was 2.5A at 220V. The motor speed was 1150 rpm. Calculate
    a. the torque
    b. the h.p. output &
    c. the efficiency. **(Feb 08)**

25. i. Explain various losses and their equations, that takes place in DC load shunt compound generator and short shunt compound motor.
    ii. Find the efficiency of long shunt compound generator rated at 250kW, 230V, when supplying 75 % of rated load, at rated voltage. The resistances of armature & series field are 9m and 3 m respectively. The shunt field current is 13 Amp. When the machine is run as a motor at no-load the armature current is 25 A at rated voltage. **(Feb 07)**

26. i. Explain constant and variable losses. Draw the graph of losses v/s load.
    ii. A 60 kW, 250 V shunt motor takes 16 Amp, when running light at 1440 RPM. The hot resistance of the armature and field are 0.2 and 125 respectively.
    a. Estimate the eciency of the motor when taking 152 A.
    b. Also estimate the eciency if working as generator and delivering a load current of 151 A at 250 V.

(Feb 07)

27. i. The following readings are obtained when performing a brake test on DC shunt motor. Spring Balances, 08 kgs and 30 kgs. Diameter of drum = 42 cm. Speed of the motor = 1000 rpm. Applied voltage = 220 V. Line current = 50 A. Calculate out put power and efficiency.
    ii. A 500 V DC shunt motor takes a current of 5 A on no-load. The resistances of the armature and field circuit are 0.2 and 300 respectively. Find, the eciency when loaded and taking a current of 125 A and the percentage change of speed. **(Feb 07)**

28. i. How the rotational losses can be computed by retardation test.
    ii. A retardation test is made on a separately excited DC machine as a motor. The induced EMF falls from 240 V to 175 V in 45 Seconds on opening the armature circuits and 5 Seconds on suddenly changing armature connection from supply to a load resistance taking an average current of 10A. Find the eciency of the machine when running as a motor & taking a current of 25 Amp on a supply of 240V. The resistance of armature is 0.4 & that of its field winding is 300. **(Feb 07)**

29. i. Explain the various losses taking place in DC machines. With the help of these losses draw the power flow diagram for a DC Motor.
    ii. A 440 V DC shunt motor takes a current of 3 A. at no-load. The armature resistance including brushes is 0.3 and the field current is 1 A. Calculate the output and eciency when the input current is 20 A.

(Nov 06)

30. i. A DC motor is fed from a constant voltage supply runs at 900 RPM. At this speed hysteresis loss is 70 W and eddy current loss is 40 W. If the motor speed is increased to 1000 RPM by reducing the flux, calculate the new core loss. Take Steinmitz's constant as 1.6 and neglect armature circuit resistance.
    ii. Explain dierent iron losses. How these losses can be reduced. **(Nov 06)**

31. i. Explain the testing method for traction motors.
    ii. A retardation test is made on a separately excited DC machine as a motor.
    The induced EMF falls from 250 V to 175 V in 48 Seconds on opening the armature circuits and 6 Seconds on suddenly changing armature connection from supply to a load resistance taking average current of 11A. Find the stray losses and eciency of the machine when running as a motor & taking a current of 28 A on a supply of 250V. The resistance of its armature is 0.48 and that of its field winding is 300 ohm. **(Nov 06)**

32. i. Describe a suitable method for determining the efficiency of a DC compound motor?
    ii. In a retardation test on DC separately excited motor the induced e.m.f in the armature falls from 220V to 190V in 30 seconds disconnecting the armature from the supply. The same fall takes place in 20 seconds if immediately after disconnection armature is connected to a resistance which takes 10A **(Mar 06, Nov 05, May 05)**

33. i. Explain with a neat circuit diagram swinburns test on DC shunt motor to find the efficiency of DC machine when if runs as motor and generator? Mention the advantages and disadvantages of this method?
    ii. The following readings are obtained when doing a load test on D.C. Shunt Motor using a brake-Drum Spring Balance reading: 10 kg & 35 kg. Diameter of Drum 40 cm. Speed of the Motor:950 R.P.M. Applied Voltage 200 V Line Current 30 A. Calculate the output power and efficiency. **(Mar 06, May 05)**

34. i. What do you mean by back-to-back test in case of DC shunt machines? What are the limitations of this test?
    ii. A 220V, 12KW, DC shunt motor has a maximum efficiency of 90% and a speed of 800 rpm. When delivering 80% of its rated output. The resistance of its shunt field is 80 . Determine the efficiency, speed when the motor draws a current of 70A from mains. **(Mar 06)**

35. i. By conducting load test, how the torque and efficiency of a D.C. series motor can be determined? Explain it with a neat circuit diagram?
    ii. A 250V, 14.92 KW shunt motor has a max. efficiency of 88% and a speed of 700 rpm. t hen delivering 80% of its rated output. The resistance of its shunt field is 100. Determine the efficiency and speed when the motor draws a current of 78A from the mains. **(Nov 05)**

36. i. In case of Hopkinson's test the efficiency of the two identical machines are not same, why?
    ii. In a test on a DC shunt generator, whose full load output is 200KW at 250V,the following figure were obtained. i. With the machine at rest, a potential difference of 8volts produced on a armature current of 400A. ii. With the motor running at no load and at rated speed the line current was 36A, the field current 12A and the supply voltage 250V. Obtain the generatorefficiency at full load and half full load. **(Nov 05)**

37. i. Describe a suitable method for determining the efficiency of series motor ?
    ii. A test on two coupled similar tramway motors, with their fields connected in series, gave the following results when one machine acted as motor and the other as a generator. Motor: armature current =56A, armature voltage=590 V, Voltage drop across field winding =40V.
    Generator: armature current =44A, armature voltage=400V, field voltage drop =40 V, resistance of each armature=0.3 ohms. Calculate the efficiency of the motor and generator at this load. **(Nov, May 05)**

38. Explain how the efficiency of d.c series motors can be determined, by conducting field's test, with a neat circuit diagram. **(May 05)**

39. i. Explain why Swinburne's test cannot be used to determine the efficiency of d.c series machines.
 ii. Explain how a swinburne's test can be used to predetermine the efficiency of a d.c machine, when used as i. a generator and ii. as a motor. **(May 05)**

40. i. What do you mean by back-to -back test in case of DC shunt machines? What are the limitations of this test?
 ii. A 220 V series motor runs at 800 rpm , when taking a current of 15 A. The motor has Ra=0.3 ohm and Rf=0.2 ohm. Find the resistance to be connected in series with armature if it has to take the same current at the same voltage a t 600 rpm . Assume flux is proportional to current. **(May 05)**

41. i. Discuss in detail, the different types of losses taking place in a dc machine?
 ii. What do you mean by power stages? Also explain
 a. Electrical efficiency
 b. Mechanical efficiency
 c. Commercial efficiency **(May 04)**

42. i. Explain with neat sketch how can you find the efficiency of small dc motor with brake test?
 ii. The Hopkinson's test on two shunt machines gave the following results for full load. The supply current was 15A at 200V. the generator output current was 85A. the field currents for motor and generator were 2.5A and 3A respectively. The armature resistance of each machine was 0.05ohm. find the efficiency of each of the machines under above loading conditions? **(May 04)**

43. i. How are large series machines tested. Explain?
 ii. The hopkinson's test on two dc shunt machines gave the following results for full load. Line voltage 250V, line current of 45A excluding field currents; motor armature current 385A; field current 5A and 4A. calculate the efficiency of each machine. Armature resistance of each machine is 0.015ohm. **(May 03)**

44. i. What are advantages of a conventional efficiency determination over direct loading? Any why direct loading is relatively impossible for large machines?
 ii. Two10 HP motors have each a full load efficiency of 0.83 the running light losses of motor A are 530w and of motor B are 420W. find the half load efficiency of each motor? **(May 03)**

45. i. Explain swinburne's test of finding the performance of dc machine working as a motor. What are advantages and disadvantages?
 ii. Write a note on brake test on dc motor? **(May 03)**

46. i. What is effect of excitation, speed and load on the losses of a dc machine?
 ii. A 230V, dc shunt motor is taking 5A when running light(ie at no load. The armature and field resistances are 0.2 and 115ohms respectively. For an input current of 72A, calculate the shaft output and efficiency. Also calculate the armature current at which the efficiency is maximum? **(May 03)**

47. i. How can you conduct the retardation test on dc shunt motors?
 ii. A field test on two mechanically coupled dc series motors(with their field windings connected in series) gave the following date; motor: armature current – 50A, armature voltage-500V, drop across field winding-38V **(May 03)**

ELECTRICAL MACHINES 1

Assignment No 2- EEE II year- Answer all the questions

(Answer to the point. Do not write unwanted information and avoid paper filling-Answer all questions-**In case of any difficulty, the Faculty may be consulted**)

1. Explain the working principle of a 3 point starter and also the protection features.

2. How is the speed of the DC shunt motor controlled? Discuss in detail the speed control and reversal of rotation of a DC shunt motor using Ward- Leonard system.

3. Explain why a series motor cannot be started at no load based on its speed- Torque characteristics.

4. A 440 Volts DC shunt motor which runs at 1000 RPM has an armature and field resistances of 0.8Ωand 220 Ω respectively. The iron and frictional losses amount to 1500 watts. Find the armature torque and shaft torque when it draws a total current of 200 Amps from the supply.

5. a) Explain how two DC shunt generators are operated in parallel.
   b) Two DC shunt generators A and B are electrically connected in parallel and feeding a common load.The output voltage is 380 v.Generator A develops an emf of 400 V and its armature resistance of 0.25 Ω, whereas the generator B has an emf of 410 V and an armature resistance of 0.4 Ω. Calculate the current and power output from each generator. Assume (i) both generators are not mechanically coupled and (ii) Field current in each generator is negligible.

6. a) How to calculate the efficiency of a DC motor?
   b)A 4 pole 250V, wave connected DC shunt motor delivers 10 KW output, when running at 1000 RPM and drawing an armature and field currents of 60 A and 1A respectively. It has 560 conductors. Armature resistance is 0.2 Ω. Brush drop 1V/brush. Determine (i) Armature (total) torque (ii) Useful torque (iii) Useful flux/pole and (iv)rotational losses and (v) efficiency of machine.

7. Explain how to calculate the efficiency of a DC shunt machine when it runs as a DC generator subject to a load based on Swinburne's test.

8. Explain Hopkinson test and calculation of efficiency of a DC shunt machine.

9. Derive an expression for torque developed in a DC motor.

10. Ashuntgeneratordelivers50KWat250Voltswhenrunningat400RPM.Thearmatureand field resistances re 0.2 Ω and 50 Ω respectively. Calculate the speed of the machine when running as shunt motor and taking an input of 50 KW at 250 Volts. Allow 1V per brush for contact drop.

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
UNIT-I					
1	Electro mechanical Energy conversion, Forces and Torques in magnetic system	Energy in magnetic system Air gap description Attracted armature relay	L1	T2-Ch2, R2-Ch1 R3-Ch4	GATE
		Determination of mechanical force Significance of mechanical energy	L2	T2-Ch2, R2-Ch1 R3-Ch4	
2	Energy Balance Energy and force in a singly excited magnetic field system Determination of magnetic force, co energy Multi excited magnetic field system	Flow of energy in electro mechanical device.	L3	T2-Ch2, R2-Ch1 R3-Ch4	
		Description of electrical energy input Evaluation mechanical work done	L4	T2-Ch2, R2-Ch1 R3-Ch4	
		Magnetic field energy stored Significance of Co energy	L5	T2-Ch2, R2-Ch1 R3-Ch4	
		Determination of force Determination of energy	L6	T2-Ch2, R2-Ch1 R3-Ch4	
		Determination of Torque for multi excited system	L7	T2-Ch2, R2-Ch1 R3-Ch4	
UNIT-II					
3	DC Generators , Principle of Operation Constructional features, Action of commutator Armature windings, lap and wave windings, Simplex and multiplex windings, Use of laminated armature	Faraday's laws of electro magnetic induction Simple loop generator Fleming's Right hand rule	L8	T2-Ch3, R2-Ch2 R7-Ch2	GATE IES
		Field system Armature Commutator Brushes, bearings and other parts	L9	T2-Ch4, R2-Ch2 R7-Ch2	
		Use of commutator Linear commutation	L10	T2-Ch4, R2-Ch2 R7-Ch3	

	EMF equation, problems	Terminology in armature windings Lap and wave windings	L11	T2-Ch7, R2-Ch2 R3-Ch7	GATE
		Design of simplex lap windings Design of simplex wave windings Use of equalizer connections	L12	R2-Ch2, R3-Ch7 R7-Ch2	
		Use of laminations Introduction to Iron loss	L13	T2-Ch3, R2-Ch2 R3-Ch4	GATE IES
		Determination of generated emf Problems on generated emf	L14	T2-Ch3, R2-Ch2 R3-Ch7	
4	Armature reaction, Cross magnetizing and De magnetizing AT/Pole, Compensating Winding	Cross magnetizing effect Demagnetizing effect	L15	R2-Ch2, R3-Ch4 R7-Ch3	GATE IES
		Determination of Cross magnetizing AT/pole Determination of Demagnetizing AT/pole	L16	R2-Ch2, R3-Ch4 R7-Ch3	
		Use of compensating windings Determination of comp. Winding turns	L17	R2-Ch2, R3-Ch4 R7-Ch3	
5	Commutation, Reactance voltage, Methods of improving commutation	Understanding the concept of commutation	L18	R2-Ch2, R3-Ch4 R7-Ch3	
		Significance of reactance voltage	L19	T2-Ch4, R2-Ch2 R7-Ch3	
		Resistance commutation	L20	T2-Ch4, R2-Ch2 R7-Ch3	
		Brush shift method Inter poles method	L21		
UNIT-III					
6	Methods of excitation, separately excited and self	Separately excited generator	L22	T2-Ch4, R2-Ch3 R7-Ch4	GATE IES

	excited generator Build – up of EMF	Circuit models and emf equation of shunt, series and compound generator	L23	T2-Ch4, R2-Ch3 R7-Ch4	
		Magnetization curve Requirements for build up of emf	L24	T2-Ch4, R2-Ch3 R7-Ch4	
7	Critical field resistance and critical speed Causes for failure to self excited and remedial measures	significance of critical field resistance Significance of critical speed	L25	T2-Ch4, R2-Ch3 R7-Ch4	
		Causes for failures to self excite . Remedial measures	L26	T2-Ch4, R2-Ch3 R7-Ch4	
8	Load Characteristics of shunt, series and compound generators Parallel operation of D.C series generators	Load Characteristics of shunt generator	L27	T2-Ch4, R2-Ch3 R7-Ch4	GATE IES
		Load Characteristics of series and compound generator	L28	T2-Ch4, R2-Ch3 R7-Ch4	
		Parallel operation of D.C series and shunt generators	L29	R2-Ch3,R7-Ch5	
9	Use of equalizer bar, Cross connection of field windings, Load Sharing and problems	Use of equalizer bars Cross-connection of field windings	L30	R2-Ch3,R7-Ch5	
		Load sharing on D.C Generators Problems	L31	R2-Ch3, R7-Ch5	
UNIT IV					
10	DC Motors Principle of Operations Back emf –Torque equation	Flemings left hand rule Lenz's law Motor Torque production	L32	T2-Ch4, R2-Ch4 R7-Ch6	GATE IES
		Importance of Back emf	L33	T2-Ch4, R2-Ch4 R7-Ch6	
		Derivation of Torque Problems on Back emf and Torque	L34	T2-Ch4, R2-Ch4 R7-Ch6	
11	Characteristics and application of shunt, series and compound	Characteristics of shunt motors, series motors Characteristics of Differential	L35	R2-Ch4, R3-Ch7 R7-Ch6	

	motors Armature reaction Commutation	and cumulative compound motors			
		Effects of armature reaction Demagnetizing and cross magnetizing effect	L36	T2-Ch4, R2-Ch4 R7-Ch6	
		Commutation process, Use of commutator Methods of commutation	L37	T2-Ch4, R2-Ch4 R7-Ch6	
12	Speed control of D.C Motors, Armature voltage and field flux control methods Ward –Leonard system of speed control	Armature control and field control of shunt motors	L38	R2-Ch4, R3-Ch7 R7-Ch7	GATE IES
		Speed control of series motor by diverted field , tapped field and series parallel control	L39	R2-Ch4, R3-Ch7 R7-Ch7	
		Ward Leonard method of speed control Disadvantages and advantages of the system	L40	R2-Ch4, R3-Ch7 R7-Ch7	
13	Motor starter Principles of Solid state starter	Necessity of starter 3 Pint starter circuit diagram and operation with advantages and disadvantages	L41	T2-Ch4, R2-Ch4 R7-Ch7	
		4 point starter circuit diagram, operation and application	L42	T2-Ch4, R2-Ch4 R7-Ch7	
		Solid state starter principle	L43	R7-Ch7, R8-Ch30	
		UNIT V			
14	Losses constant and variable losses Calculation of efficiency , condition for maximum efficiency	Iron losses Copper losses Stray losses Problems on losses	L 44	R2-Ch5, R3-Ch5 R7-Ch9	GATE IES
		Condition for maximum efficiency Problems on efficiency	L 45	R2-Ch5, R3-Ch5 R7-Ch9	
15	Methods of testing, direct, Indirect and regenerative testing	Circuit connection and procedure of Brake test and Swinburnes test	L46	R2-Ch5, R3-Ch5 R7-Ch9	

S. No.	Topics as per JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	**Remarks**
16	Brake test , swinburne's test Hopkinson's test Fields test Retardation test, separation of stray losses in a D.C motor test	Problems on brake test and Swinburne's test advantages and disadvantages of different tests	L 47	T2-Ch4, R2-Ch5 R7-Ch9	GATE IES
		Circuit diagram and procedure of Hopkinson's test	L48	T2-Ch4, R2-Ch5 R7-Ch9	
		Circuit diagram and procedure of Fields' test	L49	T2-Ch4, R2-Ch5 R7-Ch9	
		Advantages and disadvantages of tests	L50	T2-Ch4, R2-Ch5 R7-Ch9	
		Retardation test	L51	T2-Ch4, R2-Ch5 R8-Ch31	
		Separation of stray losses	L52	T2-Ch4, R2-Ch5 R8-Ch31	
		Problems on Hopkinson's test Problems on Swinburne's test	L53	T2-Ch4, R2-Ch5 R8-Ch31	