ELECTROMAGNETISM

Theory Questions

1. State and explain Faraday's law of electromagnetic induction.
2. Differentiate between statically and dynamically induced emf.
3. Explain self-induction and self-inductance.
4. Explain mutual-induction, mutual inductance and coefficient of coupling, k.
5. Obtain an expression for coefficient of coupling in terms of self-inductances and mutual-inductance of coupled coils.

Numericals

1. Two coils, A and B, are wound on the same ferromagnetic core. There are 300 turns on A and 2800 turns on B. A current of 4A through coil A produces a flux of 800μWb in the core. Calculate the self-inductances and mutual-inductance of the coils. If this current is reversed in 20ms, calculate the average emf induced in coils A and B. (Answer: 0.06H, 5.22H, 0.56H, 24V, 224V)

2. Two identical 1000 turn coils, X and Y lie in parallel plains such that 60% of magnetic flux produced by one links the other. A current of 5A in X produces a flux of 0.05mWb. If current in X changes from +5A to -5A in 0.01 second, what will be the magnitude of emf induced in Y. Also, calculate the self-inductance of each coil and mutual inductance between two coils. (Answer: 6V, 0.01H, 0.01H, 0.006H)

3. A coil of 1500 turns carrying a current of 5A produces a flux of 2.5mWb. If the current is reversed in 0.2 second, find the average value of emf induced in the coil. Also, find the self-inductance of the coil. (Answer: 37.5V, 0.75H)

4. The self - inductance of a coil of 500 turns is 0.25H. If 60% of the flux linked with the second coil of 10,000 turns, calculate the mutual inductance between the coils. Also find the emf induced in the second coil when current in the first coil changes at the rate of 100A/s. (Answer: 3H, -300V)

5. There are two coils having coefficient of coupling 0.8. The current in coil A is 3A and the total flux is 0.4mWb. The voltage induced in coil B is 85V when the current in coil A is reduced to zero in 3ms. The number of turns in coil A is 300. Determine L_1, L_2, M and N_2. (Answer: 0.04H, 0.282H, 85mH, 797)

DC GENERATOR

Theory Questions

1. With a neat diagram, explain the constructional features of a dc machine.
2. Explain the principle of operation of a DC generator.
3. Obtain the emf equation of a dc generator with usual notations.

Numericals

1. A 4 pole wave wound D.C. generator has 48 slots each slot having 24 conductors. The flux per pole is 0.018Wb. At what speed the armature be rotated to get an induced emf of 220V. What will be the induced emf developed if the armature winding is lap connected and armature runs at the same speed. (Answer: 318.28rpm, 110V)

2. The armature of a 2 pole, 200V generator has 400 conductors and runs at 300 rpm. Calculate the useful flux per pole. If the number of turns in each field coil is 1200, what is the average value of E.M.F. induced in each coil on braking the field if the flux dies away completely in 0.1 second. (Answer: 0.1Wb, 1200V)

3. A 6 pole, 2 circuit, wave connected armature has 250 conductors and runs at 1200rpm. The E.M.F. generated on open circuit is 600V. Find the useful flux per pole. (Answer: 40mWb)

4. An 8 pole lap connected armature has 960 conductors a flux of 40mWb/pole and a speed of 400rpm. Calculate the E.M.F. generated on open circuit. If the armature were wave connected for 2 circuits at what speed must it be driven to generate 400V. (Answer: 256V, 156.25rpm)

5. An 8 pole armature is wound with 480 conductors. The magnetic flux and the speed are such that the average emf generated in each conductor is 2.2V and each conductor is capable of carrying a full load current of 100A. Calculate the terminal Voltage on no load, the output current on full load and the total power generated on full load when the armature is (a) lap connected (b) wave connected. (Answer: a) 132V, 800A, 105.6KW b) 528V, 200A, 105.6KW)

6. An 8 pole lap connected armature driven at 350rpm is required to generate 260V. The useful flux per pole is about 0.05Wb. If the armature has 120 slots, calculate a suitable number of conductors per slot. **(**Answer: 8)

7. The armature of a 6 pole D.C. generator has a wave winding containing 664 conductors. Find the generated emf if the flux per pole is 0.06Wb and the speed is 250rpm. At what speed the armature be driven in order to generate the emf of 550V if the flux per pole is reduced to 0.058Wb. **(**Answer: 498V, 285.62rpm)

DC MOTOR

Theory Questions

1. Explain the principle of operation of DC motor.
2. What is back emf in a DC motor and write its expression. Explain its significance under varying load conditions.
3. What are the factors upon which the speed of a DC motor depends.
4. How are DC motors classified? Explain with relevant sketches.
5. Plot the T vs Ia, N vs Ia, N vs T (mechanical) characteristics of (i) shunt DC motor (ii) series DC motor (iii) cumulative compound DC motor.
6. Why a DC series motor should **never** be started on no-load.
7. Mention any three application of (i) shunt DC motor (ii) series DC motor (iii) cumulative compound DC motor and justify.
8. Explain the need for a starter in a DC motor.

Numericals

1. A 4-pole 500V, D.C. shunt motor has 720 wave connected conductors. The full load armature current is 60A, flux per pole is 0.03Wb and armature resistance is 0.2Ω. Assuming a contact drop of 1V/brush, find the full load speed and gross torque. (Answer: 675rpm, 412.53N-m)
2. A 4-pole D.C. shunt motor takes 22A from 200V supply. Given: $R_a = 0.5\Omega$, $R_f = 100\Omega$. The armature is lap connected with 300 conductors. If flux/pole is 20mWb, find the speed and gross torque. (Answer: 1900rpm, 19.1N-m)
3. A 4-pole lap wound 220V shunt motor has armature resistance of 0.4Ω and field resistance of 220Ω. It is running at 1500rpm when it is taking 40A from the supply. Find the speed of the motor when the motor is taking 10A from the supply. (Answer: 1588rpm)
4. Find the useful flux per pole on no load of a 250V, 6-pole shunt motor having a two circuit connected armature winding with 220 conductors. At normal working temperature, the overall armature resistance including brushes is 0.2Ω. The armature current is 13.3A at the no load speed of 908rpm. (Answer: 24.76mWb)
5. Calculate the torque in N-m developed by a D.C. motor having an armature resistance of 0.25Ω and running at 750rpm when taking an armature current of 60A from a 480V supply. (Answer: 355.23N-m)
6. A D.C. shunt motor runs at 1000rpm on 200V supply. The armature resistance is 0.8Ω and current taken is 40A in addition to field current. What resistance do you connect in series with the armature to reduce the speed to 600rpm, current in the armature remaining the same? Neglect armature reaction. (Answer: 1.68Ω)
7. A 4-pole lap connected 220V D.C. shunt motor has 36 slots, each slot containing 16 conductors. It draws 40A from the supply. The field resistance and armature resistances are 110Ω and 0.1Ω respectively. The motor develops a shaft output power of 6KW. The flux per pole is 40mWb. Calculate a) speed, b) torque developed by the armature and c) shaft torque. (Answer: 563rpm, 139.2N-m, 101.77N-m)
8. The armature resistance of 25HP, 250V series motor is 0.2Ω and series field resistance is 0.05Ω. Speed of the motor is 600rpm when it takes 80A. Find the speed when the current is 50A. (Answer: 991.3rpm)
9. A series motor with 1Ω resistance between terminals runs at 800rpm at 200V with current of 15A. Find the speed at which it will run, when connected in series with 5Ω resistor and taking same current at same supply Voltage. (Answer: 476rpm)

TRANSFORMER

Theory Questions

1. With a neat diagram, explain the constructional details of i) shell type transformer, ii) core type transformer.
2. Explain the working principle of a transformer.
3. Obtain the emf equation of a transformer with usual notations.
4. Enumerate various losses occurring in a transformer and suggest methods to reduce them.

Numericals

1. The voltage ratio of a 50Hz, 25KVA single phase transformer is 6000/250V. If the maximum flux in the core is 0.05Wb, determine the number of turns on each winding. Calculate full load primary and secondary currents. (Answer: 541, 23, 4.167A, 100A)

2. A 200KVA, 3300/240V, 50Hz single phase transformer has 80 turns on the secondary winding assuming an ideal transformer, calculate (a) The primary and secondary currents on full load (b) the maximum value of flux (c) number of primary turns. (Answer: 60.606A, 833.33A, 13.5mWb, 1100)

3. Find number of turns of primary and secondary of 415/240V, 50Hz transformer if the area of core is 50sq.cm and max value of flux density in the core is 1.3Wb/m^2. (Answer: 288, 167)

4. A 5KVA, 50Hz, single-phase transformer has primary and secondary turns of 120 and 80. At a certain flux density, the induced emf per turn in primary is 2.5V. Determine primary and secondary voltage. (Answer: 300, 200)