APPENDIX

NUMERICAL EXAMPLES WITH SOLUTIONS AND CLASSIFIED THEORY QUESTIONS FROM B.T.E. EXAMINATION PAPERS (K-SCHEME)

SUMMER 2025

Numerical Examples with Solutions :

Example 1 : *A 500 V d.c. shunt motor takes a current of 5 A on no load. The resistance of the armature and field circuits are 0.5 Ω and 250 Ω respectively. Calculate the efficiency when motor takes a current of 100 A.* **(4 Marks)**

Solution : Refer to the solution of Example 2.41 on Page 2.44.

Example 2 : *A d.c. generator has an armature e.m.f. of 200 V when the useful flux per pole is 40 mWb and the speed 800 r.p.m. Calculate the generated e.m.f.*

(i) With the same flux and speed of 1000 r.p.m.

(ii) With the flux per pole of 48 mWb and a speed of 900 r.p.m. **(6 Marks)**

Solution : Given : E_1 = 200 V, ϕ_1 = 40 mWb, N_1 = 800 r.p.m., $\phi_2 = \phi_1$, N_2 = 1000 r.p.m, ϕ_3 = 48 mWb, N_3 = 900 r.p.m

We know that, with usual notations :

$$\text{Generated E.M.F., } E = \frac{\phi ZN}{60} \times \frac{P}{A}$$

Therefore with the same number of armature conductors, number of poles and number of parallel paths through the armature winding, we have

$$\text{Generated e.m.f. } E \propto \phi N$$

(i) For a d.c. generator, if the initial values of generated e.m.f., flux per pole and speed are E_1, ϕ_1 and N_1 and corresponding final values are E_2, ϕ_2 and N_2 respectively, then it is obvious that

$$\frac{E_2}{E_1} = \frac{\phi_2}{\phi_1} \times \frac{N_2}{N_1}$$

$$\therefore \quad \frac{E_2}{200} = \frac{40 \times 10^{-3}}{40 \times 10^{-3}} \times \frac{1000}{800}$$

Hence, Generated e.m.f., E_2 = **250 V** … **Ans.**

(ii) Now in this case, if respective values of generated e.m.f., flux per pole and speed are E_3, ϕ_3 and N_3, then

$$\frac{E_3}{E_1} = \frac{\phi_3}{\phi_1} \times \frac{N_3}{N_1}$$

$$\therefore \quad \frac{E_3}{200} = \frac{48 \times 10^{-3}}{40 \times 10^{-3}} \times \frac{900}{800}$$

Hence, Generated e.m.f., E_3 = **270 V** … **Ans.**

Example 3 : *A 200 V, 4-pole, lap wound d.c. shunt motor has 800 conductors of armature winding. Armature and field winding resistances are 0.5 Ω and 200 Ω respectively. The motor takes 21 A and flux per pole is 30 mWb. Find the speed and torque developed.* **(6 Marks)**

Solution : Given : V = 200 volts, P = 4, A = P = 4 (∵ Lap wound), Z = 800, R_a = 0.5 Ω, R_{sh} = 200 Ω, I = 21 A, ϕ = 30 mWb.

(i) $$\text{Field current, } I_{sh} = \frac{V}{R_{sh}} = \frac{200}{200} = 1 \text{ A}$$

$$I_a = I - I_{sh} = 21 - 1 = 20 \text{ A}$$

$$E_b = V - I_a R_a = 200 - 20 \times 0.5 = 190 \text{ V}$$

Now, $E_b = \frac{\phi ZN}{60} \times \frac{P}{A}$

$\therefore$ $190 = \frac{30 \times 10^{-3} \times 800 \times N}{60} \times \frac{4}{4}$

$\therefore$ Speed of the motor, N = **475 r.pm.** … **Ans.**

(ii) Torque developed $= 0.159\ \phi Z\ I_a \frac{P}{A}$

$$= 0.159 \times 30 \times 10^{-3} \times 800 \times 20 \times \frac{4}{4}$$

= **76.32 Nm** … **Ans.**

Alternatively, Mechanical power developed,

$$P_m = E_b \times I_a = 190 \times 20 = 3800\ W$$

$\therefore$ Torque developed, $T = \frac{P_m \times 60}{2\pi N} = \frac{3800 \times 60}{2\pi \times 475} =$ **76.39 Nm** … **Ans.**

Example 4 : *A 1-ph, 50 kVA, 2400/120 V, 50 Hz transformer gave the following test results :*

O.C. Test (on LV side) : 120 V, 9.85 A, 396 W,

S.C. Test (on HV side) : 92 V, 20.8 A, 810 W

Calculate : (i) Equivalent circuit constants, (i) Efficiency at rated kVA and p.f. 0.8 lag, (iii) Voltage regulation.

(6 Marks)

Solution : For (i) and (ii) refer to the solution of Example 3.63 on Page 3.66.

(iii) Voltage regulation at full load 0.8 p.f. lagging

$$= \frac{(I_1 R_{t1} \cos\phi + I_1 X_{t1} \sin\phi)}{V_1} \times 100$$

$$= \frac{(20.8 \times 1.8722 \times 0.8 + 20.8 \times 4.007 \times 0.6)}{2400} \times 100$$

= **3.38 %** … **Ans.**

Classified Theory Questions from the Paper for Self-Study :

1. State the function of following in a d.c. generator : (i) Commutator, (ii) Pole shoe.

   (Answer : Sections 1.5.1, 1.5.2) **(2 Marks)**

2. Draw and explain external characteristics of d.c. generator.

   (Answer : Sections 1.16, 1.17) **(4 Marks)**

3. State the application of separately excited and shunt d.c. generator.

   (Answer : Section 1.20) **(6 Marks)**

4. State Fleming's left hand rule.

   (Answer : Section 2.2) **(2 Marks)**

5. Explain and draw following characteristics of d.c. compound motor : (i) Torque-Armature current, (ii) Speed-Armature current.

   (Answer : Section 2.11.3) **(6 Marks)**

6. Explain the need of a starter for d.c. motor. Also state different types of starters used for d.c. motors.

   (Answer : Sections 2.17, 2.17.1, 2.17.2) **(4 Marks)**

7. State and explain flux control method of speed control of a d.c. series motor.
   (Answer : Section 2.19.2) **(4 Marks)**
8. Explain with diagram, working of the brushless d.c. motor.
   (Answer : Section 2.21) **(4 Marks)**
9. State the working principle of a single-phase transformer.
   (Answer : Section 3.2) **(2 Marks)**
10. Explain the construction of a single-phase shell type transformer.
    (Answer : Section 3.4) **(4 Marks)**
11. Derive the e.m.f. equation of a transformer.
    (Answer : Section 3.5) **(4 Marks)**
12. Justify : 'Transformer rating is in kVA'.
    (Answer : Section 3.7) **(2 Marks)**
13. Draw and explain the phasor diagram of a single-phase transformer supplying load at lagging p.f.
    (Answer : Section 3.11) **(4 Marks)**
14. Draw the equivalent circuit of a transformer referred to primary. State the meaning of each term related to equivalent circuit.
    (Answer : Section 3.12) **(4 Marks)**
15. Compare ordinary efficiency and all-day efficiency on : (i) Type of efficiency, (ii) Definition, (iii) Effect of loading, (iv) Use.
    (Answer : Sections 3.15, 3.15.1) **(4 Marks)**
16. Draw a circuit diagram of different connections of a 3-phase transformer.
    (Answer : Section 4.4) **(4 Marks)**
17. Explain with the neat diagram, Scott connection scheme of a transformer.
    (Answer : Section 4.6) **(4 Marks)**
18. State the need of parallel operation of three-phase transformers.
    (Answer : Sections 4.12, 4.13) **(6 Marks)**
19. Give the criteria for selection of a power transformer as per IS : 10028 (Part-I).
    (Answer : Section 4.21.2) **(6 Marks)**
20. State the importance of 'K' factor of a transformer.
    (Answer : Section 4.24) **(2 Marks)**
21. State any two advantages of a single-phase auto-transformer over two-winding transformer.
    (Answer : Section 5.2) **(2 Marks)**
22. State the features of isolation transformer.
    (Answer : Section 5.5) **(2 Marks)**
23. Explain the following parameters of a pulse transformer :
    (i) Overshoot, (ii) Peak value (V_m), (iii) Rise time (T_r), (iv) Fall time (T_f)
    (Answer : Section 5.7) **(4 Marks)**

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