2020

RANK improvement WORKBOOK

Answer key and Hint of Objective & Conventional *Questions*

Electronics Engineering

Basic Electrical Engineering

MADE EASY
Publications

1 Magnetic Circuits & Electromagnetic Energy Conversion and Basics

LEVEL 1 Objective Solutions

1. (b)

2. (b)

3. (c)

4. (c)

5. (d)

LEVEL 2 Objective Solutions

6. (b)

7. (a)

8. (11.04)

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LEVEL 3 Conventional Solutions

Solution : 1

$$L = 68.3 \text{ mH}$$

Solution : 2

(i) $M = 1.15 \text{ H}$

(ii) $k = 0.586$

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2 Transformers

LEVEL 1 Objective Solutions

1. (b)
2. (b)
3. (b)
4. (d)
5. (b)
6. (b)
7. (c)
8. (b)
9. (d)
10. (b)
11. (d)
12. (a)
13. (a)
14. (d)
15. (d)

LEVEL 2 Objective Solutions

16. (b)
17. (c)
18. (0.1)
19. (a)
20. (a)
21. (97.91)
22. (a)
23. (c)

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LEVEL 3 Conventional Solutions

Solution : 1

$$\% \text{ Voltage regulation} = 4.648\%$$

Solution : 2

$$\eta \text{ at } 60\% \text{ of full load} = 0.904 \text{ (or) } 90.4\%$$

Solution : 3

$$V_2 = 224.385 \text{ volt}$$

Solution : 4

$$\eta_{\text{all day}} = 94.65\%$$

Solution : 5

Total core loss, $p_c = 2600$ W

Solution : 6

At 50% of rated full load, $\eta = 97.83\%$

at 100% of rated full load, $\eta = 97.918$

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3 Direct Current Machine

LEVEL 1 Objective Solutions

1. (a)
2. (c)
3. (c)
4. (d)
5. (a)
6. (c)
7. (d)
8. (c)

LEVEL 2 Objective Solutions

9. (9424)
10. (3.6)
11. (b)
12. (a)
13. (b)
14. (c)
15. (1.004)
16. (346.18)
17. (12)
18. (2.38)
19. (d)
20. (b)
21. (5652)
22. (b)
23. (c)

LEVEL 3 Conventional Solutions

Solution : 1

Speed, $N = 810.155$ rpm

Current, $I_a = 24.7175$ A

Solution : 2

$$N = 1298.142 \text{ rpm}$$

Solution : 3

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}} \times 100 = 89.21\%$$

Solution : 4

$$R_{ext} = 2.46\ \Omega$$

Speed, $N = \dfrac{E}{k_n \phi} = 420$ rpm

Solution : 5

(a) $I = 104.4$ A

$E = 236.7$ V

(b) $I_a = I + I_f = 100 + 4.52 = 104.52$ A

$E = 236.452$ V

(c) % reduction in series field $AT = 37.5\%$

Solution : 6

$n_1 = 993.58$ rpm

$T_1 = 80.95$ Nm

Solution : 7

$$N_2 = 2784.2 \text{ rpm}$$

Solution : 8

(a) $R_{ext} = 5.7\ \Omega$

(b) $R_{ext} = 1.9\ \Omega$

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4 Synchronous Machine

LEVEL 1 Objective Solutions

1. (d)
2. (c)
3. (c)
4. (c)
5. (c)
6. (b)
7. (d)

LEVEL 2 Objective Solutions

8. (6.96)
9. (b)
10. (139.85)
11. (2083.33)
12. (d)
13. (4.74)
14. (b)
15. (608.47)
16. (b)
17. (b)

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LEVEL 3 Conventional Solutions

Solution : 1

$$X_s = 5.656\ \Omega$$
$$Z_s = 5.99\angle 70.5°$$
$$V_t = 7.89\text{ kV}$$

Solution : 2

$$E_{rms} = 994.37\text{ volts/phase}$$

Solution : 3

$$E_p = 5716.13\text{ V}$$

Solution : 4

Terminal voltage, $V_t = 2395.4\text{ V}$

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5 Three-Phase Induction Machine

LEVEL 1 Objective Solutions

1. (a)
2. (b)
3. (c)
4. (c)
5. (d)
6. (b)
7. (b)
8. (d)
9. (d)
10. (d)
11. (c)
12. (c)
13. (1125)
14. (a)
15. (a)
16. (150)
17. (b)
18. (c)

LEVEL 2 Objective Solutions

19. (b)
20. (142.403)
21. (d)
22. (b)
23. (4.54)
24. (a)
25. (24.45)
26. (50)
27. (24.45)
28. (c)
29. (150)
30. (15.24)

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LEVEL 3 Conventional Solutions

Solution : 1

$$R_{ext} = 0.229\ \Omega/\text{phase}$$

Solution : 2

(i) Air gap power, $P_g = 15.0277$ kW

(ii) The developed mech. power,

$$P_{mech} = 14.5777 \text{ kW}$$

(iii) The output horse power $= 19.3311$ hp

(iv) The efficiency (η), $\%\eta = 85.5662\%$

Solution : 3

(a) $I_2 = 734.5$ A

(b) $\cos(86.35°) = 0.064$ lag

(c) $R_{ext} = 0.304 - 0.016 = 0.288\ \Omega$

(d) $I_2' = 104.32\angle{-32.1°}$

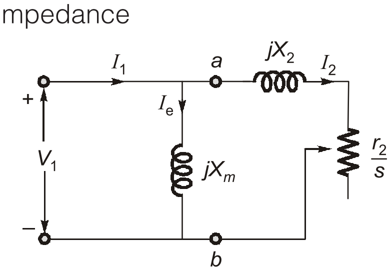
(e) p.f. $= \cos(32.1°) = 0.847$ lag.

Solution : 4

Power input to the rotor $= 17.443$ kW and Rotor copper loss $= 6.40$ kW

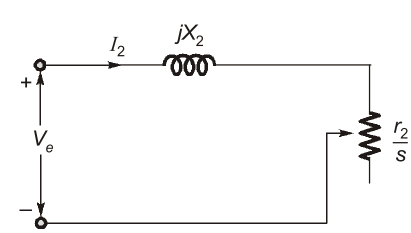
Solution : 5

Equivalent circuit without stator impedance



Induction motor equivalent circuit

By applying Thevenins theorem across *ab*



$$V_e = V_1$$

$$\therefore \quad I_2 = \frac{V_1}{\frac{r_2}{s} + jX_2}$$

Total torque,

$$T_e = \frac{m}{\omega_s} = \frac{V_1^2}{\left(\frac{r_2}{s}\right)^2 + (x_2)^2} \cdot \frac{r_2}{s}$$

where, m = number of stator phases

From the maximum power transfer theorem, the torque will be maximum when impedance r_2/s becomes equal to the magnitude of impedance seen by r_2/s towards the voltage source v_e.

$$\frac{r_2}{s_{mT}} = x_2 \Rightarrow s_{mT} = \frac{r_2}{x_2}$$

Maximum torque,

$$T_{em} = \frac{mV_1^2}{\omega_s} \frac{1}{(x_2)^2 + (x_2)^2} \cdot (x_2) = \frac{mV_1^2}{2\omega_s x_2}$$

$$\frac{T_e}{T_{em}} = \frac{m}{\omega_s} \cdot \frac{V_1^2}{\left(\frac{r_2}{s}\right)^2 + x_2^2} \cdot \frac{r_2}{s} \times \frac{2\omega_s x_2}{mV_1^2} = \frac{\frac{r_2}{s}}{\left(\frac{r_2}{s}\right)^2 + x_2^2} \times 2x_2$$

$$\frac{T_e}{T_{em}} = \frac{\frac{r_2}{s}}{\left(\frac{r_2}{s}\right)^2 + \left(\frac{r_2}{s_{mT}}\right)^2} \cdot 2 \times \frac{r_2}{s_{mT}} \qquad \left(as\ x_2 = \frac{r_2}{s_{mT}}\right)$$

$$= \frac{\frac{2}{s}}{\frac{1}{s^2} + \frac{1}{s_{mT}^2}} \times \frac{1}{s_{mT}} = \frac{2}{\frac{s_{mT}}{s} + \frac{s}{s_{mT}}}$$

Solution : 6

(i) ∵ $s = 1$

Rotar frequency, $F = 50$ Hz

(ii) ∵ $s = 0$,

Rotar frequency, $s = 0$, $sF = 0$ (as $E_2 = 0$)

(iii) $$s = \frac{N_s - (-N)}{N_s} = \frac{1500 + 1450}{1500} = 1.967$$

∴ Rotar frequency, $sF = 98.33$ Hz

(iv) $$s = \frac{1500 - 1550}{1500} = -0.033$$

∴ Rotar frequency $= sF = 1.67$ Hz

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