Technical Mathematics

For Electrician

Solution

TEVTA

GOVERNMENT OF THE PUNJAB
TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY
PUNJAB BOARD OF TECHNICAL EDUCATION
TRADE TESTING CELL, LAHORE.

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Technical Mathematics

For Electrician

Solution

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For Skilled Labour Training
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Chapter No. 1

1.1	3684.897	1.17	26533	1.33	43
1.2	2593.058	1.18	19562.8	1.34	589
1.3	943.888	1.19	196.386	1.35	10662.045
1.4	902.352	1.20	239.848	1.36	12445,045
1.5	685.672	1.21	32.852	1.37	896.625
1.6	563.891	1.22	81.968	1.38	99,536
1.7	77.096	1.23	0.125	1.39	860.259
1.8	55.286	1.24	0.007	1.40	240.584
1.9	940.925	1.25	2930	1.41	8005
1.10	609.035	1.26	3692	1.42	7001
1.11	651.770	1.27	143.473	1.43	3801.83
1.12	577.887	1.28	238.013	1.44	5511.84
1.13	247.525	1.29	11.353	1.45	4552.8
1.14	294.365	1.30	9.326	1.46	6705.532
1.15	3023.797	1.31	0.220	1.47	12073.222
1.16	0.995	1.32	17.574	1.48	16806.332

1.49 a) Jan...Feb.: (+) 3870 pieces b) 1. 102310 pieces
Feb...March: (-) 2690 pieces 2. Rs 32739.20

1.50 a) Jan...Feb: (+) 1155 pieces b) 1. 71290 pieces
Feb...March: (-) 1910 pieces 2. Rs 22812.80

1.51 a) Difference of 1970...1973 in Mill. of Rupees

Total budget	30856
Social welfare	15333
Ministry of communication	- 283
Ministry of defence	7936

b) Balance 1970 40556
Balance 1973 48436

c) Expenditure on each citizen in 1970 in Rupees

Total budget	1514.41
Social welfare	318.08
Ministry of communication	172.25
Ministry of defence	336.68
Balance	687.39

1.52 a) From 3105 citizens - 1 person/year
b) From 44 citizens - 1 person/30 years

1.53

Distances covered in km	a) Rs.	b) Ps./km	c) 1. Ps./km	c) 2. Ps./km
5000	1992	39.84	+23.64	+26.44
10000	2376	23.76	+ 7.56	+10.36
15000	2496	16.64	+ 0.44	+ 3.24
20000	3240	16.20	+-0	+ 2.80
30000	4020	13.40	- 2.80	+-0
40000	5088	12.72	- 3.48	- 0.68
50000	5640	11.28	- 4.92	- 2.12

1.54

Distances covered in km	a) Rs.	b) Ps./km	c) 1. Ps./km	c) 2. Ps./km
5000	2952	59.04	+35.76	+39.84
10000	3516	35.16	+11.88	+15.96
15000	4008	26.72	+ 3.44	+ 7.52
20000	4656	23.28	+-0	+ 4.08
30000	5760	19.20	- 4.08	+-0
40000	6864	17.16	- 6.12	- 2.04
50000	8004	16.01	- 7.27	- 3.19

Chapter No. 2

2.1 $\frac{7}{2}$; $\frac{14}{3}$; $\frac{23}{4}$

2.2 $\frac{13}{5}$; $\frac{17}{6}$; $\frac{31}{7}$

2.3 $\frac{38}{5}$; $\frac{59}{6}$; $\frac{83}{10}$

2.4 $\frac{45}{8}$; $\frac{27}{4}$; $\frac{66}{7}$

2.5 $\frac{123}{8}$; $\frac{119}{9}$; $\frac{193}{12}$

2.6 $\frac{184}{7}$; $\frac{212}{3}$; $\frac{252}{13}$

2.7 $\frac{207}{9}$; $\frac{151}{8}$; $\frac{127}{5}$

2.8 $\frac{219}{5}$; $\frac{237}{4}$; $\frac{131}{9}$

2.9 $\frac{1027}{21}$; $\frac{530}{17}$; $\frac{1039}{13}$

2.10 $\frac{1967}{24}$; $\frac{1087}{11}$; $\frac{987}{13}$

2.11 3; $7\frac{2}{5}$; $3\frac{3}{4}$;

2.12 $3\frac{2}{5}$; $5\frac{1}{3}$; $6\frac{3}{4}$

2.13 $3\frac{2}{5}$; $5\frac{1}{7}$; $8\frac{1}{8}$

2.14 $2\frac{3}{4}$; $3\frac{4}{5}$; $3\frac{5}{7}$

2.15 $10\frac{5}{12}$; $13\frac{1}{3}$; $8\frac{14}{17}$

2.16 $7\frac{3}{5}$; $4\frac{4}{13}$; $12\frac{10}{11}$

2.17 $7\frac{10}{15}$; 13; $10\frac{7}{9}$

2.18 $17\frac{2}{3}$; $14\frac{7}{8}$; 33

2.19 $3\frac{81}{82}$; 3; $3\frac{1}{120}$

2.20 3; $2\frac{124}{125}$; $8\frac{3}{17}$

2.21 $\frac{60}{48}$; $\frac{42}{33}$

2.22 $\frac{12}{20}$; $\frac{20}{35}$

2.33 $\frac{77}{81}$; $\frac{45}{48}$

2.34 $\frac{36}{44}$; $\frac{45}{108}$

2.35 $\frac{15}{25}$; $\frac{20}{1200}$

2.36 $\frac{84}{96}$; $\frac{35}{42}$

2.37 $\frac{147}{189}$; $\frac{286}{308}$

2.38 $\frac{65}{83}$; $\frac{143}{156}$

2.39 $\frac{81}{99}$; $\frac{125}{32}$

2.40 $\frac{54}{171}$; $\frac{204}{374}$

2.41 $\frac{1}{2}$; $\frac{1}{3}$; $\frac{1}{4}$

2.42 $\frac{3}{4}$; $\frac{2}{5}$; $\frac{3}{8}$

2.43 $\frac{2}{3}$; $\frac{4}{5}$; $\frac{4}{5}$

2.44 $\frac{4}{5}$; $\frac{3}{8}$; $\frac{2}{5}$

2.45 $\frac{12}{18}$; $\frac{17}{51}$; $\frac{53}{91}$

2.46 $\frac{11}{15}$; $\frac{2}{3}$; $\frac{91}{100}$

2.47 $\frac{12}{13}$; $\frac{6}{17}$; $\frac{37}{26}$

2.48 $\frac{5}{17}$; $\frac{5}{11}$; $\frac{131}{124}$

2.49 $\frac{21}{25}$; $\frac{13}{29}$; $\frac{11}{19}$

2.50 $\frac{8}{13}$; $\frac{77}{147}$; $\frac{187}{111}$

2.51 $\frac{21}{11}$; $\frac{177}{118}$; $\frac{253}{34}$

2.52 $\frac{525}{91}$; 7; $\frac{423}{112}$

2.53 $\frac{1}{20}$; $\frac{1}{240}$; $\frac{1}{20}$

2.54 $\frac{2}{25}$; $\frac{4}{100}$; $\frac{1}{20}$

2.55 $\frac{1}{20}$; $\frac{1}{2}$; $\frac{41}{100}$

2.56 $\frac{1}{25}$; $\frac{7}{10}$; $\frac{21}{50}$

2.57 20; 350; 20

2.58 $12\frac{1}{2}$; 125; 20

2.59 30; 3; 3

2.60 44; $1\frac{4}{7}$; 4

2.61 $\frac{2}{3}$; 60; $\frac{37}{20}$

2.62 35; 20; $16\frac{1}{4}$

2.63 $\frac{1}{3300}$; $\frac{1}{30}$; 110

2.64 $\frac{1}{21000}$; $\frac{1}{40}$; 70

2.65 $\frac{1}{80}$; $\frac{1}{800}$; $\frac{1}{140}$

2.66 $\frac{1}{90}$; $\frac{1}{800}$; $\frac{1}{170}$

2.67 $\frac{1}{2}$; $\frac{6}{5}$; $\frac{9}{10}$

2.68 $\frac{2}{5}$; $\frac{3}{5}$; $\frac{7}{10}$

2.69 $\frac{1}{4}$; $\frac{3}{8}$; $\frac{17}{20}$

2.70 $\frac{1}{5}$; $\frac{9}{20}$; $\frac{11}{20}$

2.71 $\frac{23}{200}$; $\frac{1}{8}$; $\frac{3}{8}$

2.72 $\frac{7}{40}$; $\frac{43}{200}$; $\frac{23}{40}$

2.73 $1\frac{1}{3}$; $2\frac{2}{3}$; $4\frac{1}{8}$

2.74 $3\frac{1}{3}$; $2\frac{1}{3}$; $4\frac{3}{8}$

2.75 $3\frac{143}{200}$; $6\frac{33}{40}$; $9\frac{3}{40}$

2.76 $3\frac{9}{40}$; $7\frac{19}{40}$; $12\frac{1}{20}$

2.77 $3\frac{21}{250}$; $15\frac{21}{125}$; $22\frac{43}{125}$

2.78 $6\frac{12}{125}$; $17\frac{22}{125}$; $34\frac{22}{125}$

2.79 $\frac{13}{125}$; $\frac{3}{40}$; $7\frac{1}{125}$

2.80 $\frac{38}{125}$; $\frac{8}{125}$; $\frac{13}{250}$

2.71	0.75; 0.8; 0.875	2.79	8.2143; 7.25; 5.3231
2.72	0.6; 0.8333; 0.625	2.80	6.1538; 9.3333; 5.3846
2.73	0.8923; 0.38; 0.2286	2.81	1.7692; 1.3077; 2.8421
2.74	0.5385; 0.36; 0.3143	2.82	4.9412; 2.4314; 2.6429
2.75	2.25; 4.4286; 8.4	2.83	0.4828; 0.8258; 0.3333
2.76	3.2; 5.4286; 7.125	2.84	0.3021; 0.5862; 0.3333
2.77	8.087; 8.48; 7.3611	2.85	0.05263; 10.6456; 3.0449
2.78	8.1304; 9.52; 10.3056	2.86	0.07692; 10.7255; 2.0294

Chapter No. 3

3.1	$1\frac{1}{12}$	3.18	$12\frac{68}{77}$	3.35	9.9125
3.2	$\frac{5}{12}$	3.19	$7\frac{7}{52}$	3.36	6.7333
3.3	$\frac{37}{80}$	3.20	$18\frac{19}{40}$	3.37	80.1611
3.4	$\frac{17}{28}$	3.21	$13\frac{3}{7}$	3.38	78.2135
3.5	$\frac{1}{60}$	3.22	$1\frac{13}{40}$	3.39	21.4111
3.6	$\frac{103}{120}$	3.23	5	3.40	28.946
3.7	$4\frac{13}{20}$	3.24	$1\frac{7}{12}$	3.41	57.275
3.8	$3\frac{31}{52}$	3.25	11.05	3.42	70.8444
3.9	$12\frac{3}{12}$	3.26	39.7284		
3.10	$5\frac{29}{75}$	3.27	17.0619		
3.11	$2\frac{23}{30}$	3.28	0.7124		
3.12	$1\frac{49}{60}$	3.29	3.75		
3.13	$5\frac{1}{2}$	3.30	14.775		
3.14	$3\frac{3}{20}$	3.31	$17\frac{11}{120}$		
3.15	$3\frac{4}{15}$	3.32	$1\frac{173}{240}$		
3.16	$5\frac{11}{15}$	3.33	$18\frac{19}{20}$		
3.17	$8\frac{43}{77}$	3.34	$14\frac{8}{15}$		

3.43 a) 60
b) 1. 5
2. 12
3. 20

3.44 a) 48
b) 1. 6
2. 8
3. 16

3.45 1 day = 30 km
2 day = 30 km
3 day = 24 km
4 day = 30 km
5 day = 16 km

3.46 1 day = 30 km
2 day = 30 km
3 day = 37.5 km
4 day = 25 km
5 day = 27.5 km

3.47 a) 6/35
b) Blacksmith Rs 180
Labourer Rs 168
Apprentice Rs 72
Total Rs 420

3.48 a) 6/35
b) Blacksmith Rs 195
Labourer Rs 182
Apprentice Rs 78
Total Rs 455

3.49 38.43 litres

3.50 48.60 litres

3.51 A - Rs 21250.--
B - Rs 34000.--
C - Rs 14166.67
D - Rs 15583.33

3.52 A - Rs 25500.--
B - Rs 40800.--
C - Rs 17000.--
D - Rs 18700.--

3.53 Rs 10.--

3.54 Rs 24.--

Chapter No. 4

4.1 $\frac{2}{5}$

4.2 $\frac{3}{64}$

4.3 $\frac{5}{28}$

4.4 $\frac{8}{55}$

4.5 $1\frac{2}{5}$

4.6 $1\frac{1}{8}$

4.7 $6\frac{6}{7}$

4.8 $5\frac{1}{3}$

4.9 $5\frac{3}{5}$

4.10 72

4.11 $544\frac{1}{8}$

4.12 98

4.13 $184\frac{17}{25}$

4.14 $137\frac{1}{5}$

4.15 344.0053

4.16 214.452

4.17 $1\frac{2}{5}$

4.18 $2\frac{2}{7}$

4.19 $2\frac{1}{2}$

4.20 $\frac{4}{5}$

4.21 $12\frac{1}{2}$

4.22 $\frac{14}{15}$

4.23 $\frac{1}{14}$

4.24 $\frac{2}{33}$

4.25 $4\frac{1}{6}$

4.26 $2\frac{2}{15}$

4.27 $1\frac{4}{7}$

4.28 $4\frac{1}{6}$

4.29 9

4.30 3.4

4.31 7

4.32 16

4.33 $2;\ \frac{6}{7};\ \frac{8}{5}$

4.34 $\frac{2}{7};\ 1\frac{3}{7};\ 4\frac{7}{11}$

4.35 $9;\ \frac{1}{84};\ \frac{2}{15}$

4.36 $9;\ \frac{5}{88};\ \frac{3}{7}$

4.37 $3\frac{5}{6};\ \frac{6}{7}$

4.38 $3\frac{1}{5};\ 2\frac{12}{72}$

4.39 1

4.40 $1\frac{1}{8} = 1.125$

4.41 1.127

4.42 1

4.43 2

4.44 3.699

4.45 a) 7/20
b) A - Rs 104
B - Rs 65
C - Rs 91

4.46 a) 7/20
b) A - Rs 136
B - Rs 85
C - Rs 119

4.47 a) 13/60
b) A - Rs 208.--
B - Rs 156.75
C - Rs 125.40
D - Rs 135.85

4.48 a) 13/60.
b) A - Rs 316.--
B - Rs 237.--
C - Rs 189.60
D - Rs 205.40

4.49 a) 120
b) 1/4 (

4.50 a) 115
b) 1/7 %

4.51 A - Rs 110
B - Rs 198
C - Rs 22

4.52 A - Rs 120
B - Rs 216
C - Rs 24

4.53 a) Rs 5000
b) Rs 12000
c) Rs 3000

4.54 a) Rs 6000
b) Rs 14400
c) Rs 3600

4.55 a) 101/420
b) A - Rs 270.--
B - Rs 315.--
C - Rs 378.--
D - Rs 472.50
R - Rs 454.50

4.56 a) 101/420
b) A - Rs 390.--
B - Rs 455.--
C - Rs 546.--
D - Rs 683.50
E - Rs 656.50

Chapter No. 5

5.1	Rs 1441.80	5.12	18.2 min.	5.21	45
5.2	Rs 459.--	5.13	Rs 42.78	5.22	2.00 $/student
5.3	Rs 4.48	5.14	a) Rs 384.--	5.23	5000 l
5.4	Rs 27.--		b) Rs 72.--	5.24	3200 kg
5.5	3.85 kg	5.15	25 hrs.	5.25	a) 144 t
5.6	38.56 kg	5.16	18 hrs.		b) 315 t
5.7	220	5.17	35 cm		c) 285 t
5.8	975 litres	5.18	a) 128 cm	5.26	14 plucks
5.9	439.89 km		b) 18.284 cm	5.27	830 t
5.10	9.577 litr.	5.19	1.1 hrs.	5.28	a) 137.14 $
5.11	80.000 km	5.20	55 min.		b) 228.57 $

Chapter No. 6

6.1	Rs 34.50	6.14	Rs 28.30	6.27	Rs 1250.--
6.2	20.25 km	6.15	Rs 242.86	6.28	Rs 2400.--
6.3	15.225 min.	6.16	36.11 %	6.29	4.5 %
6.4	Rs 43.80	6.17	15.58 %	6.30	3 %
6.5	4 %	6.18	96.25 %	6.31	1 year,320 days
6.6	5 %	6.19	Rs 5851.05	6.32	80 days
6.7	4.2 %	6.20	Rs 1346.15	6.33	Rs 381.--
6.8	4.6 %	6.21	Rs 49.58	6.34	Rs 1318.34
6.9	Rs 14.--	6.22	Rs 900.--	6.35	Rs 2566.67
6.10	Rs 10.--	6.23	Rs 144.--	6.36	Rs 120000.--
6.11	60 cm	6.24	68 kg	6.37	3.25 %
6.12	75 cm	6.25	Rs 2.40	6.38	30.32 %
6.13	Rs 58.40	6.26	Rs 4.--	6.39	308 days
				6.40	198 days

Chapter No. 7

7.1	C = 1.65 m	7.8	X = 51	7.15	3m + n
7.2	C = 149 cm	7.9	X = 69	7.16	2a + b
7.3	X = 105	7.10	X = 57	7.17	10c + 10
7.4	X = 93	7.11	3 m	7.18	7a + 7
7.5	X = 75	7.12	3 d	7.19	10a + 10b
7.6	X = 87	7.13	6a	7.20	14c + 6 m
7.7	X = 39	7.14	8c	7.21	4d + 8b + 10k

7.22	7r+6s+6t	7.45	7n+10	7.68	0
7.23	2.6c+2.6g+0.3f	7.46	14g-7h-4k+40	7.69	4
7.24	11m+3.9p+1.1	7.47	a+3c	7.70	3
7.25	$1\frac{3}{20}a + \frac{1}{2}$	7.48	r+s+t	7.71	a/2
		7.49	0.5x +1.08y+2.5z	7.72	d/2
7.26	$\frac{11}{12}b + \frac{1}{3}$	7.50	0.1c+1.1d+0.3e	7.73	e
		7.51	15 a	7.74	6
7.27	$1\frac{13}{15}c$	7.52	36 b	7.75	2
		7.53	15 ac	7.76	5
7.28	$1\frac{7}{8}k$	7.54	40 mn	7.77	2 a
7.29	0	7.55	80 acx	7.78	3 x
7.30	0	7.56	24 rst	7.79	y/z
7.31	3f	7.57	630 mn	7.80	b/c
7.32	4s	7.58	240 xy	7.81	5 a/b
7.33	a - 7	7.59	0.03 klmnpr	7.82	3 x/y
7.34	x - 9	7.60	1.575 aoder	7.83	175
7.35	q	7.61	0.396 abxyz	7.84	9
7.36	2f	7.62	2400 wwxyz	7.85	$\frac{3ad}{8x}$
7.37	a - b	7.63	$\frac{3}{10}$ ab	7.86	$\frac{4kl}{5p}$
7.38	r - t				
7.39	2 a	7.64	$\frac{1}{4}$ fk	7.87	$\frac{15a}{16b}$
7.40	2 r				
7.41	0.55 h	7.65	$\frac{1}{7}$ rs	7.88	$\frac{8f}{15k}$
7.42	0.44 y				
7.43	12a+5c	7.66	$\frac{5}{6}$ mn	7.89	$6\frac{2r}{3t}$
7.44	m+2n+3p	7.67	a	7.90	$9\frac{1m}{2n}$

Chapter No. 8

8.1	5 b	8.10	1	8.19	- n
8.2	5 a	8.11	- 2	8.20	20 b
8.3	2 x	8.12	2	8.21	- 12 m
8.4	0	8.13	30	8.22	0
8.5	- 3 b	8.14	20	8.23	- a
8.6	- x	8.15	0	8.24	- 13 a
8.7	- 11 d	8.16	0	8.25	1
8.8	- 7 e	8.17	14 a	8.26	- 18
8.9	- 2	8.18	a	8.27	- 30

8.28 -13

8.29 $+72$

8.30 $+14$

8.31 $-6a$

8.32 $-35b$

8.33 $-30b$

8.34 $-22x$

8.35 $-35ac$

8.36 $-24bd$

8.37 $-18bx$

8.38 $-16ax$

8.39 mn

8.40 $-mn$

8.41 $-9ab$

8.42 $-5bd$

8.43 $-4cx$

8.44 $-4xy$

8.45 $-x$

8.46 $-b$

8.47 $-a$

8.48 a

8.49 $-x$

8.50 6

8.51 $-2b$

8.52 $-5x$

8.53 $-3a$

8.54 $-5b$

8.55 m

8.56 3

8.57 $2a+5$

8.58 $6b+8$

8.59 $4a-b$

8.60 $2a+8$

8.61 $7x+y$

8.62 $9a+5b$

8.63 22

8.64 15

8.65 $10-a$

8.66 $16-b$

8.67 $3a-8$

8.68 $4x-12$

8.69 $3m$

8.70 $-2d$

8.71 $3x-6$

8.72 $2c-18$

8.73 $y-z$

8.74 $2l-m-n$

8.75 $5x+15$

8.76 $9b-36$

8.77 $6c+6c$

8.78 $7d+7e$

8.79 $-4f-6$

8.80 $-15m-20$

8.81 $8x+20y$

8.82 $15b-20d$

8.83 $ax-b$

8.84 $cd+c$

8.85 $-ax+bx-ax$

8.86 $-5a-5y+5z$

8.87 $a+c$

8.88 $2x+2y$

8.89 $5m+2n$

8.90 $3c+a$

8.91 $a+b$

8.92 $b+c$

8.93 $2e+d$

8.94 $3h+i$

8.95 $\frac{4}{y}+\frac{3}{x}+\frac{z}{xy}$

8.96 $4-2c$

8.97 -3

8.98 8

8.99 25

8.100 150

8.101 132

8.102 183

8.103 $-6a-b-15$

8.104 $4x+y$

8.105 $10c-11m$

8.106 $-m+n$

8.107 $2ab-4ac$

8.108 $-21ds$

8.109 a^2+2a+1

8.110 a^2-2a+1

8.111 a^2-1

8.112 x^2+4x+4

8.113 $4a^2+8a+4$

8.114 $9x^2-16$

8.115 $ab+4a+3b+12$

8.116 $ax-ay+bx-by$

8.117 $a^2+b^2+2ab+ac+bc$

8.118 $x^2-y^2+cx+cy$

8.119 65

8.120 460

8.121 $4(a+b)$

8.122 $5(x+y)$

8.123 $4(de-f)$

8.124 $y(r-u-t)$

8.125 $a(b-c-1)$

8.126 $m(x+y-1)$

8.127 $6(12a+4b-7c)$

8.128 $3x(12y-3z-2a)$

8.129 $3b(6c+4d-1)$

8.130 $m(25n+5p-1)$

Chapter No. 9

9.1	$x = 8$	9.28	$x = 29$	9.55	$x = 7$
9.2	$x = 22$	9.29	$x = 5$	9.56	$x = 3$
9.3	$x = 22$	9.30	$x = 8$	9.57	$x = 5$
9.4	$x = 24$	9.31	$x = 28$	9.58	$x = 4$
9.5	$x = -4$	9.32	$x = 6$	9.59	$x = 7$
9.6	$x = 2$	9.33	$x = 9$	9.60	$x = 7$
9.7	$x = 2.5$	9.34	$x = 1$	9.61	$x = 13$
9.8	$x = -15$	9.35	$x = 1$	9.62	$x = 14$
9.9	$x = a+b$	9.36	$x = 8$	9.63	$x = 6$
9.10	$x = a+b$	9.37	$x = 1$	9.64	$x = 14$
9.11	$x = k+m+n$	9.38	$x = 25$	9.65	$x = 1.5$
9.12	$x = k-m+n$	9.39	$x = 7.4$	9.66	$x = 8$
9.13	$x = -8$	9.40	$x = 0.8$	9.67	$x = 5$
9.14	$x = 10$	9.41	$x = 7$	9.68	$x = 3$
9.15	$x = 48$	9.42	$x = 6$	9.69	$x = -4$
9.16	$x = 0$	9.43	$x = 8$	9.70	$x = 4$
9.17	$x = 9$	9.44	$x = 8$	9.71	$x = 1$
9.18	$x = 8$	9.45	$x = 4$	9.72	$x = 3$
9.19	$x = a-b$	9.46	$x = 7$	9.73	$x = 7$
9.20	$x = b-a$	9.47	$x = 3$	9.74	$x = 5$
9.21	$x = 2a+b$	9.48	$x = 3$	9.75	$x = 13.5$
9.22	$x = r+s-t$	9.49	$x = b-a$	9.76	$x = 1$
9.23	$x = n$	9.50	$x = c-m$	9.77	$x = 17$
9.24	$x = -b$	9.51	$x = 4.5$	9.78	$x = 3$
9.25	$x = 1$	9.52	$x = 4$	9.79	$x = 13$
9.26	$x = 5$	9.53	$x = 10$	9.80	$x = 2$
9.27	$x = 5$	9.54	$x = 10$		

Chapter No. 10

10.1	$x = 0.6$	10.10	$x = -11$	10.19	$x = \frac{2}{3}$
10.2	$x = 5.5$	10.11	$x = -0.2$	10.20	$x = 0.8$
10.3	$x = 0.2$	10.12	$x = -0.4$	10.21	$x = \frac{U}{3.14}$
10.4	$x = 0.1$	10.13	$x = 3a$	10.22	$x = \frac{U}{2}$
10.5	$x = 0.8$	10.14	$x = 2$	10.23	$x = 6A$
10.6	$x = 0.6$	10.15	$x = 2$	10.24	$x = 3a$
10.7	$x = 53$	10.16	$x = 4a$	10.25	$x = 2$
10.8	$x = 1250$	10.17	$x = 3c$		
10.9	$x = -5$	10.18	$x = 5a$		

10.26 $x = 6$

10.27 $x = \frac{a}{bc}$

10.28 $x = \frac{ab}{c}$

10.29 $x = 7$

10.30 $x = 1$

10.31 $x = 7$

10.32 $x = 4$

10.33 $x = 5$

10.34 $x = 8$

10.35 $x = 9$

10.36 $x = 7$

10.37 $x = 7$

10.38 $x = 6$

10.39 $x = 8$

10.40 $x = 3$

10.41 $x = 1$

10.42 $x = 10$

10.43 $x = \frac{b+c}{a}$

10.44 $x = \frac{a-c}{b}$

10.45 $x = \frac{a}{n}$

10.46 $x = \frac{a}{b}$

10.47 $x = 7$

10.48 $x = 3$

10.49 $x = 6$

10.50 $x = 4$

10.51 $x = 5-b$

10.52 $x = b$

10.53 $x = 3$

10.54 $x = 1$

10.55 $x = 5$

10.56 $x = 2$

10.57 $x = 4$

10.58 $x = 7$

10.59 $x = -1$

10.60 $x = 9$

10.61 $x = 2$

10.62 $x = -1$

10.63 $x = -3$

10.64 $x = 24$

10.65 $x = \frac{a}{b+c}$

10.66 $x = \frac{a}{a+2}$

10.67 $x = 1$

10.68 $x = \frac{1}{a-n}$

10.69 $x = \frac{15}{a-5}$

10.70 $x = 1$

10.71 $x=21$; $x=18$

10.72 $x=14$; $x=7.56$

10.73 $x=bc$; $x=a$

10.74 $x=ab$; $x=a$

10.75 $x=15$; $x=36$

10.76 $x=8$; $x=3$

10.77 $x=6$; $x=0.6$

10.78 $x=2\frac{2}{3}$; $x=\frac{1}{3}$

10.79 $x = 8$

10.80 $x = t$

10.81 $x = 18$

10.82 $x = 250$

10.83 $x = 21$

10.84 $x = 50$

10.85 $x = 16$

10.86 $x = 25$

10.87 $x = 4$

10.88 $x = 3$

10.89 $x = 2.5$

10.90 $x = 1$

10.91 $x = 15$

10.92 $x = 15$

10.93 $x = 4.5$

10.94 $x = 4$

10.95 $x = 2.1$

10.96 $x = 20$

10.97 $x = 30$

10.98 $x = 32$

10.99 $x = 12$

10.100 $x = 60$

10.101 $x = 0.25$

10.102 $x = 7.5$

10.103 $x = 2a$

10.104 $x = 4b$

10.105 $x = 2.5\ a$

10.106 $x = 3b$

10.107 $x = b$

10.108 $x = 1.8\ d$

10.109 $x = 2.5$

10.110 $x = 0.5$

10.111 $x = 0.5$

10.112 $x = 18$

10.113 $a = \frac{bc}{d}$

10.114 $b = \frac{ad}{c}$

10.115 $c = \frac{ad}{b}$

10.116 $d = \frac{bc}{a}$

10.117 $5:8 = b:a$

10.118 $P:Q = b:a$

Chapter No. 11

11.1 a) 169; 1849; 8084; 76729; 201601; 809961
b) 196; 2025; 6241; 142129; 422500; 831744
c) 56.25; 453.69; 0.49; 0.0036; 0.0529; 0.000121
d) 72.25; 723.61; 0.81; 0.0016; 0.0289; 0.000441

11.2 a) $(6.4)^2 = 40.96$ $(10.5)^2 = 110.25$
$(6)^2 = 36$ $(10)^2 = 100$
$(7)^2 = 49$ $(11)^2 = 121$

$(0.537)^2 = 0.288369$ $(4356)^2 = 18922500$
$(0.5)^2 = 0.25$ $(4000)^2 = 16000000$
$(0.6)^2 = 0.36$ $(5000)^2 = 25000000$

b) $(8.77)^2 = 76.9129$ $(27.7)^2 = 767.29$
$(8)^2 = 64$ $(20)^2 = 400$
$(9)^2 = 81$ $(30)^2 = 900$

$(0.055)^2 = 0.003025$ $(7220)^2 = 52128400$
$(0.05)^2 = 0.0025$ $(7000)^2 = 49000000$
$(0.06)^2 = 0.0036$ $(8000)^2 = 64000000$

c) $(7.7)^2 = 59.29$ $(12.6)^2 = 158.76$
$(7)^2 = 49$ $(12)^2 = 144$
$(8)^2 = 64$ $(13)^2 = 169$

$(0.183)^2 = 0.033489$ $(5650)^2 = 31922500$
$(0.1)^2 = 0.01$ $(5000)^2 = 25000000$
$(0.2)^2 = 0.04$ $(6000)^2 = 36000000$

d) $(9.34)^2 = 87.2356$ $(33.4)^2 = 1115.56$
$(9)^2 = 81$ $(30)^2 = 900$
$(10)^2 = 100$ $(40)^2 = 1600$

$(0.045)^2 = 0.002025$ $(6800)^2 = 46240000$
$(0.04)^2 = 0.0016$ $(6000)^2 = 36000000$
$(0.05)^2 = 0.0025$ $(7000)^2 = 49000000$

11.3 a) $\sqrt{6} = 2.4495$ $(2^2 = 4 < 6 < 3^2 = 9)$

$\sqrt{60} = 7.7460$ $(49 < 60 < 64)$

$\sqrt{355} = 18.8414$ $(100 < 355 < 400)$

$\sqrt{3500} = 59.161$ $(2500 < 3500 < 3600)$

$\sqrt{6.3} = 2.50998$ $(4 < 6.3 < 9)$

b) $\sqrt{7} = 2.6458$ $(2^2 = 4 < 7 < 3^2 = 9)$

$\sqrt{70} = 8.3666$ $(64 < 70 < 81)$

$\sqrt{478} = 21.8632$ $(400 < 478 < 500)$

$\sqrt{4780} \approx 69.1$ $(3600 < 4780 < 4900)$

$\sqrt{7.5} = 2.73861$ $(4 < 7.5 < 9)$

c) $\sqrt{0.6} = 0.77460$ $(0.7^2 = 0.49 < 0.6 < 0.8^2 = 0.64)$

$\sqrt{0.85} = 0.92195$ $(0.81 < 0.85 < 1.00)$

$\sqrt{0.06} = 0.24495$ $(0.04 < 0.06 < 0.09)$

$\sqrt{0.085} = 0.291548$ $(0.04 < 0.085 < 0.09)$

d) $\sqrt{0.7} = 0.83666$ $(0.8^2 = 0.64 < 0.7 < 0.9^2 = 0.81)$

$\sqrt{0.93} = 0.96437$ $(0.81 < 0.93 < 1.00)$

$\sqrt{0.07} = 0.26458$ $(0.04 < 0.07 < 0.09)$

$\sqrt{0.093} = 0.304959$ $(0.09 < 0.093 < 0.16)$

e) $\sqrt{4650} = 68.2$ $(3600 < 4650 < 4900)$

$\sqrt{36.75} \approx 5.98$ $(25 < 35.75 < 36)$

$\sqrt{27.35} \approx 5.29$ $(25 < 27.35 < 36)$

$\sqrt{7855} \approx 88.6$ $(8400 < 7855 < 8100)$

f) $\sqrt{5620} \approx 75.0$ $(4900 < 5620 < 6400)$

$\sqrt{48.62} \approx 6.97$ $(36 < 48.62 < 49)$

$\sqrt{45.36} \approx 6.73$ $(36 < 45.36 < 49)$

$\sqrt{8495} \approx 92.2$ $(8100 < 8495 < 10000)$

g) $\sqrt{72400} \approx 269.072$ $(200^2 = 40000 < 72400 < 300^2 = 90000)$

$\sqrt{654500} \approx 809$ $(640000 < 654500 < 810000)$

$\sqrt{95150} \approx 308$ $(90000 < 95150 < 160000)$

$\sqrt{936300} \approx 968$ $(810000 < 936300 < 1000000)$

11.4 a) 36 mm; b) 49 cm; c) 86 dm; d) 146 m

Chapter No. 12

12.1 8; 27; 64; 125

12.2 16; 81; 256; 625

12.3 $2a^3$

12.4 $2m^3$

12.5 $7a^2$

12.6 a^3

12.7 $36a^2$

12.8 $25b^2$

12.9 $12c^5$

12.10 $15n^6$

12.11 $125a^6$

12.12 $9b^6$

12.13 8000

12.14 1296

12.15 125

12.16 36

12.17 30

12.18 28

12.19 5; 14

12.20 33; 7

12.21 33

12.22 78

12.23 11.1808

12.24 18.5203

12.25 5.1962; 11.1803

12.26 14.0909; 625

12.27 0.7454; 0.4330

12.28 0.5292; 0.4714

12.29 x = 2

12.30 x = 1

12.31 x = 6

12.32 x = 5

12.33 x = 4

12.34 x = 5

12.35 x = 3

12.36 x = 4 or 0

12.37 x = 7

12.38 x = 5

12.39 x = 3 or 0

12.40 x = 7 or 0

12.41 x = 25

12.42 x = 11

12.43 x = -2

12.44 x = 3

12.45 x = 49

12.46 x = 25

12.47 x = 196

12.48 x = 169

12.49 x = 12

12.50 x = 45

12.51 x = 84

12.52 x = 18

12.53 x = 8

12.54 x = 8

12.55 x = 8

12.56 x = 13

12.57 $x = x^2 + a$

12.58 $x = 9b^3 - b$

12.59 0.00000017; 0.0625

12.60 0.0000036; 0.0015

12.61 0.0278

12.62 1.8

12.63 937×10^{12}

12.64 4.44×10^{-9}

12.65 3

12.66 2.085

12.67 $h = \frac{A \times 2}{g}$

12.68 $R_2 = R - R_1 - R_3$

12.69 $d = \sqrt[3]{\frac{V \times 6}{\pi}}$

12.70 $I = \sqrt{\frac{P}{R}}$

12.71 $I = \frac{\pi \times d \times A}{2 \times t}$

12.72 $V_2 = P_1 - P_2 - V_1$

12.73 $n = \frac{v \times 60}{\pi \times d}$

12.74 $I = \frac{E - V}{R}$

12.75 $R_1 = \frac{R_2 \times R_3}{R_2}$

12.76 $X = \sqrt{Z^2 - R^2}$

12.77 $R_1 = \frac{E}{I} - R_2$

12.78 $t = \frac{W}{E \times I}$

12.79 $D = d_m \times 2 - d$

12.80 $t_1 = t_2 - \frac{\delta}{v}$

Chapter No. 13

13.1 0.662 m; 0.034 m; 7.24 m; 0.083 m; 3.372 m

13.2 53.2 dm; 0.724 dm; 0.76 dm; 4.08 dm; 4.18 dm

13.3 4750 mm; 347 mm; 838 mm; 40 mm; 85.2 mm

13.4 851.2 cm

13.5

a	b	c	d	e
1.82 m	1.20 m	2.5 m	0.0005 m	0.002 m
18.2 dm	12.0 dm	25 dm	0.005 dm	0.02 dm
182 cm	120 cm	250 cm	0.05 cm	0.2 cm
1820 mm	1200 mm	2500 mm	0.5 mm	2 mm

13.6 a) 12; b) 243.5 mm

13.7 a) 12.47 m x 7.82 m; b) 13.26 m

13.8 95.25 mm

13.9

	$1\frac{3}{4}$	$1\frac{1}{4}$	$3\frac{7}{8}$	$4\frac{1}{8}$	$7\frac{3}{8}$	$11\frac{1}{2}$
mm	44.45	31.75	98.425	104.775	187.325	292.1

		a	b	c	d	e	f
13.10	mm^2	4705	900	8000	48606	234800	4550000
13.11	cm^2	8.973	384.85	80	0.69785	3608.98	40360
13.12	dm^3	0.00348	3.8405	92.5	0.00008	0.0375	9634.5
13.13	m^3	0.038403	68.4923	0.8493	0.0008964	0.014258	0.000043
13.14	ha	879.3456	63.898	14258	0.05435	0.0908	8.6

	a	b	c	d
13.15	150.9615 m^2	16400 mm^2	537850 cm^2	0.92 dm^2
13.16	37.3 dm^2	2.36 cm^2	2.45 m^2	359.5 cm^2

		a	b	c
13.17	mm^3	485000	92721000	7500000
13.18	cm^3	8.76	486000	985000
13.19	dm^3	4.865432	9,621	956
13.20	m^3	0.008653279	0.009621	0.00807
13.21	ltr.	0.004	0.5	50

		d	g	f
13.17	mm^3	9285340000	400000	2739000000
13.18	cm^3	0.09386	8350	42000
13.19	dm^3	0.030635	0.0483	28750
13.20	m^3	0.068253428	0.0000058	0.024325
13.21	ltr.	200	82.5	1.66

	a	b	c	d	e
13.22	5.1 dm^3	41018 dm^3	804.17 cm^3	55.5 ℓ	700.36 dm^3
13.23	401.7 dm^3	99.4 cm^3	3000.06 dm^3	51 ℓ	53 ℓ

Chapter No. 14

14.1 i) a) 225 mm^2; b) 576 mm^2; c) 1296 mm^2; d) 2025 mm^2; e) 3136 mm^2

ii) a) 2.25 cm^2; b) 5.76 cm^2; c) 12.96 cm^2; d) 20.25 cm^2; e) 31.36 cm^2

iii) a) 0.000225 m^2; b) 0.000576 m^2; c) 0.001296 m^2; d) 0.002025 m^2; e) 0.003136 m^2

14.2 2.125 m^2

14.3 a) 9.26 mm; b) 19.63 mm; c) 36.95 mm; d) 75.06 mm; e) 108.7 mm

14.4 $598.325\ m^2 \approx 600\ m^2$

14.5 a) $33.52\ m^2$; b) $43\ m^2$; c) 17.6 m

14.6

	a	b	c	d
L-shape	684 mm^2	425 mm^2	384 mm^2	464 mm^2
T-shape	684 mm^2	425 mm^2	384 mm^2	464 mm^2
U-shape	888 mm^2	600 mm^2	388 mm^2	688 mm^2
H-shape	888 mm^2	600 mm^2	388 mm^2	688 mm^2

14.7 b) $0.950\ mm^2$; c) $0.502\ mm^2$; d) $0.196\ mm^2$; e) $0.0314\ mm^2$

14.8

$A\ (mm^2)$	1.5	2.5	4	6	10	16	29
d (mm)	1.38	1.78	2.26	2.76	3.57	4.52	5.65

14.9 a) d = 1.84 mm; b) d = 2.26 mm; c) d = 3.11 mm

14.10

	a	b	c	d	e
d_0 (mm)	(4)	22	(55)	(75)	32
d_1 (mm)	2	(17)	(49)	68	24
d_2 (mm)	3	19.5	52	(72)	(28)
e (mm)	(1)	12.5)	3	3	(4)
Σd_n (mm)	9.42	61.2	161	226	88
$A\ (mm^2)$	9.42	153	490	678	352

14.11 a) 566 mm; b) 640 mm; c) 671 mm; d) 652 mm; e) 1118 mm

14.12 a) $A = 6\ cm^2$, D = 36.1 mm; b) $A = 2.25\ cm^2$, D = 21.2 mm; c) t_2 = 25 mm, B = 35.4 mm

d) t_1 = 21.2 mm, $A = 4.49\ cm^2$; e) t_1 = 36.8 mm, $A = 7.81\ cm^2$

Chapter No. 15

15.1 60 litres

15.2

a	b	c	d	e
A=2.01 dm^2	A=3.14 dm^2	A=4.52 dm^2	mm	A=8.05 dm^2
V=2.81 ℓ	h=169 mm	V=9.04 ℓ	example	d=320 mm

15.3 154 kg (approx.)

15.4 Rx 46.46

15.5 305.1 kg

15.6 64.1 kg (approx.)

15.7 31 t (approx.)

15.8

	a	b	c	d
L and T	1850 g	1150 g	767 g	1250 g
U and S	2400 g	1620 g	1050 g	1860 g

15.9 a) 1.53 kg; b) 8.89 kg; c) 37.2 kg

15.10 a) 26700 g; b) 4050 g; c) 51.7 g; d) 199 g; e) 121 g; f) 295 g

15.11 12.9 kg

15.12 0.385 kg

15.13 26.35 kg

15.14 a) 6.165 m^2; b) 72.6 kg; c) 2.59 m^3

Chapter No. 16

16.1

	a	2a	c	2c
a) Cu 0.15mm	0.0195mm	0.0370mm	0.0520mm	0.0820mm
b) Cu 0.4 mm	0.0235mm	0.0385mm	0.0635mm	0.1135mm
c) Cu 0.8 mm	0.0260mm	0.0460mm	0.0660mm	0.1160mm
d) Cu 1.5 mm	---	0.0600mm	0.0700mm	0.1200mm

16.2

	a	b	c	d
d_n in mm	18.189	35.527	60.852	87.740
c_n in mm	57.143	111.612	191.298	275.644

16.3 a) 119.4 mm ; b) 157.7 mm; c) 215.1 mm

16.4 a) 223; b) 107; c) 446; d) 189

16.5 a) 200 mm; b) 90.5 m ; c) 101 g

16.6 574

16.7 a) 3.2 mm; b) 196 mm; c) 1.145 mm

16.8 a) N = 1000; l = 200.1km b) h = 32 mm; l = 79/m c) h = 109 mm; l = 1990 m

16.9 533 m

16.10 688 m

16.11 64 m (approx.)

16.12 165 mm

16.13 a) 160 mm; b) 183 mm; c) 233 mm; d) 280 mm; e) 352 mm

16.14

	a) a_1 = 30 cm	b) a_1 = 50 cm
i)	42 → 42	25.2 → 24
ii)	43	27
iii)	30 cm	48.5 cm

16.15 a) 150 cm; b) 90 cm; c) 460 cm; d) 370 cm

16.16 a) ℓ_1 = 92.5 mm; ℓ_2 = 187.5 mm; ℓ_3 = 133.5 mm
b) ℓ_1 = 37 mm; ℓ_2 = 75 mm; ℓ_3 = 53.4 mm
c) ℓ_1 = 7.4 mm; ℓ_2 = 15 mm; ℓ_3 = 10.7 mm

Chapter No. 17

	a	b	c	d	e	f
17.1	360°	180°	120°	90°	72°	30°
17.2	90°+270°	270°+90°	30°+330°	0°+360°	360°+180°	120°+240°
17.3	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{12}$	$\frac{1}{10}$	$\frac{1}{5}$
17.4	30'	20'	15'	12'	10'	6'
17.5	0.33°	0.50°	0.75°	0.83°	0.97°	30°
17.6	0.33'	0.67'	0.75'	0.83'	0.93'	0.10'
17.7	6.28 rad	3.14 rad	1.57 rad	0.785 rad	1.50 rad	1.00 rad

17.8 a) 7.256 [dm] 1256 cm
b) 115°; 9.61 cm
c) 0.667 rad; 38.24°

17.9 a) 600 mm; b) 1500 mm; c) 942 mm

	a	b	c	d	e	f
17.10	0.50 min.	0.33 min.	0.67 min.	0.83 min.	0.58 min.	1.17 min.
17.11	150 min.	378 min.	255 min.	18 min.	12 min.	1440 min.
17.12	3h+20m.	7h+30m.	2h+2min.	3h+25m.	12h+30m.	16h+40m.
17.13	10m.+40s	9m.+5s	2m.+35s	30m.+5s	3m.+2s	16m+40s

17.14

	a	b	c	d
Ra 7.40	59.20	296.-	1295.--	15540.-
ro 7.70	61.60	308.-	1347.50	16170,-
Ra 8.65	69.20	346.-	1513.75	18165.-

17.15 1.33 h

17.16 40 min. & 19.2 s

17.17

	Departure	Travelling time	Arrival
a)	(0^h 0^m 0^s)	4h 51min.40s	4^h 51^m 40^s
b)	(13^h 30^m 0^s)	1h 37min.30s	15^h 7^m 30^s
c)	(9^h 15^m 30^s)	1h 56min.40s	11^h 12^m 10^s
d)	20^h 40^m 0^s	3h 20min. 0s	(24^h 0^m 0^s)
e)	15^h 7^m 45^s	4h 18min.20s	(19^h 22^m 5^s)
f)	9^h 27^m 15^s	5h 37min. 0s	(15^h 4^m 15^s)

17.18 8.33 $\frac{m}{s}$; 32.14 $\frac{km}{h}$

17.19

	v (km/h)	v (m/s)	Distance (m)	Time
a)	3.6 km/h	1 m/s	(1800 m)	(30 min.)
b)	(5 km/h)	1.39 m/s	(10 m)	7.2 s
c)	(120 km/h)	33.56 m/s	70 km	($1\frac{1}{2}$ h)
d)	(50 km/h)	13.9 m/s	(20 m)	1.44 s
e)	216 km/h	60 m/s	(300 m)	(5 s)
f)	1200 km/h	333 m/s	2000 m	(6 s)
g)	5350 km/h	1485 m/s	($385x10^5$m)	(3 days)
h)	$1.08x10^9$km/h	($3x10^8$m/s)	($385x10^5$m)	1.28 s

17.20 a) 10 km/h; b) 18 s; c) 0.45 km;
d) 47.2 m/s; e) 85 m (approx.)

17.21 a) $\mu = 10.5 \frac{rad}{s}$; $r = 0.1$ m; $v = 1.05 \frac{m}{s}$

b) $\mu = 208 \frac{rad}{s}$; $r = 0.4$ m; $v = 83.6 \frac{m}{s}$

c) $n = 3000 \frac{U}{min}$; $r = 0.15$ m; $v = 47.1 \frac{m}{s}$

17.22 a) 5 s; b) 31.25 m

Chapter No. 18

18.1

	a	b	c	d	e
F(in N)	9.81 N ≈10 N	9.81 mN ≈ 10 mN	9810 N ≈10000 N	3.81μ N ≈10μ N	4.9 N ≈5 N

18.2 225 N

18.3 50000 N

18.4 a) 180 N; b) 20 N

18.5 a) 31 N; b) 92 N; c) 99 N; d) 100 N;
e) 50 N; f) 26 N; g) zero

18.6

	a	b	c	d	e	f	g
F_G(in N)	85	104	8.4	291	4.8	300	0.73

18.7 $F_1 = F_2 = 1720$ N

18.8 $F_1 = 3110$ N and $F_2 = 2380$ N

	a	b	c	d	e	f
18.9	73600 Nm	78500 kNm	23500 Nm	23500 Nm	2940 Nm	98100 Nm
18.10	4.5 Nm	1.44 Nm	12,5 N	0.667 m	40 Nm	4905 Nm
18.11	200 kN	100 kN	30 kN	8000 N	2400 N	400 N

18.12 589 N ≈ 600 N

18.13 327 N

18.14 a) 20 cm = 0.2 m; b) a : b = 3 : 1 and F : W = 1 : 2
c) 350 N
d) By using more pulleys, i.e. increasing $\frac{W}{F}$

18.15 618 N

18.16 687 N

18.17 19.6 N ≈ 20 N

18.18 810 N

18.19 75 % can be safed

18.20

a	b	c	d	e	f
60 Mn	240 N	300 N	400 N	480 N	600 N

18.21

a	b	c	d	e
100 N	80 N	44.7 N	55.4 N	50 N

18.22 980 N

18.23 7860 N

18.24 51850 N

18.25 a) 221 N; b) 147 N; c) 198 N; d) 132 N

18.26 F_B = 376 N) > 608 N
F_A = 232 N)

18.27 160 mm

18.28 a) 0.375 kW; b) 7.2 kW; c) 5.0 kW; d) 3600 kW

18.29 a) (13.3 hp) = 9.92 kW = 9920 Nm/s
b) 0.2 hp = 10.149 kW = 149 Nm/s
c) (4 hp) = 2.98 kW = 2980 Nm/s
d) 1.5 hp = 1.119 kW = 1190 Nm/s

18.30 a) 1.07 hp b) 1.47 hp c) 2.01 hp d) 2.95 hp
e) 4.09 hp f) 5.36 hp g) 7.37 hp

18.31 1.5 kW ≈ 2 hp

18.32 1.870 kW

18.33 1 h 19 min.

18.34 133 kW→13.6 m^3

18.35 0.818

18.36 a) 14.92 kW b) 15 kW c) 16.7 kW d) 0.898

18.37 0.535

18.38

a	b	c	d
P_{out}=8.5kW P_L =1.5kW	P_{out}=1.2kW η =0.867	P_L=0.75kW η =0.664	P_{in}=4kW P_{out}=2.8kW

18.39

	a	b	c	d
P (in N)	(500 N)	16.0 kN	44.1 kN	(720 N)
s (in m)	(1.50 m)	(14 m)	(12 m)	(5 m)
W (in Nm)	750 Nm	84 kNm	529 kNm	(3.6 kNm)
t (min,s)	(2 s)	15.27 s	(3 min.)	8 s
P_{out} ($\frac{Nm}{s}$)	375 $\frac{Nm}{s}$	5500 $\frac{Nm}{s}$	2940 $\frac{Nm}{s}$	(490 $\frac{Nm}{s}$)
P_{out} (in hp) (in kW)	0.50 hp 0.375 kW	7.37 hp (5.5 kW)	3.94 hp 2.94 kW	0.60 hp 0.45 kW
P_{el} (in W)	125 W	750 W	(1200 W)	300 W
P_{in} (in kW)	(0.5 kW)	6.25 kW	4.14 kW	0.75 kW
η = ?	0.75	(0.88)	0.71	(0.6)

18.40

a	b	c	d
2.75 kN	5.93 kN	9 kN	12.1 kN

18.41 3 kN

18.42 7.43 kN

Chapter No. 19

19.1 a) +0.5 % b) +0.05 % c) -0.5 % d) +0.05 %

19.2	a) 18.9	b) 306	c) 0.326	d) 0.0436	e) 0.424
	f) 268000	g) 30.0	h) 926000	i) 0.404	k) 7260

19.3	1-2-1	1-2-5	1-3-0	1-3-6	1-4-0
	3-0-2	3-1-0	3-1-4	3-3-0	3-3-8
	6-4-5	7-2-0	7-5-5	7-7-7	8-0-9

19.4	a) 6.00	b) 14.0	c) 330	d) 12500	e) 0.684
	f) 1900	g) 52100	h) 1200	i) 91.5	k) 0.0384

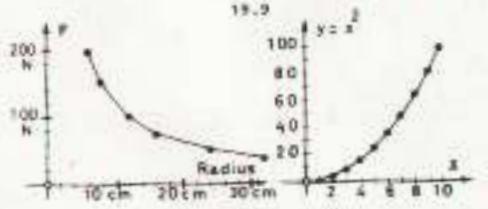
19.5	a) 60	b) 1.25	c) 31.5	d) 0.192	e) 16100
	f) 220	g) 220	h) 0.00229	i) 0.00168	k) 67900

19.6

19.7

19.8

19.9



Chapter No. 20

20.1 a) 150000 V; b) 4 kV; c) 0.037 kV

20.2 a) 380 kV; b) 3 mV; c) 2 mV

20.3 V = 0 ... 0.04 V

20.4 V = 0.0277 V

20.5

a	b	c	d	e	f	g
10000 V	750 V	0.125 V	0.015 V	5.25 kV	0.4 kV	12500 V

20.6 a) 1200 kV; b) 40 mV

20.7 0.0009 A

20.8 0.3mA

20.9

a	b	c	d	e	f
30 µA	35 A	2,1 A	7,5 µA	82,2 mA	0,06 µA

20.10 a) 1250 mA = 1250000 µA b) 0,075 A = 75000 µA c) – = 8,25 mA d) 73 mA = 73000 µA

e) – = 580 µA f) – = 0,48 mA g) 70 mA = 70000 µA

20.11 520 mA

20.12 a) 5,5 A b) 0,4 mA

20.13 a) 40000 Ω ; b) 160 Ω ; c) 1200000 Ω ; d) 300000 Ω

20.14 a) 63 k Ω ; b) 2,5 MΩ c) 0,8 m Ω

20.15 a) – = 0,68 k Ω b) – = 1200 Ω ; c) 2400 kΩ = 2400000 Ω ; d) 560 kΩ = 560000 Ω ;

e) 0,045 MΩ = 45 kΩ f) 20 kΩ = 20000 Ω ; g) – = 13800 Ω

20.16	30 V	110 V	170 V	215 V	270 V
20.17	6 A	16 A	32 A	19 A	47 A

20.18

	scale graduations					
	1	2	8	16.5	20	25
a)	10 V	20 V	80 V	165 V	200 V	250 V
b)	2 V	4 V	16 V	33 V	40 V	50 V
c)	0.4 V	0.8 V	3.2 V	6.6 V	8 V	10 V
d)	0.1 V	0.2 V	0.8 V	1.65 V	2 V	2.5 V
e)	0.4 A	0.8 A	3.2 A	6.6 A	8 A	10 A
f)	0.1 A	0.2 A	0.8 A	1.65 A	2 A	2.5 A
g)	20 mA	40 mA	160 mA	330 mA	400 mA	500 mA
h)	4 mA	8 mA	32 mA	66 mA	80 mA	100 mA

20.19

	1	3	14	25	38	47
a)	10 V	30 V	140 V	250 V	380 V	470 V
b)	2.5 V	7.5 V	35 V	62.5 V	95 V	117.5 V
c)	0.5 V	1.5 V	7 V	12.5 V	19 V	23.5 V
d)	0.2 V	0.6 V	2.8 V	5 V	7.6 V	9.4 V
e)	0.2 A	0.6 A	2.8 A	5 A	7.6 A	9.4 A
f)	0.04 A	0.12 A	0.56 A	1 A	1.52 A	1.88 A
g)	10 mA	30 mA	140 mA	250 mA	380 mA	470 mA
h)	3 mA	6 mA	28 mA	50 mA	76 mA	94 mA

20.20

	1	0.25	0.9	1.35	2.05	2.8
a)	200 V	50 V	180 V	270 V	410 V	560 V
b)	40 V	10 V	36 V	54 V	82 V	112 V
c)	10 V	2.5 V	9 V	13.5 V	20.5 V	28 V
d)	2 V	0.5 V	1.8 V	2.7 V	4.1 V	5.6 V
e)	2 A	0.5 A	1.8 A	2.7 A	4.1 A	5.6 A
f)	0.4 A	0.1 A	0.36 A	0.54 A	0.82 A	1.12 A
g)	100 mA	25 mA	90 mA	135 mA	205 mA	280 mA
h)	20 mA	5 mA	18 mA	27 mA	41 mA	56 mA

Chapter No. 21

21.1

a	b	c	d	e	f	g	h	i
200 V	300 V	160 V	4 A	5 A	8 A	40Ω	7Ω	12Ω

21.2 9 V

21.3 4 A (same current in both the conductors)

21.4 22 Ω

21.5 0.125 Ω

21.6 62.5 V

21.7 960 Ω

21.8

a	b	c	d	e	f	g	h
0.765V	363V	0.544A	356 Ω	104V	9.45Ω	4.01V	0.409A

21.9 288 V

21.10 1100 A

21.11 750 A

21.12 0.25 Ω

21.13 120 Ω

21.14 0 A — 1 A — 3.64 A — 6.83 A

21.15 6.88 A

21.16 a) 120 Ω; b) 1.83 A; c) Overloaded, winding will burnout!

21.17

a	b	c	d	e	f	g
1 A	1.67 A	2.5 A	3.33 A	4.58 A	5.21 A	9.17 A

21.18 0.206 Ω

21.19 a) 15 A b) 167 A c) 0.458 A d) 27.5 A

21.20 a) 250 V b) 333 Ω c) 1.9 MΩ
d) 2.57 V e) 825 µA f) 686 mΩ
g) 456 V h) 472 V i) 6.44 kΩ

21.21 21.7 mA

21.22 40 kΩ

21.23 4.32 V

21.24 100 mV

21.25 32 mA

21.26 25 mΩ

21.27 4,5 MΩ

21.28 4 V

21.29 15 MΩ

21.30 133 µA

21.31 625 kΩ (within the limits)

21.32 1.5 mA

21.33 a) I = 0.4 A b) V = 2600 V
c) R = 733 Ω d) I = 5.5 A
e) I = 42.9 A f) R = 9.5 MΩ
g) V = 10.8 mV h) R = 727 Ω
i) I = 3 mA

21.34 a) 0.75 A b) 0.875 A c) 1.0 A

21.35 3.3 A

21.36

a) V-ratio	1	2	3	5	0.5	0.2	0.1
b) I-ratio	1	2	3	5	0.5	0.2	0.1
c) I in A	11.3	22.6	33.9	56.5	5.65	2.26	1.13

21.37 a) 1.82 A b) 3.24 A c) 8.1 A

21.38 14.4 V

x-axis	2V	4V	6V	8V	10V	12V	14V	16V
21.39 y-axis (10Ω)	0.2A	0.4A	0.6A	0.8A	1A	1.2A	1.4A	1.6A
21.40 y-axis (5Ω)	0.4A	0.8A	1.2A	1.6A	2A	2.4A	2.8A	3.2A

21.41 a) 4V b) 6V c) 8V d) 12.5V e) 16V

21.42 a) 150 V — 0.5 A b) 1 A — 300 V

21.43 Scale: 20 Ω ≙ 1 cm ≙ 1 A

21.44 x-axis: 220 Ω ≙ 11 cm; y-axis: 11 A ≙ 11 cm

Points for the curve:

20 Ω	27.5Ω	40 Ω	55Ω	80 Ω	110 Ω	160 Ω	220 Ω
11A	8A	5.5A	4A	2.75A	2A	1.375A	1A

21.45

a) I	0.23 A	0.92A	2.3 A	4.6 A	9.2 A
b) I-ratio	1	4	10	20	40
R-ratio	1	$\frac{1}{4}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{40}$

c) Resistance 1:$\frac{1}{2}$ (50 %) — current 1:2 (100 %)

21.46 0.05 S

21.47 0.2 S

21.48 a) 6A — 2A b) 6A — 18A

21.49 0.125 Ω

21.50 0.025 mS

21.51 0.002 mS = 2 µS

21.52 17.6 V

21.53 a) 10 mS b) 33.3 mS

21.54

a	b	c	d	e	f
0.08 S	0.05 mS	0.741Ω	34 S	0.0179Ω	66.7 S

Chapter No. 22

22.1 100 W

22.2 17 A

22.3 400 V

22.4 0.5 W; 12.5Ω

22.5 a) 1320 W; b) 2200 W; c) 3520 W

22.6

a	b	c	d	e
0.909 A	2.27 A	3.64 A	6.82 A	18.2 A

22.7

	a	b	c	d
I	0.435 A	0.109 A	0.208 A	0.833 A
R	529 Ω	2110 Ω	115 Ω	7.2 Ω

22.8 a) 3.2 V; b) 51.2 W

22.9 a) 5.05 V b) 78.8 W

22.10 a) 2 V — R = 20Ω; V = 80 V; I = 4 A; P = 320 W
b) 3 V — R = 20Ω; V = 120 V; I = 6 A; P = 720 W
c) V/2 — R = 20Ω; V = 20 V; I = 1 A; P = 20 W

22.11 34.2 Ω

22.12 110 Ω

22.13 a) 2 A b) 0.316 A c) 0.224 A
d) 1.41 mA e) 0.0632 A f) 0.4 A
g) 0.707 mA h) 2 mA

22.14 a) 10 V b) 3.54 V c) 387 V
d) 707 V e) 447 V f) 447 V
g) 7.75 V h) 1.58 V

22.15 a) I = 7.5 mA; R = 53.3 kΩ
b) V = 600 V; R = 800 Ω
c) I = 200 μA; P = 132 mW
d) I = 0.127 A; R = 1.73 MΩ
e) V = 671 V; I = 373 mA
f) P = 1 MW; R = 25 Ω

22.16 a) 2640 W; b) 2205 W; c) 0.835

22.17 22.7 A

22.18 a) 24.5 W; b) 98.1 W

Chapter No. 23

23.1

a	b	c	d
0.286 Ω	0.143 Ω	0.0625 Ω	0.0833 Ω

23.2

a	b	c	d
0.000714 Ω	0.0137 Ω	0.0208 Ω	75.0 Ω

23.3 0.0744 Ω

23.4 0.0312 Ω

23.5 0.0171 Ω

23.6

a	b	c	d
2.13	2.0	0.309	0.02

23.7 6.4 mm^2

23.8 a) 1.1×10^{-6} Ωm b) chromnickel

23.9 9.80 m

23.10 0.099 mm = 0.1 mm

23.11 0.143 m

23.12 0.5 mm^2

23.13

a	b	c	d	e
28 m	84 m	224 m	896 m	3920 m

23.14 a) 2.5 mm^2 b) 4 mm^2

23.15 a) 1.6 b) 16 mm^2 c) $a_{Al}/a_{Cu} = 0.485$

23.16 a) 0.0314 mm^3 b) 176 m

23.17 0.295 Ω

23.18 a) short circuited because $R_{34} + R_{56} = R_{12}$
b) 1750 m

23.19 1.79 μ Ω

23.20 100 M Ω

23.21 a) 10 Mill. $\Omega mm^2/m$ b) 100 Mill. $\Omega mm^2/m$;
c) 1000 Mill. $\Omega mm^2/m$

23.22 4.5 A/mm^2

23.23

a	b	c	d	e
0.4 A/mm^2	1.0 A/mm^2	2 A/mm^2	10 A/mm^2	30 A/mm^2

23.24

a	b	c	d	e
0.435	1.13	1.84	2.55	3.39

23.25 0.5 A/mm^2 .

23.26 1.5 A

23.27 276 mm^2

23.28

D	A	1.5A/mm^2	2.2A/mm^2	3.5A/mm^2
a) 0.25 mm	0.0491 mm^2	0.0737 A	0.108 A	0.172 A
b) --	0.1960 mm^2	0.294 A	0.431 A	0.686 A
c) --	1.13 mm^2	1.695 A	2.49 A	3.96 A
d) 2.4 mm	4.52 mm^2	6.78 A	9.94 A	15.8 A

23.29

1) A	2) R	3) I	4) J	5) P
$=0.785 \times 0.2^2$	$=\frac{528}{54 \times 0.0314}$	$=\frac{12}{300}$	$=\frac{0.04}{0.0314}$	$=12 \times 0.04$
$=0.0314\ mm^2$	$=300\,\Omega$	$=0.04$ A	$=1.27 A/mm^2$	$=0.48$ W

23.30

	1) A	2) I	3) P	4) R	5) l
a)	0.009 mm^2	0.198 A	43.6 W	1111 Ω	9.52 m
b)	0.036 mm^2	0.792 A	174 W	278 Ω	9.53 m
c)	0.06 mm^2	1.32 A	290 W	167 Ω	9.54 m
d)	0.08 mm^2	1.76 A	387 W	125 Ω	9.52 m
e)	0.12 mm^2	2.64 A	581 W	83.3 Ω	9.52 m
f)	0.18 mm^2	3.96 A	871 W	55.6 Ω	9.53 m
g)	0.30 mm^2	6.60 A	1452 W	33.3 Ω	9.51 m
h)	0.625 mm^2	13.75 A	3025 W	16.0 Ω	9.52 m

23.31

	1) A	2) I	3) R	4) l	5) P
a)	0.0314mm^2	0.7[illegible] A	140 Ω	4.23 m	84 W
b)	0.0615mm^2	1.54 A	71.4 Ω	4.23 m	169 W
c)	0.0804mm^2	2.01 A	54.7 Ω	4.23 m	221 W
d)	0.126 mm^2	2.27 A	96.9 Ω	12.85 m	499 W
e)	0.196 mm^2	3.53 A	62.3 Ω	12.85 m	777 W
f)	0.237 mm^2	4.27 A	51.5 Ω	12.85 m	939 W
g)	0.332 mm^2	4.98 A	12.0 Ω	3.19 m	299 W
h)	0.385 mm^2	5.78 A	10.4 Ω	3.30 m	347 W
i)	0.502 mm^2	7.53 A	7.97 Ω	3.20 m	452 W

23.32

a) I	b) R	c) A	d) ℓ	e) J
=13.6 A	=16.2 Ω	=0.636 mm^2	=9.45 m	=21.4 A/mm^2

23.33

1	2
a) A = 0.0962 mm^2	f) A = 0.126 mm^2
b) R = 120 Ω	g) R = 110 Ω
c) I = 1.83 A	h) I = 2.0 A
d) P = 403 W	i) P = 440 W
e) J = 19.0 A/mm^2	k) J = 15.9 A/mm^2

23.34

a) 0.196 mm^2
b) 0.47 A
c) 234 Ω
d) 2570 m
e) 51.7 W
f) 6480 g

23.35

a) A	b) ℓ	c) R	d) I	e) J	f) P
=0.038 mm^2	=1570 m	=738 Ω	=0.149 A	=3.92 A/mm^2	=16.4W

23.36

a) 0.126 mm^2
b) 0.35 A
c) 2.77 A/mm^2
d) 629 Ω
e) 0.28 A
f) 2.22 A/mm^2
g) 49.3 W
h) $V_1:V_2 = 1:0.8$
i) $I_1:I_2 = 1:0.8$
k) $P_1:P_2 = 1:0.64$

$P_1:P_2 = (V_1:V_2)^2 = (I_1:I_2)^2$

23.37

a) 0.196 mm^2
b) 1130 m
c) 0.04 A
d) 9000
e) 103 Ω
f) 0.49 A
g) 50.5 V
h) 24.7 W

23.38

a) 0.502 mm^2
b) 66.7 Ω
c) 1.65 A
d) 3.29 A/mm^2
e) 1880 m
f) 8400 g

Chapter No. 24

24.1	3980 g	24.5	3250 Ω
24.2	80 windings	24.6	a) 36.7 m
24.3	0.287 Ω		b) 0.412 mm
24.4	6420 g	24.7	0.49 — [illegible] 49

24.8

V (V)	A	R	I	J	P
110 V	0,159 mm^2	34.6 Ω	3.18 A	20 A/mm^2	350 W
220 V	0.159 mm^2	34.6 Ω	6.36 A	40 A/mm^2	1400 W

24.9	a) 1.28 m	24.16	a) 525 mm^2
	b) 1.54 mm		b) 0.030 m
24.10	8.00 m	24.17	a) 99.5 Ω
24.11	8.66 m		b) 5350
24.12	5080 g	24.18	a) 0.852 mm
24.13	368 m		b) 10 m
24.14	8.65 m	24.19	0.94 V
24.15	4.96 V	24.20	49 W

Chapter No. 25

25.1	- 25°C			25.9	0.488 Ω
25.2	a) + 80°C	b) - 80°C		25.10	a) 5.94 Ω
	c) + 87°C	d) - 10°C			b) 6.77 Ω
	e) - 30°C	f) + 15°C		25.11	a) 0.00426
25.3	a) + 4 Ω	b) - 4 Ω			b) 0.00408
	c) 70 Ω	d) 30 Ω			c) 0.00392
	e) 102 Ω	f) 60.5 Ω			d) 0.00351
25.4	a) + 4 Ω	b) + 8 Ω			e) 0.00299
	c) + 12 Ω	d) + 16 Ω			f) 0.00444
	e) + 24 Ω	f) + 32 Ω		25.12	+ 85°C
25.5	a) 15 Ω			25.13	1.94 A
	b) 48.4 Ω			25.14	40.1 Ω (≈40Ω
	c) 1,004 Ω			25.15	a) 1000 Ω
25.6	a) + 37 Ω				b) 1333 Ω
	b) + 57°C				c) 1500 Ω
	c) + 77°C				d) 1737 Ω
25.7	+ 320°C				e) 2000 Ω
25.8	+ 64°C			25.16	a) I_{20} = 2 mA
					b) I_{40} = 4 mA
					c) I_{60} = 6 mA

Chapter No. 26

26.1 $R = 12\Omega$; $I_1 = I_2 = I = 2$ A; $V_1 = 20$ V; $V_2 = 4$ V;

26.2 $R = 44\Omega$; $I = 5$ A; $V_1 = 10$ V; $V_2 = 200$ V; $V_3 = 10$ V

26.3

	a	b	c	d	e
R	50 Ω	15 Ω	24 Ω	8Ω	100 Ω
I	2 A	4 A	0.5A	3 A	2 A
V_1	20 V	28 V	3 V	12 V	80 V
V_2	50 V	12 V	6.5V	9 V	100 V
V_3	20 V	20 V	3.5V	3 V	40 V

26.4

	R(Ω)	V(V)	I(A)
1)	6	7	
2)	10	50	7
3)	7	7	
To-tal	7	125	

	R(Ω)	V(V)	I(A)
1)	6	30	
2)	10	50	5
3)	9	45	
To-tal	25	125	

26.5 4.4 A

26.6 $V_1 = 16$ V; $V_2 = 8$V

26.7 $R_1 = 30\Omega$; $R_2 = 54\Omega$; $R = 84\Omega$; $V = 210$ V

26.8 $R_1 = 1800\ \Omega$ and $R_2 = 1200\Omega$

26.9 a) 10 Ω

b)

1) 60 V	2) 80 V	3) 110 V
$R_1 = 10\Omega$	$R_1 = 16.7\Omega$	$R_1 = 25.7\Omega$

26.10 600 Ω

26.11 245 Ω

26.12 45 V

26.13 a) 15Ω; b) 0.82 mm; c) 4.74 m

26.14 120 kΩ

26.15 62.5 kΩ

26.16

R_2	a) 80Ω	b) 60Ω	c) 40 Ω	d) 20Ω
I_1	2 A	2.4 A	3 A	4 A
V_1	80 V	96 V	120 V	160 V

26.17 a) I = 12 A; V_{1-4} (in V) 60 + 0 + 0 + 0

b) I = 4 A; V_{1-4} (in V) 20 + 40 + 0 + 0

c) I = 2 A; V_{1-4} (in V) 10 + 20 + 30 + 0

d) I = 1.2A; V_{1-4} (in V) 6 + 12 + 18 + 24

26.18 I = 1.33 A; V_1 = 16 V

26.19

	a) 107 Ω	b) 52 Ω	c) 26.5 Ω
V_I	218 V	216 V	212 V
V_{II}	216 V	212 V	204 V
V_{III}	214 V	208 V	196 V

26.20 a) 1 : 2 : 5 b) 22.4Ω : 44.8Ω : 112Ω

c) 4V : 8V : 20V; 22.4Ω, 44.8Ω, 112Ω

d) 0V : 0V : 0V; 22.4Ω, 44.8Ω, 112Ω

26.21 a) 0.5 A; b) 0.4 A; c) 1.6 V; d) 4.20 m

26.22 a) 6Ω ; b) 0.5 A; c) 2.5 V

26.23 a) 2Ω ; b) 3 A ; c) 0.9 V;

d) 5.1 V; e) 0.6 V; f) V_{II} = 4.5 V

g) $V_I = V_{II}$ = 6 V

26.24 R_1 = 0.2 Ω

26.25 a) b) c) correct

d) R remains constant; V and I double; P four times high

26.26 P = 90 W — I = 1.5 A = $I_1 = I_2$ — V_1 = 10 V — R_1 = 6.67 Ω

— V_2 = 50 V — R_2 = 33.3Ω — R = 40 Ω

26.27

a)	R (Ω)	V (V)	I (A)	P (W)
1)	3.5	10.5		31.5
2)	16.5	49.5		148.5
Total	20	60	3	180

b)	R (Ω)	V (V)	I (A)	P (W)
1)	160	176		193.6
2)	40	44		48.4
Total	200	220	1.1	242

c)	R (Ω)	V (V)	I (A)	P (W)
1)	30	150		750
2)	15	75		375
Total	45	225	5	1125

d)	R (Ω)	V (V)	I (A)	P (W)
1)	10	30		90
2)	30	90		270
Total	40	120	3	360

e)	R (Ω)	V (V)	I (A)	P (W)
1)	10	70		490
2)	20	140		980
Total	30	210	7	1470

f)	R (Ω)	V (V)	I (A)	P (W)
1)	17.4	24.3		34
2)	61.2	85.7		120
Total	78.6	110	1.4	154

g)	R (Ω)	V (V)	I (A)	P (W)
1)	28.8	240		2000
2)	43.2	360		3000
Total	72	600	8.33	5000

26.28 a) 2.04 A; b) 174Ω.

26.29 a) $R_1 = 484\,\Omega$; $R_2 = 202\,\Omega$
b) I = 0.321 A
c) $V_1 = 155$ V; $V_2 = 65$ V
d) $P_1 = 50$ W; $P_2 = 21$ W

26.30 a) 18.2 A; b) 4.16 V; c) 224.2 V;
d) 1.8 %; e)—2.08 V

26.31 a) $P_{out} = 7.35$ kW; $P_{in} = 9.24$ kW
b) 0.795; c) 10.5 V; d) 230.5 V;
e) 4.8 %; f)—3.15 V

c)

	R(Ω)	V(V)	I(A)
Series R	20k	24	
Ⓐ	1	1.2m	
Parall.I.	20k		1.2m
Ⓥ	20k		1.2m
Total	10k	24	2.4m
By measurement (= %)	24 : 1.2mA = 20kΩ (+ 0 %)		

d) e)

	R(Ω)	V(V)	I(A)	R(Ω)	V(V)	I(A)
Parall.R	3		8	200		0.120
Ⓥ	20k		0.8m	20k		1.2 m
Series I	2	16		198	23.9	
Ⓐ	1	8		1	0.121	
Total	3	24	8	199	24	0.121
By measurement (= %)	16V : 8A = 2Ω (- 0 %)			23.9 : 0.121 = 198Ω (- 1 %)		

f)

	R(Ω)	V(V)	I(A)
Parall.R	20k		1.2m
Ⓥ	20k		1.2m
Series I	10k	24	
Ⓐ	1	2.4m	
Total	10k	24	2.4m
By measurement (= %)	24 : 2.4mA = 10kΩ (-50%)		

38.21

	a	b	c	d	e
I	1A	1.16A	1.56A	2.45A	6A
V_2	0V	12.9V	20.3V	38.7V	100V

R (y-axis): $R_{23} = 400\,\Omega$; $R_{14} = 40\,\Omega$; $R = 36.4\,\Omega$

R (x-axis): $R = 36.4\,\Omega$

27.8 $P_1 = 484$ W; $P_2 = 1016$ W; $R_2 = 47.6\,\Omega$

27.9

n	a	b	c	d	e	f
P	1250 W	2500 W	3750 W	5000 W	6250 W	7500 W
I	5.68 A	11.4 A	17.0 A	22.7 A	28.4 A	34.1 A
R	38.7 Ω	19.4 Ω	12.9 Ω	9.68 Ω	7.74 Ω	6.45 Ω

27.10 a) 5500 W + 4400 W + 4400 W + 3520 W + 3520 W + 2200 W

b) P = 23540 W; I = 107 A; R = 2.06 Ω

27.11 a) 1.5 V; b) $R_1 = 0.1\,\Omega$

c) $\delta V = 0.2$ V; $V = 1.5 - 0.2 = 1.3$ V

Chapter No. 28

28.1 $R = 20\,\Omega \rightarrow I = 5.5$ A $\rightarrow$ 44 V + 66 V $\rightarrow I_2 + I_3 = 4.125\text{A} + 1.375$

28.2

		R(Ω)	V(V)	I(A)
Parall.	2)	30		3.33
	3)	60		1.67
Series	I.	20	100	
	1)	24	120	5
Total		44	220	

28.3

		R(Ω)	V(V)	I(A)
Series	2)	20	24	
	3)	30	36	
Parall.	I.	50		1.2
	1)	10		6
Total		8.33	60	7.2

28.4

		R(Ω)	V(V)	I(A)	
Series	1)	2	10.5		
	2)	6	31.6		I.
Series	3)	20	35.2		
	4)	4	7.0		II.
Parall.	I.	8		5.27	
	II.	24		1.76	
Total		6	42.15	7.03	

28.5

		R(Ω)	V(V)	I(A)	
Parall.	1)	2		9.1	
	3)	20			I. 0.9
Parall.	2)	4		4	
	4)	4			II. 4
Series	I.	1.82	18.2		
	II.	2.4	24		
Total		4.22	42.15	10	

28.6 120 Ω

28.7 10 Ω

28.8 $1.2\,\Omega$

28.9 $R = 9.8\Omega$; $V = 116$ V; $I = 11.8$ A

28.10 $R = 120\,\Omega$; $V = 120$ V; $I = 1$ A

28.11 $R_2 = 120\Omega$ $R_3 = 77.5\,\Omega$

28.12 $I = 27.5$ A; $V_1 = 110$ V; $I_1 = 5.5$ A

28.13 $R = 10\,\Omega$; $V = 15$ V; $I = 1.5$ A

28.14 16 A (approx.)

28.15

	a	b	c	d	e	f
R_p	120 Ω	60 Ω	40 Ω	30 Ω	24 Ω	20 Ω
R	240 Ω	180 Ω	160 Ω	150 Ω	144 Ω	140 Ω
I	0.92 A	1.22 A	1.38 A	1.47 A	1.53 A	1.57 A
V_L	110 V	73 V	55 V	44 V	37 V	31 V

28.16 a) $90\,\Omega$; b) 60Ω; c) $10\,\Omega$; d) $6\,\Omega$

28.17 a) $4.5\,\Omega$; b) $3\,\Omega$; c) $1.5\,\Omega$

28.18
a) 225 Ω ; 1.0 A
b) 150 Ω ; 1.5 A
c) 112.5Ω ; 2.0 A
d) 75 Ω ; 3.0 A
e) 50 Ω ; 4.5 A
f) 37.5 Ω ; 6.0 A
g) 25 Ω ; 9.0 A

28.19 $31\,\Omega$

28.20

a) b)	R(Ω)	V(V)	I(A)	R(Ω)	V(V)	I(A)
Series Ⓐ	2 1	16 8		200 1	23.9 0.119	
Parall.I. Ⓥ	3 20k	8 1.2m		201 20k		0.1194 1.2m
Total	3	24	8	199	24	0.121
By measurement (= R)	24V : 8A = 3 Ω (+ 50 %)			24 : 0.1194 = 201 Ω (+ $\frac{1}{2}$ %)		

26.32 a) 30 V; b) 18 V; c) 18 ... 30 V

26.33

	n	R_i	δV	V	I_s
a) 3 V	2 cells	0.24 Ω	0.48 V	2.52 V	12.5 A
b) 4.5V	3 cells	0.36 Ω	0.72 V	3.78 V	12.5 A
c) 12 V	8 cells	0.96 Ω	1.92 V	10.1 V	12.5 A

26.34 a) 8r. b) 10r c) 18

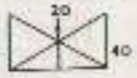
Chapter No. 27

27.1 $V = V_1 = V_2 = 240$ V — $I_1 = 24$ A — $I_2 = 6$ A — $I = 30$ A — $R = 8\,\Omega$

27.2 a) $I_1 = 5.5$ A; $I_2 = 5.5$ A; $I = 11$ A

b) $R = 20\,\Omega$

c) $\frac{1}{1/40 + 1/40} = \frac{1}{0.025 + 0.025} = \frac{40}{2} = \frac{40}{40} \& \frac{40}{40}$



27.3

a)

R (Ω)	V (V)	I (A)
15	150	10

b)

R (Ω)	V (V)	I (A)
5	60	12

c)

R (Ω)	V (V)	I (A)
10	9	0.9

d)

R (Ω)	V (V)	I (A)
30	24	0.8

e)

R (Ω)	V (V)	I (A)
9.6	12	1.25

27.4 a) 202 mΩ; b) 50.1 mΩ; c) 10.0 mΩ

27.5 a) 2 Ω ; b) 24 V ; c) $I_1 = 1.33$ A; $I_2 = 2$ A; $I_3 = 2.67$ A; $I_4 = 6$ A

27.6 $I_1 = 440$ mA; a) $I_2 = 2.2$ mA = 0.5 %; b) $I_3 = 0.22$ mA = 0.05 %

27.7

Parall.	R (Ω)	V (V)	I (A)	P (W)
1)	50		4	800
2)	800		0.25	50
3)	800		0.25	50
4)	200		1	200
Total	38.4	200	5.5	1100

28.22

	a)	b)	c)	d)	e)
V	− 4V	− 2V	0V	+ 2V	+ 8V

28.23

	R(Ω)	V(V)	I(A)	P(W)
R_2	80		0.5	20
R_3	26.7	40	1.5	60
R_{23}	20			80
R_1	30	60	2	120
R_4	50	100		200
Total	100	200		400

28.24

	R(Ω)	V(V)	I(A)	P(W)
R_1	25		2	100
R_2	8.33	50	6	300
R_3	30	150	5	750
R_4	50		3	450
R_{12}	6.25	50		400
R_{34}	18.75	150		1200
Total	25	200	8	1600

28.25

	R(Ω)	V(V)	I(A)	P(W)
R_1	12	60	5	300
R_2	20		3	180
R_3	30		2	120
R_{123}	6		10	600
Cond.	4	40		400
Total	10	100		1000

28.26 a) I = 16 A; b) V_L = 3.2 V
c) P_L = 51.2 W; d) V = 323.3 V

28.27 3.64 V

28.28 a) 50 Ω; 800 W
b) 30 Ω; 1500 W
c) 20 Ω; 2250 W
d) 12 Ω; 3750 W

28.29

a)	R(Ω)	V(V)	I(A)
R_1	1.5		0.96
R_2	1		1.44
R_o	0.6	144	
R_1	0.4	0.96	
Total	1	2.4	2.4

b)	R(Ω)	V(V)	I(A)
Parall. 1)	1.5		1.2
2)	1		1.8
Series off	0.6	1.8	
on	0.6	1.8	
Total	1.2	3.6	3

28.30

	R(Ω)	V(V)	I(A)
R_1	8		0.45
R_2	8		0.45
R_3	6		0.6
R_{1-3}	2.4	3.6	
$R_{cond.}$	0.8	1.2	
R_a	3.2	4.8	
R_i	0.8	1.2	
Total	4	6	1.5

28.31 a) I = nill; V = 6.3 V
b) I = 13.8 A; V = 6.09 V
c) I = 105 A; V = 4.73 V

28.32 a) R = 12 V
b) V = 11.4 V
c) V = 6.0 V

Chapter No. 29

		a	b	c	d
29.1	P in kWh	0.25	0.0035	0.01	50
29.2	P in Ws	24320	[illegible]	5720000	900 Mill.
29.3	P in MWsin	10.5	216	24000	6000000
29.4	P in Wh	1.5	7.5	643	30000

	a	b	c	d	e	f
29.5	3 kWh	1.04 kWh	0.015 kWh	1.75 kWh	0.012 kWh	0.008 kWh
29.6	75 Wh	36000 Ws	40 kWh	15 MWh	0.3 kWh	7200 Wh
29.7	8 Wh	9.9 MWh	9 kW	180 s	3270 W	156 min.

29.8 a) Please see example
b) 1.1 kWh

29.9 4.5 kWh

29.10 1.19 kWh

29.11 a) 150 W
b) 323 Ω

29.12 a) 15 kWh
b) 0.204 kWh

29.13 4 h

29.14 18 kWh

29.15 18 A

29.16 0.002 kWh (approx.)

29.17 3.6 Mill. Ws

29.18 2400 W

29.19 480 W

29.20 6000 W

29.21 22 h 05 min.

29.22 0.1 kWh

29.23 0.00667 kWh

29.24 5

29.25 48 s

29.26

a	b	c	d	e	f
0.2 kW	0.6 kW	6 kW	0.1 kW	0.3 kW	4 kW

29.27 1.5 kW

29.28 300 W

29.29 4.5 kW

29.30

a	b	c	d	e	f
400	200	100	80	50	40

29.31 37 rpm

29.32

	P	I	R
a) 25 rpm	4000 W	18.2 A	12.1 Ω
b) 18 rpm	2880 W	13.1 A	16.8 Ω

29.33 a) 1.50 Pa.; b) 11.25 Pa.; c) 62.5 Pa.; d) 15 Pa.

29.34

	a	b	c	d	e	f
C in Rs	7.90	14.96	17.45	19.59	28.13	40.55
$\hat{p}$ in Rs/kWh	0.247	0.220	0.190	0.170	0.151	0.137

29.35 C = Rs 71.68; $\hat{p}$ = Rs 0.279/kWh

29.36 a) 225 kWh ; b) Rs 62.88;

29.37 a) C = Rs 7.20; b) $\hat{p}$ = Rs 200/kWh

29.38 Rs 12.38

29.39 a) 8.08 Pa./h b) 640 W

29.40 a) C = Rs 167.61; b) $\hat{p}$ = Rs 0.134/kWh

29.41

	a	b	c	d
W/month	864 kWh	3150 kWh	48000 kWh	6000 MWh
C in Rs	86.40	252	2880	900000

Chapter No. 30

30.1 24100 kJ; 5760 kcal

30.2 -7530 kJ; -1800 kcal

30.3

a	b	c	d	e	f
23.4 MJ	20.3 MJ	5.64 MJ	836 kJ	21.8 MJ	343 kJ

30.4 6016 kJ

30.5 2320 kJ

30.6 1280 kJ

30.7 5510 kJ

30.8 2.24 kcal

30.9 a) 882 kg b) +68 °C 144 MJ

30.10

a	b	c	d	e
720 kJ	3800 kJ	7300 kJ	14.4 MJ	21.6 MJ

30.11 0.003 Pa./kJ

30.12 a) 5.4 GJ/month b) 64.8 GJ/year
c) 50 kWh/day d) 5 kW

30.13 1 kWh

30.14 2320 W

30.15 13.1 kN

30.16 0.93

30.17 a) 43.9 MJ b) 48.5 MJ c) 4.6 MJ
d) 13.5 kWh e) 1.69 kW

30.18 4180 J/kg °C

30.19 a) 0.813 b) 0.887 c) 0.813

30.20 459 s ≈ 7 min. 40 s

30.21 3470 W ≈ 3.5 kN

30.22 a) 4500 kJ b) 26.5 m^3

30.23 2.03 m^3 ≈ 2 m^3

30.24 a) 3.48 kN b) 15.8 A c) 13.9 Ω

30.25 a) + 25.0 °C b) + 27.6 °C
c) V_A + 5%; F_L + 10%; ΔT = + 10% (approx.)

30.26 455 g

30.27 1) R(series) = 242 Ω; I = 0.91 A; P = 200 W
2) R = 67 Ω ; I = 3.28 A; P = 722 W
3) R = 48.5 Ω ; I = 4.54 A; P = 999 W

30.28 a) $R_2 = 56\,\Omega$; $R_1 = 146\,\Omega$
b) $R_2 = 34.6\,\Omega$; $R_2 = 726\,\Omega$

30.29 1) R = 242 Ω ; I = 0.91 A; P = 200 W
2) R = 145 Ω ; I = 1.52 A; P = 334 W
3) R = 96.8 Ω ; I = 2.27 A; P = 500 W
4) R = 48.4 Ω ; I = 4.55 A; P = 1000 W
5) R = 32.3 Ω ; I = 6.81 A; P = 1500 W
6) R = 24.2 Ω ; I = 9.09 A; P = 2000 W

30.30 2 resistances of 129Ω each and 1 resistance of 64.5Ω.

30.31 a) 0.24 mm = 0.24 ‰ b) 0.48 mm = 0.48 ‰

30.32 454 kJ

30.33 a) 461 kJ b) Danger of burning

30.34 a) 2.4 Ω b) 4 A
c) battery 3.2 N; conductor 6.4 N; heating coil 38.4 W
d) battery 11.5 kJ; conductor 23 kJ; heating coil 138 kJ

30.35 a) 1:2 b) 1:2 c) 1:4 d) 1:4

30.36

a	b	c	d	e	f
P×9	P×16	P×1.44	P×100	I÷4	I÷25
Q/t×9	Q/t×16	Q/t×1.44	Q/t×100	Q/t÷4	Q/t÷25

30.37 a) R x 2 → V_1 x 2 → Q x 2
b) A x 2 → cooling x 2
c) final temperature remains constant
d) J remains constant

30.38 a) 43300 mm^2 b) 86700 mm^2
c) If $A_1 : A_2 = 1 : 4$ then cooling surface = 1 : 2

30.39

	a	b	c	d	e	f	g
1 mm^2	1 Ω	6A	36W	130kJ	1.13mm	0.199m^2	6A/mm^2
4 mm^2	0.25Ω	24A	144W	518kJ	2.26mm	0.397m^2	6A/mm^2

30.40 a) 2.5 mm^2 b) 4 mm^2 c) 10 mm^2

30.41 a) 4.83 Ω
b) 10 kW
c) 0.906
d) 940 W
e) 13.4 A/mm²
f) 50 A
g) 10 mm² (for Cu, group 1)
h) 1.3 V = 1.5 %
i) 59.2 W

Chapter No. 31

31.1 8 h 29 min.

31.2 a) 150 A b) 42.6 g c) 26 $\frac{1}{4}$ min.

31.3 a) 92.4 A b) 27.3 g c) 20 $\frac{1}{2}$ min.

31.4

a	b	c
0.46 V	0.47 V	0.78 V

31.5

a	b	c	d	e	f
5 A	15 A	60 A	2 kA	15 A	2 kA

31.6 a) 1.5 V; b) 1.25 V; c) 1 V; d) 0.875 V;
e) Nil

31.7 a) y-axis E = 1.5 V; x-axis I_{sc} = 1.5 : 0.1 = 15 A
b) y-axis E = 3.0 V; x-axis I_{sc} = 3.0 : 0.2 = 15 A
c) y-axis E = 1.5 V; x-axis I_{sc} = 1.5 : (0.1:2) = 30 A

31.8 16 Ω

31.9

	E(V)	R_i (Ω)	I_N (A)	V(V)
a)	48	24/1 — 0.48	9	48 - 4.32 = 43.68
b)	24	12/2 — 0.12	18	24 - 2.16 = 22.84
c)	16	8/3 — 0.0533	27	16 - 1.44 = 14.56
d)	12	6/4 — 0.03	36	12 - 1.08 = 10.92
e)	8	4/6 — 0.0133	54	8 - 0.72 = 7.28
f)	6	3/8 — 0.0075	72	6 - 0.54 = 5.46
g)	4	2/12 — 0.00333	108	4 - 0.36 = 3.64
h)	2	1/24 — 0.00083	216	2 - 0.18 = 1.82

31.10

R_1 (Ω)	R_a (Ω)	I (A)	V_{cc} (V)	V(V)	P_{out} (W)
1.5	3.0	2	9	6	12
1.5	1.5	3	4.5	4.5	13.5
1.5	0.75	4	6	3	12

b) $R_i = R_a$ c) η_i = 50 % and P_i = 50 %

31.11 7.2 A (approx.)

31.12 600 hrs.

31.13 15 hrs.

31.14 a) 20 cells b) 184 Ah c) 294 kg

31.15 1) n = 122 4) c_2 = 444 Ah
2) V_c = 330 V 5) $I_{avg.}$ = 74 A
3) c_1 = 400 Ah 6) η_{Ah} = 0.71

Chapter No. 32

32.1

	H	B	F
a)	200 AT/m	0.6 T	144 N
b)	400 AT/m	1.0 T	400 N
c)	800 AT/m	1.3 T	676 N

32.2 a) 313 AT
b) 314 mm
c) 1000 AT/m
d) 0.00125 T
e) $\mu = \mu_0 =$ 1.26 x 10^{-6} H/m
($\mu_r = 1$)
f) 314 mm^2
g) 0.393 μWb
h) 0.00125 μH

32.3 a) 1.21 T
b) 27300 mm^2
c) ≈ 6000 μWb
d) 0.0153 T
e) 17700 μWb
f) 28.1 mm

32.4 a) 4125 AT;
b) 5500 AT;
c) 891 AT

	a	b	c	d	e	f
32.5	2400AT/m	180AT	33600AT	900mm	1790AT/m	1410AT
32.6	300AT/m	1.5 T	840000AT/m	0.0487	0.4 T	800AT/m

32.7 a) 0.125 T b) 0.25 T

32.8 a) 2.7 N b) 486 N

32.9 12 mA

Chapter No. 33

33.1 730 AT

33.2 a) 1140 AT b) 1620 AT c) 1940 AT

33.3 ϕ = 600 μWb B_2 = 1.3 T B_3 = 0.6 T
(ϕ remains constant)

33.4

	a	b	c	d
ϕ	150 μWb	900 μWb	420 μWb	660 μWb
B_2	0.375 T	2.25 T	1.05 T	1.65 T
B_3	0.15 T	0.9 T	0.42 T	0.66 T

33.5 a) 1440 H b) 3500 AT (approx.)
c) 2190 mm^2 d) 0.6 mm
e) R = 107 Ω
H = 6230

33.6 a) 80000 AT/m b) 0.1 T c) 3.2 H

33.7 a) 0.35 T b) 200000 AT/m c) 2400 AT

33.8 a) 600 AT b) 250 mm^2
c) 0.071 mm^2 d) 56 Ω; 2800 turns

33.9 a) 64000 AT/m b) 8300 AT c) 830 turns

33.10 a) 0.049 μH b) 0.0078 T

Chapter No. 34

34.2 43.2 V

34.3 0.057 m

34.4 0.833 T

34.5 51.03 ≈ 51 V

34.6 a) 225.28 ≈ 225 V d) 3.474 m/s
b) 534.16 ≈ 534 V e) 254 turns
c) 0.1217 m = 12.17 cm f) 2.45 T

34.7 b) P_2 = 77 kW; η = 0.88
c) I = 209.09 A; T = 0.856
d) V = 440 V; P_1 = 84.27 kW
e) P_2 = 90 kW; I = 409 A

34.8 η = 0.88; P_2 = 6000 W

34.9 19.55 kW

34.10 a) $I = 481.81$ A b) $\eta = 88$ %
c) $P_g = 7$ kW $\triangleq$ 11.6 %

34.11 121.18 A

34.12 $\eta = 0.916$; $P_g = 825$ kW; $I = 1500$ A

34.13 a) 2640 N b) 3666 N c) 13.24 Nm

34.14 a) 5.22 kW b) 47.45 A c) 0.87

34.15 a) 32.9 kN b) 26.98 kW c) 122.83 A

34.16 $I_{ac} = 1533$ A; $V_{dc} = 244.55 = 245$ V

34.17 $V = 440$ V
$\frac{P_2}{P_g} = \frac{117.3}{1}$

34.18 a) 230 V b) 50 A
c) 0.25 Ω d) 460.8 V

Chapter No. 35

35.1 1.575 N
35.2 10.71 A
35.3 0.39 Ω
35.4 0.66 Ω
35.5 54.4 N
35.6 52.08
35.7 84 N; 70 N
35.8 a) 420 N b) 48.3 Nm
35.9 1a) 0.2 N(appr.) 1b) 1.2 N 1c) 1.9 N
2a) 36 N 2b) 576 N 2c) 912 N
3a) 8.88 Nm 3b) 53.28 Nm 3c) 84.36 Nm
35.11 a) 0.833; 1100 W $\triangleq$ 16,7 %
b) 0.84 ; 1838 W $\triangleq$ 16 %
c) 0.85 ; 2000 W $\triangleq$ 14.28%
d) 0.80 ; 2200 W $\triangleq$ 20 %
e) 0.70 ; 250 W $\triangleq$ 30 %
f) 0.729; 650 W $\triangleq$ 27.08%

35.12 a) 1.532 kW b) 80 % c) 7.636 kW
d) 7.53 kN e) 0.778 f) 2.2 kW

35.13 b) P_1 = 25300 W e) P_1 = 17600 W
η = 0.873 η = 0.852
c) P_2 = 24.27 kW f) P_1 = 30030 W = 30 kW
I = 63.4 A P_2 = 25.95 kW
d) P_1 = 6.7 kW
V = 60 V

35.14 I = 111.2 A

35.15 a) 113.33 A c) 8 kW
b) 0.90

35.16 η = 0.84; P_1 = 700 W; W = 52.8 kWh

35.17 29.4 A; 16.33 A

35.18 Rs 990.00

35.19 Rs 609.20

35.20 31.9 h

35.21 a) P_1 = 5.28 kW
P_2 = 4.33 kW; P_2 = 5.8 hp
W = 12.3 kWh; C = Rs 1.23
b) P_1 = 6.27 kW
P_2 = 4.52 kW ; P_2 = 6.06 hp
W = 33.2 kWh; C = Rs 3.98
c) I = 17.05 A ;
P_2 = 5.85 kW ; P_2 = 7.84 hp
W = 50.6 kWh; C = Rs 5.06
d) V = 220 V ;
P_2 = 15.4 kW ; P_2 = 20.64 hp
W = 277.7kWh; t = 15.6 h
e) P_2 = 23.05kW ; P_1 = 31.5 kW
I = 143.2 A ; W = 323 kWh
C = Rs 32.30
f) V = 440 V ; P_2 = 22.05 kW
η = 0.848 = 84.8 %
W = 78 kWh; t = 3 h

35.22 a) motor 1: 35.86 A
motor 2: 34.68 A
motor 3: 53.45 A
b) 123.99 A ≈ 124 A
c) 46.362 kNm

35.23 a) 211 V b) 108 W

35.24 a) 213.75 V b) 104.6 V c) 425.7 V
d) 103.12 V e) 207.45 V f) 477.5 V

35.25 410 V

35.27 a) 1535 rpm b) 1514 rpm c) 1471 rpm

35.28 a) 0.806 b) 21.70 V; 1345 W
c) 31 V; 1922 W d) 3267 W ≈12 %

35.29 a) 5.3 kW b) 1.68 A; ≈ 370 W
c) 130.8 Ω d) 6 %

35.30 a) 36.7 A b) ≈ 318 W
c) 402.6 W d) 1.83 A; 4.98 %

35.31 366 A

35.32 36.6 A

35.33 a) ≈ 4.94 Ω b) ≈ 2.34 Ω c) ≈ 1.72 Ω

35.35 a) 6.22 Ω b) ≈ 7.85 Ω

35.37 1466.6 A

35.38 a) 8.47 Ω b) 2.29 Ω

35.39 1a) 1. 7.8 Ω 2. 3.7 Ω 3. 2.73 Ω
2a) 1. 9.7 Ω 2. 4.7 Ω 3. 3.48 Ω
3a) 1. 4 Ω 2. 1.9 Ω 3. 1.4 Ω

35.40 a) 1503 W b) 10 kW c) 0.85
d) 44.5 A e) 1.0 A f) 2.42 %
g) 3.38 Ω

35.41 a) 1.27 A b) 32.23 A c) 0.81
d) 16.7 V e) 0.53 Ω f) 203.24 V
h) 3.34 Ω i) 8.9 %

35.42 a) ≈ 8.6 Ω b) ≈ 2.17 Ω c) ≈ 0.54 Ω

35.43 a) 350 W; 1.66 A b) 84.66 %

Chapter No. 36

36.1

	$\delta\phi$	E
a)	120 μWb	0.3 V
b)	60 μWb	0.03 V
c)	250 μWb	8 V

36.2 60 V

36.3

1. sec.	2. sec.	3. sec.	4. sec.	5. sec.	6. sec.
+200 μWb	± 0 μWb	-200 μWb	-200 μWb	± 0 μWb	+200 μWb
-3 V	0 V	+ 2 V	+ 2 V	0 V	- 2 V

36.4 a) 0.45 V b) 36 V

36.5

a	b	c	d	e	f
0.25 s	2 H	as for 'b'	4 Ω	50 s	1.8 m/H

36.6 a) 0.6 V d) 6 s
b) 1200 V e) 1 Ω
c) 30 V f) 1.2 Ω

36.7 a) 1.2 s b) 0.4 s

36.8 1.69 ... 0.76 H

36.9 7.8 mH

36.10 1.3 mH

36.11 a) 375 mH b) 1.5 Ω

Chapter No. 37

37.1 a) 1 As b) 0.06 As c) 5 mAs

37.2 a) 3.3 A b) 30 μA

37.3 a) 400 V/cm b) 400 V/mm = 4 kV/cm = 400 kV/m
c) 0.24 s d) 2 cm

37.4 a) V = 1000 V; E = 500 V/mm
b) V = 400 V; E = 200 V/mm
c) V = 125 V; E = 25 V/mm

37.5 a) 0.005 F b) 0.000 025 F c) 0.000 02 F
d) 0.000 000 8 F e) 0.000 000 12 F f) 0.000 000 002 F

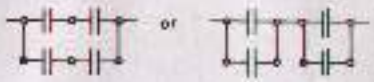
37.6 a) 25 As b) 1 000 As c) 0.004 8 As
d) 0.052 5 As e) 0.000 1 As f) 0.000 000 16 As

37.7 a) + 3.2 A b) + 0.11 A c) − 0.4 A
d) − 2 mA

37.8 a) 177 nF b) 4.96 µF c) 221 pF
d) 3540 µF

37.9 In series a) 6 µF b) 4 µF c) 2 µF
Parallel a) 24 µF b) 36 µF c) 72 µF

37.10

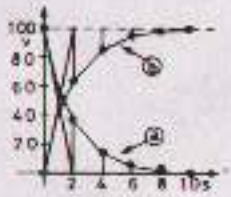


37.11 a) 100 s b) 20 s c) 5 s d) 0.8 s

37.12

a	b	c	d	e	f
5 s	5 s	25 s	0.2 s	15 ms	7.5 ms

37.13



After 1 x T → 37 %
" 2 x T → 14 %
" 3 x T → 5 %
" 4 x T → 2 %

Chapter No. 38

38.1

a	b	c	d	e
13 cm	17 cm	13.2 cm	42.7 cm	4.8 cm

38.2

	a	b	c	d	e
α	$72^\circ 30'$	$66^\circ 25'$	$18^\circ 10'$	$89^\circ 30'$	$31^\circ 50'$
β	$14^\circ 30'$	$20^\circ 30'$	$61^\circ 40'$	$38^\circ 20'$	$35^\circ 30'$
γ	$3^\circ 40'$	$13^\circ 20'$	58°	42°	$79^\circ 10'$

38.3

$\leq$	sin	cos	tan	cot
0°	0	1	0	∞
30°	0.5	0.866	0.577	1.732
45°	0.707	0.707	1	1
60°	0.866	0.5	1.732	0.577
90°	1	0	∞	0

Observations:

sin	$0 \longrightarrow 1$
cos	$1 \longrightarrow 0$
tan	$0 \longrightarrow \infty$
cot	$\infty \longrightarrow 0$

38.4

a) $49^\circ 30'$ $\sin\alpha = 0.760$ $\tan\alpha = 1.171$
b) $36^\circ 50'$ $\sin\alpha = 0.600$ $\tan\alpha = 0.749$
c) $64^\circ 10'$ $\cos\alpha = 0.436$ $\tan\alpha = 2.066$
d) $56^\circ 20'$ $\cos\alpha = 0.554$ $\sin\alpha = 0.832$
e) $26^\circ 30'$ $\cos\alpha = 0.895$ $\sin\alpha = 0.446$

38.5

a) $b = 176$ mm ; $\alpha = 36^\circ 50'$; $\cos\alpha = 0.8$;
b) $\sin\alpha = 0.906$; $\cos\alpha = 0.423$; $c = 45$ mm ;
c) $\sin\alpha = 0.799$; $\cos\alpha = 0.602$; $b = 45.7$ mm;
d) $\alpha = 41^\circ 20'$; $\sin\alpha = 0.660$; $a = 82.7$ mm;
e) $\alpha = 42^\circ 50'$; $\cos\alpha = 0.733$; $b = 84.3$ mm;

38.6

a) $a = 5.07$ cm ; $b = 10.9$ cm; $\beta = 65^\circ$;
b) $c = 11.7$ cm ; $a = 8.94$ cm; $\alpha = 50^\circ$;
c) $\sin\alpha = 0.833$; $\alpha = 56.5^\circ$; $\beta = 33.5^\circ$;
$b = 6.61$ cm;

38.7 12.02 m

38.8 1.20 m^2 (approx.)

38.9 23.4 %

38.10 x (in cm) a) 0 cm b) 2.50 cm c) 4.33 cm d) 5 cm

38.11

α	0	30	60	90	120	150	180	210	240	270	300	330	360
x	0	3	5.2	6	5.2	3	0	-3	-5.2	-6	-5.2	-3	0

38.12

α	0	30	60	90	120	150	180	210	240	270	300	330	360
x	0	4	7	8	7	4	0	−4	−7	−8	−7	−4	0
Inclination/30°	+4	+3	+1	−1	−3	−4	−4	−3	−1	+1	+3	+4	

38.13 a) 3600 degrees/s c) 3.14 m/s
b) 62.8 rad/s d) 3.14 m/s

38.14

	0°	30°	60°	90°
a)	nill	80 μWb	140 μWb	160 μWb
b)	8000 μWb/s.	7000 μWb/s.	4000 μWb/s.	nill

Chapter No. 39

39.1

	E_{max}	$K_0/K_{30}/K_{60}/K_{90}$
a)	0.08 V	0/0.04/0.07/0.08 ...
b)	4 V	0/2/3.5/4 ...
c)	168 V	0/84/147/168 ...
d)	10 mV	0/5/8.7/10 ... (mV)

39.2

	f	T	ω
a)	50 Hz	0.02 s	314/s
b)	$16\frac{2}{3}$ Hz	0.06 s	105/s
c)	60 Hz	0.0167 s	377/s
d)	$60\frac{1}{4}$ Hz	0.16 s	38.2/s

39.3

a	b	c	d	e
f = 50 Hz	$f=16\frac{2}{3}$Hz	f=200Hz	T=0.67μs	T=0.01μs
ω = 314/s	T=0.06s	ω=1256/s	ω=94.2000/s	ω=628x10⁶/s

39.4

	$V_{avg.}$	$V_{max.}$	$\alpha V_{max.}$
a)	0 V	310 V	97.3 kV/s
b)	0 V	536 V	168 kV/s
c)	0 V	85 V	214 kV/s

39.5 177 V

39.6 7.05 A

39.7 5024 rad/s

39.8 a) V_{max} = 705 V; b) I_{max} = 28.2 mA; c) V_{eff} = 380 kV;
d) I_{eff} = 6.38 A

39.9 a) λ = 500 m; b) λ = 3 m; c) λ = 0.5 µm; d) = 0.001 µm

39.10 5.45 cm

39.11 a) and b)

α	0	30	60	90	120	150	180	210	240	270	300	330	360
I_1 (A)	0	4	7	8	7	4	0	-4	-7	-8	-7	-4	0
I_2 (A)	-1.5	-2	0	3	5.5	6	5.5	2	0	-2	-1.5	-4	-5.5
I_z (A)	-1.5	2	7	10	10.5	8	5.5	-2	-7	-10	-10.5	-8	-5.5

c) the sum of I_z gives a new sine wave with the same frequency.

d) $\frac{\text{Max. value}}{\sqrt{2}}$ = effective value; φ = 39°

e) I_{max} = 10.6 A; I_{eff} = 7.52 A; δ = 19°

39.12

a	b	c	d	e	f
8 A	7.74 A	7 A	5.83 A	2 A	5.83 A

39.13 a) I = 10 A; b) I = still

39.14 V = 8 V (when both the generators are running in the same direction)

Chapter No. 40

	a	b	c	d	e
40.1	9.42 Ω	94.2 Ω	1510 Ω	18.8 kΩ	94.2 kΩ
40.2	785 Ω	262 Ω	942 Ω	6280 Ω	23.5 kΩ

40.3

a	b	c	d
ω = 314/s	ω = 314/s	ω = 314/s	f = 796 Hz
X_L = 628 Ω	X_L = 4.4 Ω	L = 0.318H	X_L = 2500 Ω

40.4

	L	X_L
a)	2.85 H	107 Ω
b)	1.05 H	330 Ω
c)	0.545 H	171 Ω

40.5 a) $L = 0.05$ H; $X_L = 15.7\,\Omega$
b) The value of X_L does not depend on the current any more.

40.6 7 A

40.7 a) 94 V b) 1880 V c) 35 V

40.8 a) $I_1 = 4$ A; $\varphi_1 = 0^\circ$
b) $I_2 = 7.5$ A; $\varphi_2 = 90^\circ$ (lagging)
c) $I = 8.5$ A
d) $I = 8.5$ A

40.9

a	b	c	d	e	f
6170 Ω	398 Ω	15.9 Ω	3.18 Ω	0.531 Ω	0.064 Ω

40.10

a	b	c	d
$\omega = 314/s$	$\omega = 628000$	$\omega = 105/s$	$\omega = 314/s$
$X_C = 318\,\Omega$	$X_C = 2650\,\Omega$	$f = 16\frac{2}{3}$ ms	$C = 31.8\,\mu F$

40.11

a	b	c	d	e	f
6.91 A	0.353 A	6.91 mA	20.7 mA	0.345 mA	4.14 μA

40.12 a) $I_1 = 3$ A ($\varphi = 0^\circ$)
b) $I_2 = 4$ A ($\varphi = 90^\circ$) (leading)
c) $I = 5$ A
d) $I = 5$ A

40.13 ($I_1 = 3$A; $I_2 = 4$A; $I_3 = 4$A;)
$I = 3$A

Chapter No. 41

41.1

	$\Sigma(\Omega)$	V(V)	I(A)	P_a (VA)	φ
Series R	150	195		254	0°
L	80	104		135	$+90^\circ$
Total	170	221	1.3	287	$+28^\circ$

41.2 100 Ω

41.3 a) 120 Ω
b) 0.382 H
c) Impedance triangle: 80 Ω = 4 cm (base),
150 Ω = 7.5 cm (hypotenuse)

41.4 a) $R = 12\Omega$; b) $Z = 15\Omega$;
c) $X_L = 9\Omega$; d) $L = 28.7$ mH

41.5

a) X_L	b) Z	c) I	d) $\cos\phi$
98.2 Ω	177	1.24 A	0.847

41.6

	a	b	c	d	e
f	50 Hz	$16\frac{2}{3}$ Hz	60 Hz	800 Hz	1.5 kHz
ω	314/s	105/s	377/s	5024/s	9420/s
X_L	60 Ω	20Ω	72 Ω	960 Ω	1800 Ω
R	100Ω	82.5 Ω	108Ω	961 Ω	1802 Ω
I	3.2 A	2.57 A	2.04 A	0.220 A	0.122 A
$\cos\varphi$	0.8	0.970	0.741	0.083	0.044
$\sin\varphi$	0.6	0.242	0.667	0.997	0.999

41.7 0.14 H

41.8 a) $R_T = 30\Omega$ b) $X_T = 40\Omega$ c) $Z_T = 50\Omega$

41.9 $Z = 50\Omega$ [approx.]: $I = 4.4$ A

41.10

	Z (Ω)	V (V)	I (A)	P_s (VA)	φ
Series R	100	117		137	0°
C	159	186		218	-90°
Total	188	220	1.17	257	-36°

41.11

	Z (Ω)	V (V)	I (A)	P_s (VA)	φ
Series L	55	220		880	$+90^\circ$
C	22	88		352	-90°
Series X_T	33	132		528	$+90^\circ$
R	44	176		704	0°
Total	55	220	4	880	$+37^\circ$

41.12

	Z (Ω)	V (V)	I (A)	P_s (VA)	φ
Series L	251	346		477	$+90^\circ$
C	127	175		241	-90°
Series X_T	124	171		236	$+90^\circ$
R	100	138		190	0°
Total	159	220	1.38	303	$+51^\circ$

41.13

		Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Series	L	157	864	|	4730	$+90^\circ$
	C	159	870	|	4810	-90°
Series	X_C	2	11	|	60	-90°
	R	40	220	|	1210	0°
Total		40	220	5.5	1210	-3°

41.14 15.9 Hz

Chapter No. 42

42.1

		Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall.	R	150	|	1.6	384	0°
	L	80	|	3.0	720	$+90^\circ$
Total		70.6	240	3.4	816	$+28^\circ$

42.2 a) I_R = 1 A; I_L = 1,17 A
b) I_Σ = 1.54 A
c) Z_L = 163 Ω

42.3 I = 9.6 A; Z = 22.9 Ω

42.4 Z = 38.4 Ω

42.5

		Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall.	R	100	|	2.2	484	0°
	C	100	|	2.2	484	-90°
Total		70.7	220	3.11	684	$+45^\circ$

42.6

		Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall.	R	50	|	4.4	968	$+90^\circ$
	C	55	|	4.0	880	-90°
Total		550	220	0.4	88	$+90^\circ$

42.7

	Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall. R_1	200	↑	1.1	242	0°
R_2	50		4.4	968	0°
Parall. R_T	40	↑	5.5	1210	0°
C	100		2.2	484	−90°
Total	37	220	5.93	1300	−22°

42.8

	Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall. L	100	↑	2.20	484	+90°
C	150		1.47	323	−90°
Parall. X_T	300	↑	0.73	161	+90°
R	80		2.75	605	0°
Total	77.3	220	2.85	627	+15°

42.9

	Z (Ω)	V (V)	I (A)	P_a (VA)	φ
Parall. L	40	↑	5.5	1210	+90°
C	40		5.5	1210	−90°
Parall. X_T	∞	↑	0	0	—
R	55		4	880	0°
Total	55	220	4	880	0°

42.10 f = 398 Hz

42.11 X_T = 17.7 Ω; I_T = 12.4 A;
I_R = 5.83 A; I_X = 10.9 A

42.12 a) Z = 26 Ω; b) I_T = 8.46 A
c) I_L = 12.2 A; I_C = 5.08 A

Chapter No. 43

43.1

	a	b	c	d	e	f
P_a in VA	150	20	1100	66	60	684
cos φ	0.8	0.6	0.7	0.606	0.6	0.322

43.2

	a	b	c	d
cos φ during attraction	0.750	0.667	0.375	0.333
cos φ during holding	0.333	0.278	0.300	0.300

43.3

	a	b	c	d	e	f
P in W	148	198	348	560	729	357

43.4 $\cos \varphi = 0.734$

43.5 1 A

43.6 a) $\cos \varphi_1 = 0.503$

b) $I_2 = 0.159$ A

43.7

a	b	c	d
147 kW	168 kW	178 kW	210 kW

43.8 Ra 0,29

43.9 a) 3360 W b) 0,382 kWh

43.10 $\cos \varphi = 0.750$

43.11 3.66 A

43.12 $\cos \varphi = 0.404$

43.13 a) 242 Ω b) 8 Ω

43.14 a) 2.42 Ω b) 5 Ω

43.15 a) 78.5 Ω b) 113 VAr

43.16 a) $Z = 5.6\,\Omega$ b) $P_{Cu} = 100$ W c) $P_{Fe} = 40$ W

43.17 a) $I_1 = 44$ A; $P_1 = 9680$ W

b) $I_2 = 2.33$ A; $P_2 = 27.1$ W

c) AC-coils are overloaded when connected to DC-source.

43.18

	b) 220V~100 Hz	c) 220V~300 Hz	d) 220V~600 Hz
X_L	160 Ω	480 Ω	1281 Ω
Z	171 Ω	484 Ω	1283 Ω
I	1.29A	0.455 A	0,172 A
P_a	284 VA	100 VA	37.8 VA
P_z	266 VAr	93.4 VAr	37.3 VAr
P	100 W	12.4 W	1.77 W
$\cos \varphi$	0.35	0.124	0,047

43.19 a) 50 VA b) 40 VAr c) 0.60

d) 0.80 e) 160 Ω f) 250 Ω

43.20 170 V

43.21

	a	b	c	d	e	f
V_a in V	19.2	36.4	82.5	198	304	425
V_r in V	14.4	21	72.8	95.9	238	283

43.22

	a	b	c	d	e	f
I_a in A	4	0.072	301	1625	13.7	26.6
I_r in A	3	0.096	132	1900	11.7	15.4

43.23

	Series				Parallel			
	Z (Ω)	V(V)	I(A)	P_a (VA)	Z (Ω)	V(V)	I(A)	P_a (VA)
b) Active	120	201	|	338	143	|	1.54	338
Reactive	53.3	89.9	|	151	320	|	0.69	151
Total	131	220	1.68	370	131	220	1.68	370
c) Active	120	117	|	114	425	|	0.518	114
Reactive	192	187	|	182	366	|	0.827	182
Total	226	220	0.973	214	226	220	0.973	214
d) Active	120	10.3	|	0.89	54500	|	0.004	0.89
Reactive	2560	220	|	18.9	2560	|	0.086	18.9
Total	2560	220	0.086	18.9	2560	220	0.086	18.9

43.24

	a	b	c	d	e
I	4.55 A	9.09 A	22.7 A	45.5 A	114 A

43.25

	a	b	c	d	e
C	165 μF	329 μF	658 μF	1650 μF	3298 μF
C	55.1 μF	110 μF	220 μF	551 μF	1100 μF
C	28.9 μF	57.8 μF	116 μF	289 μF	578 μF

43.26

	a	b	c	d	e
P_r (kVAr)	11.3	21.6	86.5	379	2160
P_y (kVAr)	3.75	7.24	28.9	260	724
P_z (kVAr)	13.6	26	104	935	2600

43.27 a) 3.85 μF b) 63500 VAr

c) V_1 = 4615 V; V_2 = 923 V; V_3 = 462 V

43.28 a) cos φ = 0.5 b) P_r = 152 VAr; C_1 = 10 μF

c) C_2 = 3.35 μF d) V_2 = 380 V

43.29 a) P_a = 120 VA; I = 80 W;
$\cos\varphi = 0.667$ ($\varphi = 48^\circ 10'$);
P_L = 83.4 VAr; P_{Cu} = 28.8 W;
P_{Fe} = 51.2 W;

b) P_C = 83.4 VAr; X_C = 112 Ω;
ω = 314 1/s; C = 28.4 µF;
I_C = 0.894 A; I_R = 0.8 A;

c) V_{Cu} = 24 V; $\tan\varphi_1 = 1.75$ ($\varphi_1 = 60^\circ 10'$);
I_{Fe} = 0.398 A; I_L = 1.04 A;
R_{Fe} = 143 Ω; X_L = 82.8 Ω;
U_1 = 86 V;

d) L = 0.264 H; A_L = 0.066 µH;
Θ = 2080 A; Φ = 137 µVs;
n = 86 V;

Chapter Sc. 44

44.1 At any moment the total value is zero.

44.2 a) I = nill
b) The branch currents will continue to flow.

44.3 V = nill

44.4 V_{DY} = 173 V

	a	b	c	d	e
44.5	222.1 V	218.2 V	227.8 V	216.5 V	219.4 V
44.6	220 V	180 V	= 660 V	220 V	127 V

44.7 a) V_p = 220 V; b) I_p = 10 A;
c) P_p = 2200 W; d) P = 6600 W;
e) I_L = 17.3 A

44.8

	V_p	I_p	P_p	P	I_L
a) Y	127 V	4.7 A	= 600 W	=1800 W	4.7 A
b) Δ	220 V	8.15 A	=1800 W	=5400 W	14.1 A

44.8 a) 12600 W b) 502 V
c) 14.5 A d) 230 V
e) 25.1 A

44.10 6 kW

44.11 13.5 A

44.12 2.5 kW

44.13

a	b	c	d	e	f
37.3 kW	35.3 kW	33.2 kW	31.1 kW	24.9 kW	20.7 kW

44.14

	a	b	c	d
V	380 V	220 V	380 V	220 V
I	4.54 A	11.7 A	13.6 A	13 A
P	3000 W	4450 W	9000 W	4950 W

44.15 a) 5.5 A b) 9.52 A c) 16.5 A

44.16 a) 54.6 A b) 30 kW c) 50 %

44.17 a) P = 6.25 kW b) P = 8.35 kW

44.18

	a	b	c
P_a	28.5 kVA	16.4 kVA	12.4 kVA
P	25.1 kW	12.6 kW	6.8 kW
P_r	13.5 kVAr	10.5 kVAr	10.4 kVAr
sin φ	0.47	0,64	0,84
tan φ	0,54	0.83	1.53
η	0.88	0.87	0.81

44.19 a) 146 kWh b) 63.5 kWh c) 51.7 kWh
d) 2.47 kWh; Total = 263.7 kWh

44.20 P_2 = 330 W

44.21

	a	b	c	d
	Series Y	Series Δ	Parall.Y	Parall.Δ
Z_p	170 Ω	170 Ω	70.6 Ω	70.6 Ω
cos φ	0.882	0.882	0.47	0.47
sin φ	0.47	0.47	0.882	0.882
V_p	220 V	380 V	220 V	380 V
I_p	1.29 A	2.24 A	3.11 A	5.38 A
P_p	≈250 W	≈750 W	≈320 W	≈960 W
I	1.29 A	2.88 A	3.11 A	9.31 A
P_A	≈850 VA	≈2550 VA	≈2040 VA	≈6120 VA
P	≈750 W	≈2250 W	≈960 W	≈2880 W
P_r	≈400 VAr	≈1200 VAr	≈1800 VAr	≈5400 VAr
P_r (phase)	≈133 VAr	≈400 VAr	≈600 VAr	≈1800 VAr
C_p	≈2.95 μF	≈8.8 μF	≈13.3 μF	≈39.8 μF

44.22

	lamp 1	lamp 2	lamp 3	P (Y)
a)	100 W	100 W	100 W	300 W
b)	-	100 W	100 W	200 W
c)	-	-	100 W	100 W
d)	100 W	100 W	100 W	300 W
e)	-	75 W	75 W	150 W
f)	-	-	-	0 W

44.23

	lamp 1	lamp 2	lamp 3	P (Δ)
a)	100 W	100 W	100 W	300 W
b)	-	-	-	0 W
c)	25 W	100 W	25 W	150 W
d)	-	100 W	100 W	200 W
e)	-	-	100 W	100 W
f)	-	100 W	-	100 W
g)	25 W	-	25 W	50 W

44.24 a) I_N ≈ 13 A

b) I_R ≈ 31 A; I_S ≈ 26.5 A; I_T = 39 A

Chapter No. 45

45.2 a) 1.666 % b) - 1.666

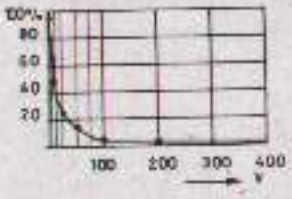
45.3

	a	b	c	d	e	f
Error in indication	0,003A	±0.012V	±2.5V	±2.5V	±0.125A	±0.5A
Error in %	0.222%	0.343%	1.923%	2.94%	2.5%	6,41%

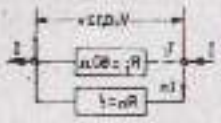
45.4 a) ± 6 V

b)

		Error in %
1.	200 V	± 3 %
2.	100 V	± 6 %
3.	50 V	± 12 %
4.	25 V	± 24 %
5.	12.5 V	± 48 %
6.	6.25 V	± 96 %



45.5



a) 1.224 Ω b) 0.2006 Ω c) 0.04803 Ω
d) 0,012002 Ω b) 0,0030005 Ω

b)

45.6 a) 2985 Ω b) 19985 Ω c) 74985 Ω
d) 124985 Ω e) 199985 Ω

45.7 a) 1000 Ω b) 4000 Ω c) 7000 Ω

45.8 a) 0.0666... Ω b) 0.0333... Ω c) 0.02 Ω
d) 0.0111... Ω

45.9 $\frac{V_1}{V_2} = \frac{R}{R_2} = \frac{8}{10} = \frac{4}{5}$

$V_1 = 97.77$ V $\quad V_2 = 122.23$ V

45.10 0.189 Ω

45.11 a) 124980 Ω = 125 kΩ b) 2 W

45.12 10 mA

45.13 0.5×10^{-4} A

45.14 100 k Ω

45.15 74.94 k Ω

45.16 a) 100 Ω b) 0.009 A

45.17 a) 30
b) High tension values

1	60 V	1800 V
2	75 V	2250 V
3	84 V	2520 V
4	92 V	2760 V
5	95 V	2850 V

45.18 a) 4.5 A b) 3.5 A c) 2.5 A
d) 1.5 A e) 1.2 A f) 0.8 A

45.19 350 A

45.20 3750

Chapter No. 46

46.3 a) 600 Ω b) ≈682 Ω c) 82 Ω = 13.6 %

46.4

R	$R_1=\frac{V}{I}$	$R=\frac{R_M R_1}{R+R_1}$	V	I	I_M	$I-I_M$	$R_x=\frac{V}{I}$	$R_x=\frac{V}{I-\frac{V}{R_1}}$	Approx. value in %
10k Ω	10000 Ω	5000 Ω	100V	20mA	10mA	10mA	5000 Ω	10000 Ω	50 %
	50000 Ω	8333.3Ω	100V	12mA	2mA	10mA	833.3Ω	50000 Ω	16.66 %
	100000Ω	9090.9Ω	100V	11mA	1mA	10mA	9090.9Ω	100000Ω	9.1 %
100Ω	10000 Ω	99.0Ω	100V	1.010A	10mA	1A	99.0Ω	10000 Ω	1 %
	50000 Ω	99.8Ω	100V	1.002A	2mA	1A	99.8 Ω	50000 Ω	0.2 %
	100000Ω	99.9Ω	100V	1.001A	1mA	1A	99.9 Ω	100000 Ω	0.1 %

Conclusions

a) Smaller measuring error is obtained with low value of 'R' and higher internal resistance of voltmeter.
b) Suitable circuit for measuring small resistances.

46.5 a) 2000 Ω ; 1840 Ω ; b) 160 Ω = 8 %

46.6 480 Ω

46.7

R	V	I	R_1	V_M	V_{R_x}	$R_x=\frac{V}{I}$	$R_x=\frac{V-IxR_1}{I}$	Approx. value in %
10k Ω	100V	9.98mA	20Ω	0.2V	99.8V	10020Ω	10000 Ω	0.2 %
	100V	9.95mA	50Ω	0.5V	99.5V	10050Ω	10000 Ω	0.5 %
100Ω	100V	0.833A	20Ω	16.7V	83.3V	120 Ω	100 Ω	20 %
	100V	0.666A	50Ω	33.4V	66.6V	150 Ω	100 Ω	50 %

Conclusions

a) Smaller measuring error is obtained with high value of 'R' and lower internal resistance of ammeter.
b) Suitable circuit for measuring high resistances.

46.8 $R_x = \frac{R_1}{R_2} \times R_v$

46.9 140 Ω

46.10 80 Ω

46.11 $t_1 : t_2 = 200 : 800$

46.12 $t_1 : t_2 = 0.696$ m : 0.304 m

46.13 18 Ω

Chapter No. 47

47.1 a) R = 7002.7Ω ; I_p = 0.031 A; V_R = 201.5 V;
b) R = 5002.7Ω ; I_p = 0.044 A; V_R = 198 V ;
c) R = 4502.1Ω ; I_p = 0.049 A; V_R = 198 V ;
e) R = 2302.7Ω ; I_p = 0.086 A; V_R = 173 V ;

47.2 21 kΩ (not sufficient)

47.3 a) 74.64 kΩ b) 65.04 kΩ; c) 57 kΩ

47.4 a) 12.45 V b) 6.22 V

47.5 190 kΩ (wrong data)

Chapter No. 48

48.1 a) 2.5 Ω ; 87.65 A; b) 1.37 Ω; 86.6 A;
c) 8.8 Ω ; 25 A; d) 1.25 Ω; 88 A;
e) 6.28 Ω; 35 A; f) 0.88 Ω ; 250 A;

48.2 a) 1.88 Ω ; b) 2.6 Ω ;

48.3 a) 6.29 Ω; b) 8.8 Ω ;

48.4 a) 216.6 Ω; 80 Ω ; b) 130 Ω ; 48 Ω ;
c) 65 Ω ; 24 Ω ; d) 21.66Ω) 8 Ω ;

48.5 a) 24 V ; b) 28 V ;
c) 36 V ; d) 48 V ;
e) 52 V ;

48.6 87.5 A

48.7 35 A

48.9 5 earth conductors, each 25 m long

48.10 R = 25 Ω; n = 5 plates

Chapter No. 49

49.2 e_2 = 1.43 V; N_2 = 284 V;
a) N_3 = 568 V; b) E_3 = 852 V; c) E = 1136 V;

49.3 a) ϕ = 3.92 mWb; b) e_2 = 0.87 V; c) E_2 = 435 V;

49.4 ≈ 234

49.5 0.00055 m^2

49.6 a) 0.00165 m^2; b) 0.00069 m^2; c) 0.00046 m^2;

49.7 a) ϕ = 3.48 mWb; b) B_{max} = 0.392 T

49.8 a) E_2 = 275 V; Φ_{max} = 4.32 x 10^{-3} Wb
b) e_2 = 1.408 V; A = 63.5 x 10^{-4} m^2;
ϕ = 6.35 x 10^{-3} Wb
c) N_2 = 603; e_2 = 0.365 V;
ϕ = 1.64 x 10^{-3} Wb
d) B = 0.5 T; N_2 = 1570; e_2 = 0.1065 V

49.10 N1=136 N2=1872

49.11 B_{max} = 1.032 T; N_2 = 18000 $Z = \frac{15}{T}$

49.12 223 V

49.13 a) 1.1 V; $Z = \frac{200}{T}$; b) 27.5 V; $Z = \frac{8}{T}$;
c) 110 V; $Z = \frac{2}{T}$; d) 330 V; $Z = \frac{1}{1.5T}$;
e) 66000V; $Z = \frac{1}{30}$;

49.15 0.655 A

49.16 14.4 A

49.17 N_2 for 8 Volts = 16; N_2 for 5 Volts = 11;
N_2 for 3 Volts = 6.3;

49.18 60 VA

49.19 210 kVA

49.20 b) I_1 = 1.36 A ; I_2 = 7.14 A ; c) I_1 = 2.27 A; I_2 = 11.9 A ;
d) I_1 = 2.63 A ; I_2 = 41.66 A; e) I_1 = 4 A ; I_2 = 43.61 A;
f) I_1 = 15.78 A; I_2 = 56.54 A;

49.21 I_2 = 90.9 A; I_1 = 6.67 A

49.22 I_1 = 10 A ; I_2 = 22 A
A_1 = 5 mm ; A_2 = 11 mm^2

49.23 a) I_2 = 8.33 A b) P_1 = 210.5 W c) I_1 = 0.96 A

49.24 a) P_2 = 1000 W; P_1 = 1087 W
b) I_1 = 2.86 A; I_2 = 41.66 A
c) P_t = 87 VA

49.25 a) 10 kW b) 8.7 kW c) 5 kW
a) I_2 = 34.64 A; b) I_2 = 49.45 A; c) I_2 = 22.72 A;
I_1 = 1.92 A; I_1 = 0.877 A; I_1 = 1.35 A;

49.26 a) 5.28 kW; b) 13.46 kW; c) 12.69 kW;
d) 7.5 kW; e) 15.4 kW;

49.27 a) I_2 = 95.2 A; b) I_1 = 18.18 A; c) I_1 = 18.18 A;

49.28 a) P_2 = 150 kW; b) 144 kW; c) 120 kW;
I_2 = 400 A ; I = 400 A; I = 400 A;
d) 96 kW; e) 80 kW; f) 48 kW;
I = 400 A; I = 400 A; I = 400 A;
g) 16 kW;
I = 400 A;

49.29 a) P_a = 25.83 kVA b) I_2 = 234.82 A
A = 85 mm^2

49.30 a) P_2 = 1360 W; b) P_1 = 1431 W;
I_1 = 6.5 A; c) P_t = 71 W;

49.31 a) P_{A2} = 17.4 kVA; b) P_1 = 15.8 kW;
c) I_1 = 3.06 A; I_2 = 48.5 A;
d) P_t = 0.8 kW;

49.32 a) η = 0,97; b) P_t = 3 W;

49.33 a) I_2 = 11.19 A; I_1 = 2.32 A;
b) P_1 = 600 W; P_2 = 700 W;
c) P_t = 100 W;
d) P_z = 239.7 VAr;

49.35

	V-ratio	S-ratio
Transformer I:	$\gamma = \frac{3}{1}$	$\gamma = \frac{9}{1}$
Transformer II:	$\gamma = \frac{4}{1}$	$\gamma = \frac{16}{1}$
Transformer III:	$\gamma = \frac{6}{1}$	$\gamma = \frac{36}{1}$

49.36 a) $N_2 = 165$; b) $I_2 = 4$ A; $I_1 = 0.363$ A;
c) $\gamma = \frac{11}{1}$; d) $\gamma = \frac{121}{1}$;

49.37 $\gamma = \frac{3}{1}$

49.38 a) $\gamma = \frac{25}{1}$; b) $\frac{6.67}{1}$; c) $\frac{5}{1}$;
d) $\gamma = \frac{50}{1}$; e) $\frac{18}{1}$; f) $\frac{10}{1}$;

49.39 $\gamma = \frac{3}{1}$

49.40 $R_1 = 55.125\ \Omega$

49.41 $\gamma = \frac{25}{1}$; $N_1 = 1250$;

Chapter No. 50

50.2 a) $I_{N1} = 4.81$ A; $I_{N2} = 125$ A;
b) $I_{N1} = 4.34$ A; $I_{N2} = 108$ A;
c) $I_{N1} = 3.85$ A; $I_{N2} = 110$ A;
d) $I_{N1} = 3.98$ A; $I_{N2} = 180$ A;
e) $I_{N1} = 15.4$ A; $I_{N2} = 176$ A;
f) $I_{N1} = 11.55$A; $I_{N2} = 500$ A;

50.3 a) $I_{N1} = 4.62$ A; $I_{N2} = 231.31$ A;
b) $I_{N1} = 3.46$ A; $I_{N2} = 173.41$ A;
c) $I_{N1} = 2.31$ A; $I_{N2} = 115.6$ A;
d) $I_{N1} = 5.31$ A; $I_{N2} = 265.89$ A;

13

50.4 a) $I_{N1} = 3.47$ A; $I_{N2} = 180.6$ A; $Y = \frac{52}{T}$;
b) $I_{N1} = 3.61$ A; $I_{N2} = 180.6$ A; $Y = \frac{50}{T}$;
c) $I_{N1} = 3.78$ A; $I_{N2} = 180.6$ A; $Y = \frac{48}{T}$;

50.5 380 V Δ : $I_{N1} = 3.85$ A; $I_p = 2.25$ A;
380 V λ : $I_{N2} = 152$ A; $I_p = 152$ A;
400 V : $I_{N2} = 144.5$ A; $I_p = 144.5$ A;
420 V : $I_{N2} = 137.7$ A; $I_p = 137.7$ A;

50.6 $I_{N1} = 9.25$ A; Y: $I_l = I_p = 9.25$ A
$I_{N2} = 176.16$ A; Δ : $I_p = 101.82$ A

50.7 a) $N_2 = 73$; b) $Y = \frac{19}{T}$;
c) $\frac{N_1}{N_2} = \frac{10.9}{T}$

50.8 a) $P_2 = 30$ kW b) $P_2 = 24.6$ kW
c) $P_2 = 16.5$ kW

50.9 a) $P_1 = 31.25$ kW b) $I_1 = 0.3$ A
$I_2 = 43.35$ A

50.10 a) $V_{N2} = 380$ V; $V_{N1} = 10000$ V;

50.11 $P_2 = 81$ kW

50.12 $P_2 = 93.75$ kW; $P_1 = 3.9$ kW;

50.13 a) $P_1 = 12.37$ kW b) $P_a = 14.63$ kVA
c) $I_1 = 1.45$ A

50.14 a) $I_1 = 13.87$ A b) $P_1 = 108$ kW
c) $Y = \frac{76}{T}$ d) $I_2 = 0.192$ A
e) $P_2 = 103.68$ kW; $P_{a2} = 126.4$ kVA

50.15 b) = 0.876 c) = 0.767
d) = 0.726 e) = 0.534

50.16 $\eta = 0.956$

50.17 a) $P_1 = 4.19$ kW; $\eta = 0.884$; b) 0.947; c) 0.93;
d) 0.964; e) 0.967; f) 0.973; g) 0.974;

Chapter No. 51

51.2 V_{DC} = 30.8 V; v_{ac} = 14 %

51.3 1) v_{ac} = 4.56 % 2) 4.45 % 3) 2.7 %

51.5 a) I_{N1} = 30.82 A; I_{N2} = 2312 A;
b) I_{ac1} = 513.6 A; I_{ac2} = 38533 A;

51.6 I_a = 14829 A

51.7 a) I_{ac1} = 321 A b) I_a = 815.34 A

51.8 a) I_{ac2} = 6.25 A b) I_a = 15.88 A

51.9

Protective transformer	Bell transformer	Ignition transformer
I_{ac1} = 17.53 A	I_{N2} = 1.5 A	I_{ac1} = 0.38 A
I_{ac2} = 277.7 A	I_{ac2} = 3.75 A	I_{ac2} = 0.6 A
I_{a1} = 44.53 A	I_{a2} = 9.51 A	I_{a3} = 1.52 A

51.11 P_{aI} = 18.75 kVA; P_{aII} = 56.25 kVA

51.12 a) v_{ac} = 2.28 %
b) P_{aI} = 114 kVA; P_{aII} = 146 kVA
c) I_{II} = 165 A ; I_{II} = 210.9 A

51.13 P_a = 334 kVA

Chapter No. 52

52.1 a) 800 Hz b) 3500000 Hz c) 520 x 10^6 Hz
d) 6500 Hz e) 900000 Hz f) 50 Hz

52.2 a) T = 0.02 s b) T = 0.00125 s c) T = 0.0001 s
d) T = 0.00000125 s

52.3 a) 33.84 V b) 59.22 V c) 84.60 V
d) 151.1 V e) 176.25 V f) 310.2 V
g) 535.8 V h) 1692 V

52.4 a) 4.25 V b) 35.46 V c) 85.10 V
d) 425.53 V e) 567.37 V f) 921.98 V
g) 14184.39 V

52.5 35.25 A

52.6 500 V

52.7 a) 102.6 V b) 212.13 V c) 229.8 V
d) 278.16 V e) 293.46 V f) 300 V
g) 72.57 V h) 158.32 V

52.8 a) 0 A b) 2.5 A c) 3.84 A
d) 5 A

52.9 a) 5 Hz b) 16 2/3 Hz c) 25 Hz
d) 40 Hz e) 50 Hz f) 60 Hz

52.10 a) 500 1/min b) 428.57 1/min c) 375 1/min
d) 300 1/min e) 250 1/min

52.11 a) 1 b) 2 c) 3
d) 4 e) 5

52.12 n_{max} = 761.25 1/min; n_{min} = 738.75 1/min

52.13 n = 168.6 1/min; f = 15.32 Hz ≙ 8 %

52.14 n = 33 1/min ≙ 8.8 %

52.15 a) 11 kW; b) 37.5 kW c) 43 kW

52.17 P_2 = 14.72 kW; P_a = 17.32 kVA

52.18 a) P_a = 1800 kVA b) 3000 kW c) 1575 kW

52.19 a) 0.818 b) 97.83 A

52.20 0.835 ≈ 0.84

52.21 a) 1 b) 0.792 c) 880 W
d) $\frac{18.217}{1}$

52.22 P = 5275.6 W P_a = 6440 VA P_r = 3693.9 VAr

52.23 a) P_2 = 1.29 kW; I = 7.75 A
b) P_1 = 4.8 kW ; I = 25.97 A
c) P_1= 17.36 kW; cos φ = 0.71
d) I = 102.82 A; η = 0.771
e) P_2 = 2105 kW; V = 6 kV

Chapter No. 53

53.1 250 1/min

53.2 a) η = 84 %; b) 60 kW

53.3 a) P_t = 120 kNm/s; η = 77 %
b) P_2 = 435 kW; η = 0.75
c) P_2 = 38.7 kW; P_t = 6300 $\frac{Nm}{s}$
d) P_1 = 81.52 kW; P_t = 6520 W
e) P_1 = 467.6 kW; P_t = 87800 W ≙ 117.69 hp
f) P_1 = 16000 hp P_t = 2387.2 kN

53.5 134200 kW

53.6 P_2 = 210796 kW; P_t = 37300 kN

53.7 ω = 33840 $\frac{s^2}{h}$

53.8 P_a = 5652 kVA

53.9 b) 175 kW c) 250 kW; d) 225 kW
e) 187.5 kW

53.10 b) P_1 = 154 kW; P_a = 175 kVA
c) P_2 = 169.2 kW; $\cos\varphi$ = 0.965
d) $\cos\varphi$ = 0.75; η = 0.9
e) P_1 = 60 kW; $\cos\varphi$ = 0.9

53.11 b) P_2 = 97.31 kW c) P_2 = 19.48 kW d) P_2 = 12.87 kW

53.12 a) P_2 = 30.4 kW b) P_2 = 47.5 kW c) P_2 = 20.9 kW
d) P_2 = 28.5 kW e) P_2 = 13.3 kW

53.13 a) $\cos\varphi$ = 0.801

b) P_c = 88.42 kVAr

53.14

	a	b	c	d
1. P_a in kVA	56.3	56.3	56.3	56.3
2. P_2 in kW	45	56.3	39.6	33.8
3. P_r in kVAr	33.8	0	40.1	45
4. I_a in A	52	65	45.5	39
5. I_r in A	39	0	46.4	52

53.15 $I_p = I_L = 730$ A

53.16 Delta connection: $V_L = V_p = 500$ V

Star connection: $V_L = V_p \times 1.73 = 500 \times 1.73 = 865$ V

Chapter No. 54

54.1

	P = 2	P = 6	P = 8	P = 10
a) 16 2/3 Hz	500 1/min	200 1/min	125 1/min	100 1/min
b) 50 Hz	1500 1/min	600 1/min	375 1/min	300 1/min
c) 60 Hz	1800 1/min	720 1/min	450 1/min	360 1/min

54.2 3820 1/min; 1410; 940; 705; 564; 470

54.3 a) 479 1/min b) 1437 1/min c) 1725 1/min
d) 2874 1/min

54.4 a) 750 1/min b) 3750 1/min

54.5 a) 3600 1/min; 1800 1/min; 1200 1/min;
900 1/min; 720 1/min
b) 5.55 %

54.6 a) 1380 1/min; 1488 1/min
b) 920 1/min; 992 1/min

54.7

a	b	c
n_F = 1000 1/min	n_F = 1800 1/min	n_p = 250 1/min
n = 950 1/min	f = 60 Hz	p = 4

d	e	f
n = 1410 1/min	n_F = 375 1/min	s = 6.8 %
f = 25 Hz	s = 2.93 %	p = 4

54.8 a) 240 A b) 135 A c) 45 A

54.9 a) t = 6.45 s b) t = 7 s c) t = 7.5 s
d) t = 8 s e) t = 8.7 s f) t = 9.48 s
g) t = 11.48 s h) t = 12.48 s

54.10

	a	b	c	d
P_1	1.83 kW	3.5 kW	6.4 kW	31.8 kW
I_N	5.8 A	6.2 A	~11.7 A	~43 A
I_{start}	7x5.8 ~40 A	6.5x6.2 ~40 A	2.5x11.7 ~29 A	1.5x43 ~65 A
Capacity of fuse	16 A	16 A	16 A	50 A
x-sect. area	1.5 or 2.5 mm^2	1.5 or 2.5 mm^2	1.5 or 2.5 mm^2	10 or 6 mm^2

54.13 a) 36.52 Nm b) 42.63 Nm

54.14 a) 424.3 N b) 265.2 N

Chapter No. 55

55.1 a) P_1 = 2.195 kW; I_N = 5.8 A
b) P_2 = 4.8 kW; I_N = 9,85 A
c) P_1 = 13,95 kW; cos φ = 0,87
d) η = 0,85 ; cos φ = 0,82
e) η = 0,86 ; V = 500 V
f) P_1 = 17 kW ; P_2 = 14.96 kW
g) P_1 = 0.736 kW; η = 0,75
h) P_2 = 7,5 kW ; I_N ≈ 12 A
i) P_2 = 1.48 kW; cos φ = 0,76
j) η = 0.65 ; V = 380 V
k) P_1 = 8,88 kW; I_N = 16,47 A
l) η = 0.84 ; cos φ = 0,845

55.2 a) 6.55 kW b) 7.13 hp c) 11.58 A

55.3 P_1 = 2.33 kW; η = 0,773; sin φ = 0.63

55.4 P_a = 4.49 kVA; P_r = 2.65 kVAr

55.5 500 V

55.6 a) cos φ = 0,788; b) φ = 38° c) sin φ = 0.615
d) η = 0,76

55.7 a) I_λ = 6.6 A b) I_Δ = 11.5 A

55.8 cos φ = 0.88; sin φ = 0.47

55.9 λ : I_L = 27.5 A
Δ : I_L = 82.18 A

55.10 2.5 Ωx

55.11 121.2 A

55.12 a) 12.53 A; 1.5 mm^2 b) 15.78 A; 1.5 mm^2
c) 25.65 A; 2.5 mm^2 d) 33.86 A; 4 mm^2
e) 51.4 A; 10 mm^2 f) 97.5 A; 25 mm^2

55.13 3.24 kW

55.14 a) 2.53 kW b) 12.3 kW
c) 2.32 kW d) 26 kW

55.15 Rs 229.--

Chapter No. 56

56.1 a) I = 4.7 A; P_z = 1.95 kVAr
b) $\cos\varphi_2$ = 0.88; P_{z2} = 486 VAr
c) without C: I_z = 2.95 A
with C : I_z = 0.74 A
d) $\varphi_1 = 39^\circ \rightarrow \varphi_2 = 11^\circ$

56.2 56 kW
a) 64 kW b) 69.6 kW c) 72 kW

56.3 Before compensation:
a) $\cos\varphi$ = 0.849; $\sin\varphi$ = 0.53 (approx.)
After compensation:
a) $\cos\varphi$ = 0.96; $\sin\varphi$ = 0.27
b) P_A = 14134 VA; P_z = 7.5 kVAr (approx.)
P_s = 13690 VA; P_z = 3.4 kVAr (approx.)

56.4 a) I_a = 18.75 A
b) I_s = 25 A; I_a = 6.25 A

56.5 $\cos\varphi$ = 0.808

56.6 a) P_s = 105.8 kVA
b) P = 74.76 kW
P = 38.61 kW

56.7

	b	c	d
P_1	2.4 kW	9.75 kW	14.1 kW
P_{s1}	3.7 kVA	13 kVA	19.6 kVA
P_{z1}	2.82 kVAr	8.6 kVAr	13.6 kVAr
P_{s2}	2.67 kVA	10.3 kVA	16.6 kVA
P_{z2}	1.17 kVAr	1.32 kVAr	8.74 kVAr
P_{zc}	1.65 kVAr	5.28 kVAr	4.8 kVAr
R_C	88 Ω	27.5 Ω	30.2 Ω
C	36 μF	115 μF	105 μF

56.9 a) 67.12 kVAr
b) 68.0 kVAr

56.10 53.9 kVAr

Chapter No. 57

57.1 21.6 Nm

57.2 16.4 Nm

57.3 102 Nm

57.4 47.75 Nm

57.5 a) 28.65 Nm b) 47.07 Nm c) 13.55 Nm
d) 25.62 Nm e) 3.89 Nm f) 1.68 Nm

57.6 a) 3400 Nm/s b) 5.4 kW c) ≈7.24 hp

57.7 a) 60.3 Nm b) 430.7 N

57.8 a) P_1 = 0.749 kW = 749 Nm/s
b) P_2 = 2.26 kW = 2260 Nm/s
c) P_3 = 3.89 kW = 3890 Nm/s
d) P_4 = 5.68 kW = 5680 Nm/s
e) P_5 = 8.93 kW = 8930 Nm/s
f) P_6 = 12.66 kW = 12660 Nm/s

57.9 26.82 Nm

57.10 4.2 Nm

57.11 a) 0.97 Nm b) 25.8 A c) 2.43 Nm
d) 1.65 Nm

57.12 a) 58.19 Nm b) 146.92 Nm c) 172.52 Nm

57.13 11.89 A

57.14 930.5 rpm

57.15 η = 0.84

57.16 a) I = 29.38 A d) T = 12.66 Nm
b) n = 1393 rpm e) η = 0.93
c) T = 10.21 Nm f) T = 6.16 Nm

57.17 a) 8.69 kW ≈ 11.65 hp b) 0.92
c) 770 W

57.18 a) 16.8 Nm b) 12.31 kW

57.19 146.9 N

Chapter No. 58

58.1 a) 40.21 Nm b) 335.08 N

58.2 33.08 kW = 44.34 hp

58.3 904.3 N

58.4 170.45 A

58.5 T = 7.3 Nm; F = 40.55 N

58.6 P_{2Motor} = 11.52 kW; I = 28.49 A

58.7 a) 4.24 kW b) 5.65 kW

58.8 79.92 Nm

58.9 50 kW = 50000 Nm/s = 67.02 hp

58.10 n = 1432 1/min

58.11 a) 52.08 kW b) 11 64 A

58.12 a) 46.15 kW b) 63 m c) 276 A

58.13 a) 165000 kg/hr c) 4.85 kW

58.14 a) 0.98 kW 1.86 kW c) 8.45 A

58.15 a) 57.97 Nm b) ≈ 349 kg

58.16 ≈ 209 m^3

58.17 a) 0.128 kW b) 0.15 kW c) ≈0.28 A; A = 1.5 mm^2
d) Bm 0.288

58.18 1.12 kW = 1120 Nm/s = 1.50 hp

58.19 A = 240 mm^2

Chapter No. 59

59.1 a) 317 mm b) 18.46 m/s c) $\frac{2.54}{1}$

59.2 a) 864 mm b) 22.61 m/s c) $\frac{1.92}{1}$

d) 846.7 mm

59.3 a) d_1 = 200 mm e) n_2 = 350 rpm
b) n_1 = 1250 rpm f) d_1 = 160 mm
c) d_2 = 320 mm g) n_1 = 800 rpm
d) n_2 = 700 rpm h) d_2 = 830 mm

59.4 a) n_2 = 171 rpm b) d_2 = 480 mm c) d_1 = 600 mm
i = $\frac{1.2}{1}$ i = $\frac{1}{1.25}$ i = $\frac{1}{1.6}$
A = 2430 mm A = 3240 mm A = 2925 mm

d) n_1 = 900 rpm e) n_1 = 600 rpm
i = $\frac{1}{1.66}$ i = $\frac{1}{1.5}$
A = 1320 mm A = 3000 mm

59.5 a) α = 178.32° b) α = 188° c) α = 175.7°
d) α = 175° e) α = 176°

... e of the above cases a Jockey Pulley is required.

59.6 a) b) n_1 = 140 rpm
d_2 = ... mm d_2 = 250 mm
d_1 = 724 d_1 = 1143 mm

c) n_1 = 350 rpm d) n_1 = 320 rpm
d_2 = 252 mm d_2 = 370 mm
d_1 = 93 mm d_1 = 163 mm

59.7 a) $i_1 = \frac{5.7}{1}$ b) $i_2 = \frac{2.94}{1}$ c) $i = \frac{32.3}{1}$

d) n_2 = 125.3 rpm

59.8 a) $i_1 = \frac{3.36}{1}$ b) $i_2 = \frac{2.5}{1}$ c) d_2 = 756 mm

d) d_2 = 300 mm e) $i = \frac{8.4}{1}$

59.9 a) D = 28 mm b) D = 327 mm c) D = 570 mm
d) D = 95 mm e) D = 120 mm f) D = 77 mm

59.10 a) d_a = 224 mm b) d_a = 630 mm c) d_a = 140 mm
d) d_{a1} = 112 mm e) d_a = 56 mm f) d_a = 125 mm

59.11 5.2 m/s

59.12 1006 rpm

59.13 $i = \frac{z}{1}$

59.14 a) 6.28 m/s b) d_{a2} = 400 mm c) $i = \frac{5}{1}$

Chapter No. 60

60.3 z_1 = 32

60.3 z_2 = 30

60.4 z_1 = 24; n_2 = 133 rpm

60.5 z_2 = 40; n_2 = 800 rpm

60.6 n_2 = 38.47 rpm; $i = \frac{3.8}{1}$

60.7 n_4 = 250 rpm; $i = \frac{8}{1}$

60.8 a) z_1 = 80; n_1 = 150 rpm
b) n_1 = 600 rpm; z_2 = 30
c) z_2 = 30; n_2 = 180 rpm
d) z_1 = 13; n_2 = 25 rpm
e) n_1 = 600 rpm; z_2 = 36

60.9

	Position I	Position II	Position III
Shaft 1	200 rpm	120 rpm	72 rpm
Shaft 2	n_2 = 40 rpm	24 rpm	14.4 rpm

60.10 $i = \frac{8}{1}$; n_2 = 56.25 rpm

60.11 $i = \frac{1}{14.4}$; n_2 = 806.4 rpm

60.12 n_1 = 200 rpm; z_2 = 48; $i_2 = \frac{1}{2.4}$; z_4 = 40; n_2 = 480 rpm

60.13 $i = \frac{9}{1}$; z_3 = 54; n_3 = 175 rpm; n_2 = 175 rpm; z_1 = 25

60.14 n_4 = 1384 rpm; $i \approx \frac{1.05}{1}$

60.15 $n_2 = 18$ rpm

60.16 $i = \frac{30}{1}$

60.17

	a	b	c	d	e
n_2 in rpm	10	75	20	36	36
i	$\frac{50}{1}$	$\frac{10}{1}$	$\frac{72}{1}$	$\frac{40}{1}$	$\frac{40}{1}$

Chapter No. 61

61.2 a) $s = 5.33$ % b) $s = 5.33$ % c) $s = 6$ %
d) $s = 6$ %

61.3 a) $n_s = 333.2$ rpm; $n = n_s - s = 313$ rpm
b) $n_s = 1000$ rpm; $n = 940$ rpm
c) $n_s = 1200$ rpm; $n = 1128$ rpm
d) $n_s = 2000$ rpm; $n = 1880$ rpm

61.4 12

61.5 a) $n_s = 250$ rpm; $s = 15$ rpm
b) $n_s = 375$ rpm; $s = 8.8$ %
c) $n_s = 600$ rpm; $n = 585$ rpm
d) $n = 2880$ rpm; $f = 50$ Hz
e) $n_s = 1500$ rpm; $s = 3.8$ %
f) $p = 2$; $s = 5.3$ %

61.6 $\cos \varphi = 0.734$; $\sin \varphi = 0.677$

61.7 a) $P_1 = 1.298$ kW; $P_s = 1.084$ kVAr $P_r = 1.226$ kVAr
b) $P_2 = 0.883$ kW
c) $T = 5.94$ Nm

61.8 a) $P_1 = 3.31$ kW; $P_s = 4.19$ kVAr $P_r = 2.63$ kVAr
b) $I = 19.94$ A

61.9 $P_1 = 1136$ W $I = 6.62$ A

61.10 a) $\eta = 0.68$ b) $P_s = 472$ VA c) $\cos \varphi = 0.59$
$\sin \varphi = 0.80$
d) $P_r = 378.4$ VAr e) $I_a = 1.27$ A f) $\varphi = 53^0$
$I_r = 1.72$ A

61.11 180 V (approx.)

61.12 180 V (approx.)

61.13 P_2 = 287.08 W ≈ 0.288 kW

T_N = 1 Nm

61.14 a) P_2 = 1.84 kW b) P_1 = 2.45 kW; I = 13.92 A

61.15 a) P_2 = 1.4 kW b) P_1 = ? kW; I = 11.38 A

61.16 C_D ≈ 82 µF; C_S = 27.3 µF

61.17 Ma 0.10

61.18 Ma 0.25

61.19 56.40 kWh

61.20 a) I_{start} = 10.5 A b) T_N = 3.15 Nm

c) T_{start} = 11.17 Nm T_{max} = 5.74 Nm

Chapter No. 62

62.1 t = 18.89 cm

62.2 t = 11.18 cm

62.3 a) d = 9.77 cm b) d = 5.23 cm

62.4 d = 1.04 cm

62.5 a) t = 20.7 cm b) t = 12.24 cm

62.6

Size of the plate	Type A 25 V circuit	
	g	M
18 x 18	S = 0.92 A/cm^2	S = 1.85 A/cm^2
40 x 40	S = 0.094 A/cm^2	S = 0.188 A/cm^2
80 x 100	S = 0.062 A/cm^2	S = 0.125 A/cm^2

Size of the plate	Type B 30 V circuit	
	g	M
18 x 18	S = 0.077 A/cm^2	S = 0.15 A/cm^2
40 x 40	S = 0.087 A/cm^2	S = 0.174 A/cm^2
80 x 100	S = 0.052 A/cm^2	S = 0.106 A/cm^2

62.7

	a	b	c	d
Size of the plate	100x100mm^2	100x300mm^2	200x200mm^2	300x400mm^2
Self cooling	I = 14 A	I = 21 A	I = 28 A	I = 56 A
Artificial cooling	I = 40 A	I = 60 A	I = 80 A	I = 160 A

62.8 Artificial cooling: 7.68 A
Self cooling: 3.84 A

62.9 572 cm^2

62.10 66.6 $\frac{A}{cm^2}$

62.11

	a	b	c	d
Data for plates	CuO_2 100x100mm^2	Ag 100x300mm^2	Ge ϕ 5.9 mm	Si ϕ 5.5 mm
A in cm^2	100	300	0.2375	0.2375
I in A (self cooling)	12	21	5.5	19
R_i in Ω	900	380	$0.2375 \times 4 \times 10^{-3}$	0.2375×10^{-3}

62.14 25 μF

62.15

	a	b	c	d	e	f
C_1 in μF	33.5	39.8	6.6	22.5	9	11

Chapter No. 63

63.2 a) n = 7 plates in each branch in series; total no. 12
b) n = 10 plates in each branch in series; total no. 40

63.3 Circuit a: V_1 = 100 V; V_{a-} = 45 V; I_- = 5 A
Circuit b: V_2 = 25 V; V_{a-} = 11.25 V; I_- = 32 A
Circuit c: V_3 = 50 V; V_{a-} = 22.5 V; I_- = 16 A

63.4 Circuit K: V_{a-} = 22.5 V; I_- = 0.1 A
Circuit M: V_{a-} = 32.5 V; I_- = 0.2 A
Circuit S: V_{a-} = 45 V; I_- = 0.3 A

63.5 a) $V_{o-} = 270$ V b) $I_- = 6$ A
c) $V_{2\sim} = 330$ V d) $P_a = 1461$ VA (approx.)
e) $V_z = 3$ V f) $P = 1068$ W

63.6 a) $V_{o-} = 90$ V b) $V_{2\sim} = 220$ V
c) $V_{2max} = 310$ V d) $V_z = 4$ V
e) $A \approx 17\ cm^2$ f) $P_z = 4.8$ W
g) $P_a = 166$ VA h) $W \approx 101.2$ V

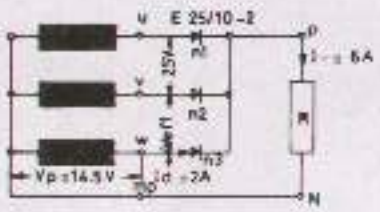
63.7 a) $I = 1.5$ A b) $I_G = 1.5$ A
c) $I_- = 3$ A d) $V_z = 2$ V
e) $V_- = 85$ V f) $P_a = 183$ VA
g) $W = 21.5$ V h) $R = 14.1\ \Omega$

63.8 $V_{o-} = 94$ V $V_z = 1$
$V_- = 83$ V $P_a = 258$ VA

63.9 $I_G = 1.5$ A

63.10 a) $V_{dr} = 380$ V b) $V_{dr} = 180$ V

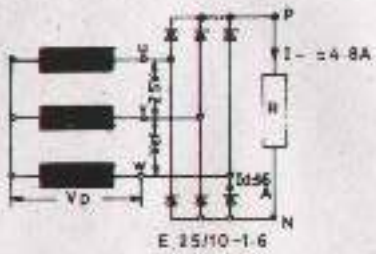
63.11



$\hat{V}\sim = 14.5 \times 1.41 = 20.4$ V
$V_{o-} = 0.83 \times 20.4 = 17$ V at no load

a) V_p = 14.5 V
b) V_{o-} = 17 V
c) I_d = 2 A
d) I_- = 6 A
e) P_- = 102 W
f) P_a = 134 VA
g) W = 3.3 V

63.12



E 25/10-1.6

$\hat{U}_2$ = 25 x 1.41 = 35.2 V

V_{o-} = 0.96 x 35.2 = 33.7 at no load

a) V_{o-} = 33.75 V
b) I_d = 1.6 A
c) I_- = 4.8 A
d) P_- = 162 W
e) P_a = 187 VA
f) W = 1.64 V
g) V_p = 14.5 V

Chapter No. 64

64.1 δV_{RL} = ± 0.25 %

64.2 R_i = 0.15

64.3 δV_{in} = ± 14.1 %

64.4 R_2 = 1.85 k Ω

64.5 P_{2max} = 1.5 W

64.6 R_x = 2 k Ω

64.7 $R_E = 3.19\ k\Omega$

$S = 0.05$; $\delta V_{RL} = + 0.0314\ V$

64.8 $R_E = 11.15\ k\Omega$ (>3.19 kΩ);

$S = 0.0298$ (<0.004751);

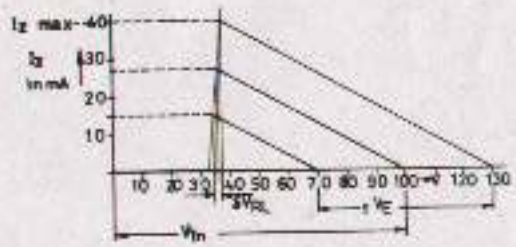
$\pm\ \delta V_{RL} = \pm\ 0.197\ V$ (>0.0314 V)

64.9 $\delta V_{RL} = \pm\ 18.25\ mV$

64.10 $\delta V_{RL} = \pm\ 0.0075\ V$ —— $\pm\ 0.0075\ V < \pm\ 0.01\ V$; condition fulfilled

$S = 0.0075$; $R_E = 450\Omega$

64.11 a) & b) see diagram



c) $\delta V_{RL} = 2.5\ V$

d) $\delta V_{RL} = 2.58\ V$

a) I_E not constant

b) I_L may be ignored

Chapter No. 65

65.1 $I_E = 10.15\ mA$

65.2 $I_B = 0.6\ mA$; $I_E = 50.6\ mA$

65.3 a) $V_{CB} = 0.8\ V$ b) $I_B = 0.119\ A$; c) $P_L = 7.5\ W$

$I_E = I_C + I_B$

$= 5 + 0.119$

$= 5.119\ A$

65.4 β = 50

65.5 I_C = 2.15 mA

65.6 a) R_{in} = 500 Ω c) R_{in} = 73 Ω

b) R_{in} = 133 Ω d) R_{in} decreases as I_B increases

65.7 $r_{in} = \frac{0.1\ V}{2 \times 10^{-3}\ A}$ = 50 Ω

65.8 $R_a = \frac{V_{CE}}{I_C}$; $-V_{CE}$ = 3 V

a) R_a = 50 Ω b) R_a = 15 Ω c) R_a = 3.4 Ω

d) R_a = 7.5 Ω e) R_a = 6.2 Ω

R_a decreases as I_C increases

65.9 r_o = 100 Ω

65.10 h_i = 78.13

65.11 A_v = 215; A_p = 17082

65.12 P_g = 5 mW P_c = 6 μW

65.13 177.5 kΩ

65.14 72.5 μA

65.15 R_1 = 3.43 kΩ R_2 = 333Ω

65.16 V_{BE} = 0.27 V

65.17 V_{B1} = 0.41 V; V_{B2} = 0.61 V; V_{CC} = 6.4 V

R_1 = 58 kΩ R_2 = 3.44 k Ω

Chapter No. 66

66.1 R = 1061 Ω

66.2 One needs a constant resistance from 0 - ∞ R

66.3 φ = 30°

66.4 V_C = 2.12 V; V_B = 3.68 V

66.5 a) φ = 0 ... 170°

b) φ = 90° —— between 0° and 180°

66.6 V_B = 1.293 V

66.7 a) Positive half-wave at point 'a':
T_1, D_2, D_4 open T_2, D_1, D_3 biased beyond cut-off

b) Negative half-wave at point 'a':
T_2, D_1, D_3 open T_1, D_2, D_4 biased beyond cut-off

Chapter No. 67

67.1

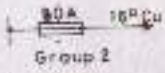
	a	b	c	d	e	f
A in mm²	1.5	6	4	35	2.5	10
I_F in A	16	35	25	100	20	50

67.2

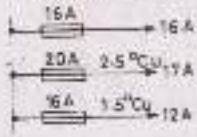
	a	b	c	d	e	f
A in mm²	-	-	2.5	-	-	4
Load group	-	1	-	2	-	-
I_F in A	25	-	-	-	16	-

67.3

67.4



67.5



67.6

a) rubber insulation

b) plastic insulation

67.7

	a	b	c	d	f
1. Room temperature in °C	25	30	35	45	50
2. X-sect. at +25°C for I=80A	16	16	16	16	16
3. Fuse corr. acc. to gr.1 for Cu	63	63	63	63	63
4. Loading capacity at +25°C in A	65	65	65	65	65
5. Loading cap. at above mention. room temp. in A: x% for 65A	100% 65	92% 59.8	85% 55.3	65% 42.3	53% 34.5
6. X-sect. for 25°C with 16	corr.	i d e n t i c a l			
7. New bigger X-section	-	25	25	35	50
8. Loading capacity at +25°C	-	88	88	110	140
9. Loading cap. at room temp.	-	81	75	71.5	74
10. Result	-	s u f f i c i e n t			
11. Fuse for A=16mm² in A	63	63	63	63	63

67.8

		a	b	c	d	e	f
Repeating the calculated values	Current in A	85	30	100	55	22	200
	Room temp. in °C	30	55	35	50	45	40
	Group	2	1	1	3	3	2
	Cond. material	Cu	Al	Cu	Al	Cu	Al
Conductor values for 25°C	X-sect. in mm²	16	4	35	10	1,5	95
	Fuse in A	80	20	100	63	25	224
	Load capacity	87	21	110	61	23	210
Loading cap. at room temp. in %		92	38	85	53	65	75
Loading cap. at room temp. in A		80	8	93.5	32.3	16.2	158
Estimated nominal X-section		n o t	s u f f i c i e n t				
New X-section in mm²		25	25	50	35	2,5	150
Loading capacity at 25°C		115	69	140	107	34	280
Loading cap. at room temp.		106	26,3	119	56.6	22.1	210
Result		s u f f i c i e n t				without reserve	
Fuse current in A		80	20	100	63	25	225

67.9

	a) 10 mm²	b) 16 mm²	c) 50 mm²
a) 25°C	Group I: 48 A J = 4.8 A/mm²	Group I: 65 A J = 4.06 A/mm²	Group I: 140 A J = 2.8 A/mm²
b) 35°C	85%: I=40.8 A J = 4.08 A/mm²	85%: I=55.25 A J = 3.45 A/mm²	85%: I=119 A J = 2.38 A/mm²
c) 55°C	38%: I=18.24 A J = 1.824 A/mm²	38%: I=24.70 A J = 1.54 A/mm²	38%: I=53.2 A J = 1.06 A/mm²

67.10 13.55 kWh

67.11 295.84 kcal

67.12 a) V_L = 14.11 V b) V = 205.89 V c) Q = 4010000 J

Chapter No. 68

		a	b	c	d	e	f
68.1	V in V	216.1	368.6	108.68	482	238.62	420.2
68.2	V_L = 4%	1.82	2.27	6.36	3	4	3.1
68.3	V_L	1.9	4.7	2.1	1.8	3.2	3.75
	P_L	19	117.5	88.2	32.4	256	112.5

68.4 a) L = 10 m b) I = 40 A c) L = 14 m
d) I = 23.4 A e) L = 19.5 m f) I = 84 A

68.5 a) L = 11.6 m b) I = 46 A c) V_L = 3.1 V
d) I = 23 A e) V_L = 1.9 V f) L = 9.7 m

68.6 I = 33 A: Gr. 1: 35 A

68.7 I = 20 A: Gr. 1: 27 A

68.8 I = 37.2 A: Gr. 1: 35 A

68.9 216.64 V

68.10 a) V = 216.88 V b) V_L = 1.42 % c) P_L = 147.9 W

68.11 a) I = 22.7 A b) A = 4 mm^2, Cu, Gr. 1
c) V_L = 1.65 % d) P_L = 82.86 W

68.12 a) I = 27.4 A b) A = 6 mm^2, Cu, Gr. 1
c) V_L = 1.3 %

68.13 a) A = 2.5 mm^2 Cu because of high starting current
b) V = 375.7 V
c) I_{start} without λ/Δ starter
I_{start} = 95.2 A

68.14 a) A = 10 mm^2, Cu, Gr. 1
b) Loading capacity 75 % at + 40°C = 75 % of 48 A = 36 A
c) New X-section: 16 mm^2 at 65 A
Check: 75 % of 65 A = 48.8 A, i.e. for 40 A sufficient
I_n = 50 A as for 10 mm^2, Cu

68.15 a) New X-section: A = 25 mm² A) for Gr. 2 at 90 °
85 % of 90 A = 76.5 A, i.e. 25 mm² A) sufficient
b) V_g = 1.45 %

68.16 a) X-section (rubber insulation)

A in mm²	I in A	I at 50°C	Result
4	27	14.3	too small
6	35	18.5	selected
10	46	25.4	too big

b) Without considering temperature coefficients:
V_g = 0.61 %

68.17 a) X-section (rubber insulation)

A in mm²	I in A	I at 40°C	Result
2.5	25	15.75	too small
4	27	20	selected
6	35	26.2	too big

b) Without considering temperature coefficients:
V_g = 0.94 %
c) V_g = 1.61 %

68.18 P_g = 323 W = 3.4 %

68.19 a) A = 2.5 mm², Cu, Gr. 3
b) A = 6 mm², Cu, Gr. 3

68.20 a) Selected X-section = 4 mm², Gr. 2, Cu
b) A = 6 mm², Gr. 3, Cu

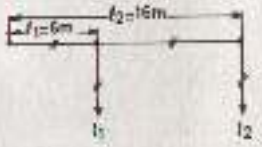
68.21 a) Motor 1: I = 21.36 A
Motor 2: I = 21.77 A
Motor 3: I = 16.17 A
b) Mains supply line:
M_1: A = 4 mm², Cu, Gr. 1
M_2: A = 4 mm², Cu, Gr. 1
M_3: A = 2.5 mm², Cu, Gr. 1
c) A = 16 mm², Cu, Gr. 1

68.23 a) A = 10 mm², Cu, Gr. 1
b) V_g = 2.57 V = 2.33 %

68.24 a) $V_2 = 217.4$ V

$V = 218.44$ V

68.25



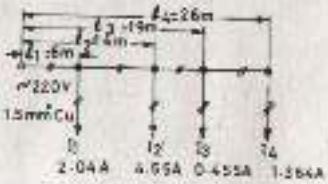
a) $I_1 = 21.7$ A
$I_2 = 13.3$ A
$I = 35$ A

b) $A = 6\ mm^2$, Al, Gr. 2

c) $V_2 = 436.66$ V

d) $V_1 = 435.725$ V

68.26



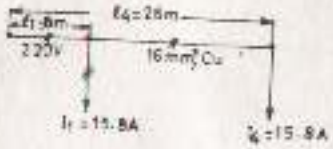
$V_4 = 217.15$ V

68.27 a) $I_1 = 15.8$ A b) $I = 33.3$ A

c) $A = 16\ mm^2$, Cu, Gr. 1

d) $V_4 = 217.93$ V

c)



V_4 = 218.93 V

68.28 a) Motor 1: I_1 = 4.2 A
Motor 2: I_2 = 4.9 A
Motor 3: I_3 = 11.4 A
Motor 4: I_4 = 19.7 A

I = 40.2 A

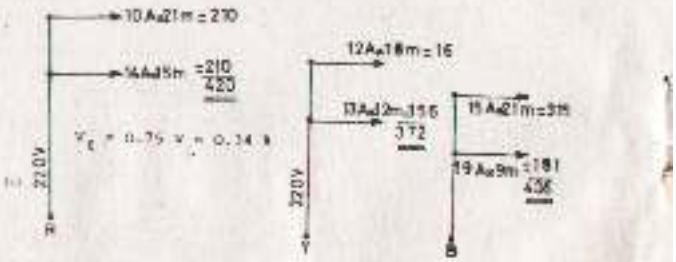
b) A = 6 mm², Cu, Gr. 2; average value of $\cos\varphi$ = 0.85

c) Motor 1: A = 1.5 mm², Cu, Gr. 2
Motor 2: A = 1.5 mm², Cu, Gr. 2
Motor 3: A = 1.5 mm², Cu, Gr. 2
Motor 4: A = 1.5 mm², Cu, Gr. 2

68.29 V_L = 0.565 %

68.30 V_L = 0.5 %

68.31 a)



V_L = 0.885 = 0,3 %

V_L = 0,4 %

68.32 a) V_L = 1.32 V b) V_L = 0.35 % (approx.)

Chapter No. 69

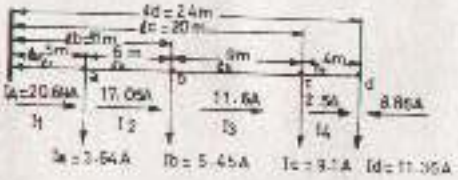
69.1 a) I_B = 48.41 A; I_A = 46.59 A

b) Reversing point of current:
Point c

c) Branch current A: 18.1 A
Branch current B: 6.9 A
25.0 A at joint c

69.2 a) I_D = 20.42 A; I_A = 20.58 A

b) Reversing point of current: Branch 'd'

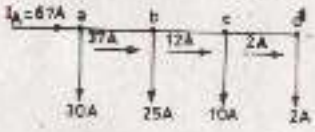


c) A = 6 mm^2, Cu, Gr. 2

d) I_E = 50 A

e) P_L = 30.48 W

69.3 Reversing point of current: Branch 'd'

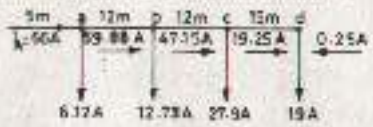


a) A = 16 mm^2, Cu, Gr. 2

b) I_F = 63 A

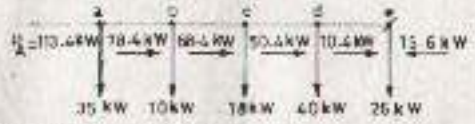
c) R_1: A = 4 mm^2, Cu, Gr. 2; I_D = 35 A
R_2: A = 2.5 mm^2, Cu, Gr. 2; I_F = 25 A
R_3: A = 1.5 mm^2, Cu, Gr. 2; I_E = 20 A
R_4: A = 6 mm^2, Cu, Gr. 2; I_E = 50 A
R_5: A = 1.5 mm^2, Cu, Gr. 2; I_F = 20 A

69.4 Generating point of current: Branch 'd'



Selected X-section: 10 mm^2, Cu, Gr. 2

69.5 Generating point of current: Branch 'e'



A = 264 mm^2, Cu, Gr 1

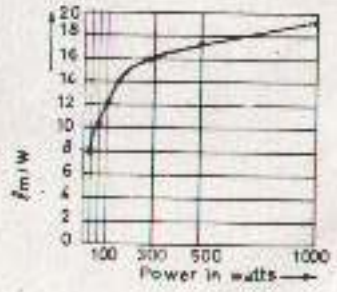
Chapter No. 70

70.1 A = 0.000526 mm

70.2 A_{red} = 0.00075 to 0.00085 mm
A_{blue} = 0.0005 to 0.000439 mm

70.3

	Im/W
a)	8
b)	10.2
c)	12.5
d)	14
e)	16.6
f)	18.5



70.4

	a	b	c	d	e	f
lm/W	37.5	47.5	42.5	48	43	61.5

70.5 a) E = 84 lx b) E = 31.2 lx c) E = 33.3 lx
d) E = 54 lx e) E = 30 lx f) E = 40 lx

70.6 a) E = 100 lx
b) Power needed = $\frac{P}{A} = \frac{21}{3} = 10.3 \frac{W}{m^2}$

70.7 a) No. of lamps= 40
b) Power needed= 10.7 $\frac{W}{m^2}$

70.8

	a	b
1. No. of lamps	~22	100
2. Connected load in kW	22	6.5
3. Power needed per m^2	73.5	21.6
4. Current in A	100	29.5

70.9 a) E = 116 lx
b) E = 345 lx

70.10 a) No. of lamps = 15.6 ≈ 16
b) P = 1040 W

70.11 a) η = 0.5 b) E = 250 lx
c) No. of lamps = 200

70.12 a) No. of lamps = 45

70.13 a) No. of lamps = 3.38 ≈ 4
b) Power needed = 44 W/m^2

70.14 a) E = 50 lx
b) Not sufficient, needed 120 lx