

Scilab Textbook Companion for  
Fundamentals Of Electrical Engineering  
by R. Prasad<sup>1</sup>

Created by

Suji M

BE

Electrical Engineering

St.Xavier's Catholic College of Engineering

College Teacher

None

Cross-Checked by

None

July 31, 2019

<sup>1</sup>Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website <http://scilab.in>

# Book Description

**Title:** Fundamentals Of Electrical Engineering

**Author:** R. Prasad

**Publisher:** PHI Learning Private Limited

**Edition:** 3

**Year:** 2014

**ISBN:** 9788120348950

Scilab numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

**AP** Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

# Contents

List of Scilab Codes	4
1 Fundamentals of Electrical Energy	6
2 Circuit Analysis Resistive Network	26
3 Circuit Analysis Time Varying Excitation	58
4 Electrostatics	97
5 Electromagnetism and Electromechanical Energy Conversion	121
7 Transformer	139
8 Direct Current Machines	160
9 Synchronous Machines	188
10 Three Phase Induction Motor	206
11 Special Purpose Electrical Machines	226
12 Analysis of Three Phase Circuits	233

13 Dynamic Response of Network	262
14 Electrical Power System	271
15 Domestic Lighting	282

# List of Scilab Codes

Exa 1.1	Determination of Energy consumed and Electricity charge . . . . .	6
Exa 1.2	Determination of resistance value of the resistor . . . . .	8
Exa 1.3	Determination of resistance value of the resistor and its power rating . . . . .	9
Exa 1.4	Calculation of equivalent resistances and power dissipation . . . . .	11
Exa 1.5	Sketch the capacitance current and voltage and charge and power and stored energy . .	11
Exa 1.6	Plotting power waveform and calculate dissipated power . . . . .	14
Exa 1.7	Identification of electric device from the given plot . . . . .	16
Exa 1.8	Calculation of capacitor voltage and current and energy dissipated . . . . .	18
Exa 1.9	Determination of equivalent capacitance value	20
Exa 1.10	Plotting voltage and power and energy waveform . . . . .	21
Exa 1.11	Determination of current and voltage and dissipated energy . . . . .	24
Exa 2.1	Determination of unknown currents and voltages . . . . .	26
Exa 2.2	Determination of currents in the given network	28
Exa 2.3	Conversion of current source into a voltage source and voltage source into a current source	30
Exa 2.4	Determination of voltage and current using nodal analysis method . . . . .	32

Exa 2.5	Determination of voltage and current using nodal method . . . . .	34
Exa 2.6	Determination of voltage and current using mesh analysis method . . . . .	37
Exa 2.7	Determination of voltage using nodal analysis method . . . . .	38
Exa 2.8	Determination of current using mesh voltage method . . . . .	40
Exa 2.9	Determination of current using a principle of superposition . . . . .	42
Exa 2.10	Determination of current in all resistance using superposition principle . . . . .	45
Exa 2.11	Determination of current using Thevenins theorem . . . . .	48
Exa 2.12	Determination of current using Norton theorem . . . . .	48
Exa 2.13	Determination of load resistance . . . . .	50
Exa 2.14	Determination of driving point resistance of the voltage source . . . . .	53
Exa 2.15	Determination of driving point resistance at the pair of terminals . . . . .	53
Exa 2.16	Determination of resistance value and amount of power . . . . .	55
Exa 3.1	Calculation of impedance and admittance . . . . .	58
Exa 3.3	Determination of voltage across resistance and inductance and capacitance . . . . .	59
Exa 3.4	Determination of current through conductance and capacitance and inductance . . . . .	60
Exa 3.5	Determination of current and voltage across inductance . . . . .	62
Exa 3.6	Determination of forced component of current . . . . .	63
Exa 3.7	Determination of average and RMS value of voltage . . . . .	65
Exa 3.8	Determination of circuit current and voltage using phasor method . . . . .	66
Exa 3.9	Determination of current through different elements and voltage . . . . .	69

Exa 3.10	Determination of voltage and current using complex method . . . . .	71
Exa 3.11	Calculation of resonance frequency and quality factor and bandwidth . . . . .	74
Exa 3.12	Calculation of resonance frequency and quality factor and bandwidth . . . . .	75
Exa 3.13	Determination of current using nodal method	77
Exa 3.14	Determination of voltage using nodal method	80
Exa 3.15	Determination of current using mesh analysis	81
Exa 3.16	Determination of voltage using mesh analysis	83
Exa 3.17	Determination of voltage using Thevenins theorem . . . . .	84
Exa 3.18	Determination of current using Thevenins theorem . . . . .	86
Exa 3.19	Determination of current using Norton theorem . . . . .	87
Exa 3.20	Calculation of impedance and maximum power	90
Exa 3.21	Determination of voltage and power and reactive power . . . . .	91
Exa 3.22	Determination of capacitance and current of alternator . . . . .	93
Exa 3.27	Plotting the four components from the given circuit . . . . .	94
Exa 4.1	Determination of force between two spheres	97
Exa 4.3	Calculation of force . . . . .	98
Exa 4.4	Determination electric field intensity . . . . .	100
Exa 4.5	Calculation of electric field intensity . . . . .	101
Exa 4.7	Determination of distance between two charges at which electric field strength is zero . . . . .	102
Exa 4.11	Determination of maximum torque and work done . . . . .	103
Exa 4.14	Determination of charge . . . . .	104
Exa 4.15	Calculation of potential difference between two points . . . . .	105
Exa 4.16	Calculation of net potential . . . . .	106
Exa 4.18	Calculation of electric field . . . . .	108
Exa 4.19	Calculation of potential and field strength . . . . .	109
Exa 4.22	Determination of electric field strength . . . . .	111



Exa 4.24	Determination of capacitance of the capacitor and potential difference across the capacitor	113
Exa 4.26	Calculation of electric field intensity and electric flux density . . . . .	114
Exa 4.27	Calculation of capacitance of the line . . . . .	116
Exa 4.28	Calculation of thickness of the dielectric . . . . .	117
Exa 4.29	Determination of loss energy . . . . .	118
Exa 5.5	Determination of mmf and total flux and flux density . . . . .	121
Exa 5.6	Determination of mmf . . . . .	123
Exa 5.7	Calculation of reluctance and current . . . . .	124
Exa 5.8	Calculation of reluctance and current . . . . .	125
Exa 5.9	Calculation of mmf . . . . .	127
Exa 5.10	Calculation of magnetizing current . . . . .	128
Exa 5.12	Calculation of inductance and time at pickup value of current . . . . .	129
Exa 5.13	Calculation of cross sectional area of the core and magnetizing current . . . . .	131
Exa 5.14	Determination of steady state value of current and resistance and inductance of the coil and stored energy . . . . .	132
Exa 5.15	Calculation of load current and impedance referred to primary and secondary side . . . . .	134
Exa 5.16	Calculation of instantaneous values of induced emf . . . . .	135
Exa 5.17	Determination of torque exerted on the coil	137
Exa 7.1	Calculation of current and number of turns and maximum flux value . . . . .	139
Exa 7.2	Calculation of primary current and power factor . . . . .	141
Exa 7.3	Determination of primary current and power factor and secondary terminal voltage . . . . .	143
Exa 7.4	Calculation of impedance and voltage regulation . . . . .	145
Exa 7.5	Calculation of efficiency . . . . .	147
Exa 7.6	Calculation of maximum efficiency . . . . .	150
Exa 7.7	Calculation of efficiency and voltage regulation and secondary terminal voltage . . . . .	151

Exa 7.8	Calculation of primary line current and voltage and line to line transformation ratio . . .	155
Exa 7.9	Determination of position of tapping point and current in each part of winding and copper saved . . . . .	156
Exa 7.10	Determination of ratio error . . . . .	158
Exa 8.1	Calculation of design parameters for a dc machine . . . . .	160
Exa 8.2	Calculation of design parameters for a dc machine . . . . .	161
Exa 8.3	Calculation of design parameters for a dc machine . . . . .	163
Exa 8.4	Calculation of design parameters for a dc machine . . . . .	164
Exa 8.5	Calculation of generated emf . . . . .	166
Exa 8.6	Calculation of number of conductors per slot	167
Exa 8.7	Calculation of number of demagnetizing and cross ampere turns per pole . . . . .	168
Exa 8.8	Calculation of armature resistance and generated emf . . . . .	169
Exa 8.9	Calculation of armature generated voltage .	171
Exa 8.10	Calculation of generated emf . . . . .	172
Exa 8.11	Calculation of motor speed . . . . .	173
Exa 8.12	Calculation of motor speed and gross torque developed . . . . .	175
Exa 8.13	Calculation of motor speed and current and speed regulation . . . . .	176
Exa 8.14	Calculation of current and kW input of the motor . . . . .	178
Exa 8.15	Calculation of external resistance and electric braking torque . . . . .	179
Exa 8.16	Calculation of speed at full load torque . . .	181
Exa 8.17	Calculation of efficiency of generator at full load and half load . . . . .	183
Exa 8.18	Calculation of efficiency of the generator . .	185
Exa 8.20	Determination of time . . . . .	186
Exa 9.1	Calculation of distribution factor . . . . .	188

Exa 9.2	Calculation of number of poles and flux per pole . . . . .	189
Exa 9.3	Determination of short circuit ratio and synchronous reactance . . . . .	191
Exa 9.4	Calculation of leakage reactance and field current . . . . .	193
Exa 9.5	Determination of excitation voltage . . . . .	194
Exa 9.6	Calculation of voltage regulation . . . . .	195
Exa 9.7	Calculation of voltage regulation . . . . .	197
Exa 9.8	Determination of capacity of the condenser . . . . .	199
Exa 9.9	Determination of capacity of the synchronous condenser . . . . .	200
Exa 9.10	Determination of line current and power factor . . . . .	202
Exa 9.11	Determination of increase in additional loss and decrease in line current and final line current . . . . .	203
Exa 10.1	Calculation of synchronous speed and rotor speed and rotor frequency . . . . .	206
Exa 10.2	Calculation of flux per pole and rotor emf and phase angle . . . . .	207
Exa 10.3	Calculation of output power and mechanical power developed and rotor copper loss and efficiency . . . . .	209
Exa 10.4	Determination of synchronous speed and slip and maximum torque and rotor frequency . . . . .	211
Exa 10.5	Calculation of number of poles and slip and rotor copper loss . . . . .	213
Exa 10.6	Determination of starting torque . . . . .	215
Exa 10.7	Calculation motor parameters and slip and pullout torque . . . . .	216
Exa 10.9	Determination ratio of starting current to full load current . . . . .	218
Exa 10.10	Calculation of starting torque and starting current . . . . .	219
Exa 10.11	Calculation of plugging torque . . . . .	221
Exa 10.12	Calculation of external resistance . . . . .	223
Exa 10.13	Calculation of speed and power ratio and frequency . . . . .	224

Exa 11.1	Determination of motor parameters and stator current and power factor and speed and torque . . . . .	226
Exa 11.2	Calculation of developed power and copper loss . . . . .	228
Exa 11.3	Calculation of motor speed and torque . . . . .	230
Exa 11.4	Calculation of magnetic flux . . . . .	232
Exa 12.1	Calculation of line current of load and alternator . . . . .	233
Exa 12.2	Determination of phase and line current of the load . . . . .	236
Exa 12.3	Calculation of total KVA of capacitors and capacitance value . . . . .	237
Exa 12.4	Calculation of total KVA of capacitors and capacitance value . . . . .	239
Exa 12.5	Calculation of line current and neutral current	241
Exa 12.6	Determination of complex power and line current . . . . .	242
Exa 12.7	Calculation of line current and phase current and total power dissipated . . . . .	244
Exa 12.8	Calculation of total power and reactive power	248
Exa 12.9	Calculation of neutral current and power taken by each phase . . . . .	250
Exa 12.10	Determination of phase voltage and current	253
Exa 12.11	Calculation of each branch voltage and current	256
Exa 12.12	Calculation of line current or star phase current . . . . .	258
Exa 12.13	Calculation of line current . . . . .	260
Exa 13.1	Calculation of resistance . . . . .	262
Exa 13.2	Determination of current and time . . . . .	264
Exa 13.5	Determination of time constant and damping ratio and current . . . . .	264
Exa 13.6	Determination of current values . . . . .	266
Exa 13.7	Calculation of current ratio . . . . .	268
Exa 13.14	Determination of current . . . . .	269
Exa 14.1	Calculation of average load and energy consumption and load factor . . . . .	271

Exa 14.2	Determination of diversity factor and load factor and combined average load . . . . .	273
Exa 14.3	Calculation of annual bill of the consumer .	275
Exa 14.4	Calculation of overall cost per kWh . . . . .	276
Exa 14.5	Calculation of monthly bill of the consumer	277
Exa 14.6	Calculation of annual bill of the consumer .	279
Exa 15.1	Calculation of lamp efficiency and luminous intensity and MSCP . . . . .	282
Exa 15.2	Calculation of average luminance of the sphere	283
Exa 15.3	Determination of illumination . . . . .	285
Exa 15.4	Calculation of distance between two lamps .	286
Exa 15.5	Determination of size of the conductor . . .	287

# List of Figures

1.1	Determination of Energy consumed and Electricity charge . . . . .	7
1.2	Determination of resistance value of the resistor . . . . .	8
1.3	Determination of resistance value of the resistor and its power rating . . . . .	9
1.4	Calculation of equivalent resistances and power dissipation . . . . .	10
1.5	Sketch the capacitance current and voltage and charge and power and stored energy . . . . .	12
1.6	Plotting power waveform and calculate dissipated power . . . . .	16
1.7	Plotting power waveform and calculate dissipated power . . . . .	17
1.8	Identification of electric device from the given plot . . . . .	17
1.9	Calculation of capacitor voltage and current and energy dissipated . . . . .	18
1.10	Determination of equivalent capacitance value . . . . .	20
1.11	Plotting voltage and power and energy waveform . . . . .	21
1.12	Determination of current and voltage and dissipated energy . . . . .	24
2.1	Determination of unknown currents and voltages . . . . .	27
2.2	Determination of currents in the given network . . . . .	29
2.3	Conversion of current source into a voltage source and voltage source into a current source . . . . .	31
2.4	Determination of voltage and current using nodal analysis method . . . . .	33
2.5	Determination of voltage and current using nodal method . . . . .	35

2.6	Determination of voltage and current using mesh analysis method	37
2.7	Determination of voltage using nodal analysis method	39
2.8	Determination of current using mesh voltage method	41
2.9	Determination of current using a principle of superposition	43
2.10	Determination of current in all resistance using superposition principle	45
2.11	Determination of current using Thevenins theorem	47
2.12	Determination of current using Norton theorem	49
2.13	Determination of load resistance	51
2.14	Determination of driving point resistance of the voltage source	52
2.15	Determination of driving point resistance at the pair of terminals	54
2.16	Determination of resistance value and amount of power	56
3.1	Calculation of impedance and admittance	59
3.2	Determination of voltage across resistance and inductance and capacitance	60
3.3	Determination of current through conductance and capacitance and inductance	61
3.4	Determination of current and voltage across inductance	62
3.5	Determination of forced component of current	64
3.6	Determination of average and RMS value of voltage	66
3.7	Determination of circuit current and voltage using phasor method	67
3.8	Determination of current through different elements and voltage	70
3.9	Determination of voltage and current using complex method	72
3.10	Calculation of resonance frequency and quality factor and bandwidth	74
3.11	Calculation of resonance frequency and quality factor and bandwidth	76
3.12	Determination of current using nodal method	78
3.13	Determination of voltage using nodal method	80
3.14	Determination of current using mesh analysis	82
3.15	Determination of voltage using mesh analysis	83
3.16	Determination of voltage using Thevenins theorem	85
3.17	Determination of current using Thevenins theorem	86
3.18	Determination of current using Norton theorem	88
3.19	Calculation of impedance and maximum power	89

3.20	Determination of voltage and power and reactive power . . . .	91
3.21	Determination of capacitance and current of alternator . . . .	93
3.22	Plotting the four components from the given circuit . . . . .	95
4.1	Determination of force between two spheres . . . . .	98
4.2	Calculation of force . . . . .	99
4.3	Determination electric field intensity . . . . .	100
4.4	Calculation of electric field intensity . . . . .	101
4.5	Determination of distance between two charges at which electric field strength is zero . . . . .	102
4.6	Determination of maximum torque and work done . . . . .	103
4.7	Determination of charge . . . . .	105
4.8	Calculation of potential difference between two points . . . .	106
4.9	Calculation of net potential . . . . .	107
4.10	Calculation of electric field . . . . .	108
4.11	Calculation of potential and field strength . . . . .	110
4.12	Determination of electric field strength . . . . .	111
4.13	Determination of capacitance of the capacitor and potential difference across the capacitor . . . . .	113
4.14	Calculation of electric field intensity and electric flux density	115
4.15	Calculation of capacitance of the line . . . . .	116
4.16	Calculation of thickness of the dielectric . . . . .	117
4.17	Determination of loss energy . . . . .	119
5.1	Determination of mmf and total flux and flux density . . . .	122
5.2	Determination of mmf . . . . .	123
5.3	Calculation of reluctance and current . . . . .	124
5.4	Calculation of reluctance and current . . . . .	126
5.5	Calculation of mmf . . . . .	127
5.6	Calculation of magnetizing current . . . . .	128
5.7	Calculation of inductance and time at pickup value of current	130
5.8	Calculation of cross sectional area of the core and magnetizing current . . . . .	131
5.9	Determination of steady state value of current and resistance and inductance of the coil and stored energy . . . . .	133
5.10	Calculation of load current and impedance referred to primary and secondary side . . . . .	134
5.11	Calculation of instantaneous values of induced emf . . . . .	136



5.12	Determination of torque exerted on the coil . . . . .	137
7.1	Calculation of current and number of turns and maximum flux value . . . . .	140
7.2	Calculation of primary current and power factor . . . . .	142
7.3	Determination of primary current and power factor and secondary terminal voltage . . . . .	143
7.4	Calculation of impedance and voltage regulation . . . . .	145
7.5	Calculation of efficiency . . . . .	148
7.6	Calculation of maximum efficiency . . . . .	150
7.7	Calculation of efficiency and voltage regulation and secondary terminal voltage . . . . .	152
7.8	Calculation of primary line current and voltage and line to line transformation ratio . . . . .	154
7.9	Determination of position of tapping point and current in each part of winding and copper saved . . . . .	156
7.10	Determination of ratio error . . . . .	158
8.1	Calculation of design parameters for a dc machine . . . . .	161
8.2	Calculation of design parameters for a dc machine . . . . .	162
8.3	Calculation of design parameters for a dc machine . . . . .	163
8.4	Calculation of design parameters for a dc machine . . . . .	165
8.5	Calculation of generated emf . . . . .	166
8.6	Calculation of number of conductors per slot . . . . .	167
8.7	Calculation of number of demagnetizing and cross ampere turns per pole . . . . .	168
8.8	Calculation of armature resistance and generated emf . . . . .	170
8.9	Calculation of armature generated voltage . . . . .	171
8.10	Calculation of generated emf . . . . .	172
8.11	Calculation of motor speed . . . . .	174
8.12	Calculation of motor speed and gross torque developed . . . . .	175
8.13	Calculation of motor speed and current and speed regulation . . . . .	176
8.14	Calculation of current and kW input of the motor . . . . .	178
8.15	Calculation of external resistance and electric braking torque . . . . .	180
8.16	Calculation of speed at full load torque . . . . .	181
8.17	Calculation of efficiency of generator at full load and half load . . . . .	183
8.18	Calculation of efficiency of the generator . . . . .	185
8.19	Determination of time . . . . .	187

9.1	Calculation of distribution factor . . . . .	189
9.2	Calculation of number of poles and flux per pole . . . . .	190
9.3	Determination of short circuit ratio and synchronous reactance . . . . .	191
9.4	Calculation of leakage reactance and field current . . . . .	193
9.5	Determination of excitation voltage . . . . .	194
9.6	Calculation of voltage regulation . . . . .	196
9.7	Calculation of voltage regulation . . . . .	198
9.8	Determination of capacity of the condenser . . . . .	199
9.9	Determination of capacity of the synchronous condenser . . . . .	200
9.10	Determination of line current and power factor . . . . .	201
9.11	Determination of increase in additional loss and decrease in line current and final line current . . . . .	203
10.1	Calculation of synchronous speed and rotor speed and rotor frequency . . . . .	207
10.2	Calculation of flux per pole and rotor emf and phase angle . . . . .	208
10.3	Calculation of output power and mechanical power developed and rotor copper loss and efficiency . . . . .	210
10.4	Determination of synchronous speed and slip and maximum torque and rotor frequency . . . . .	212
10.5	Calculation of number of poles and slip and rotor copper loss . . . . .	214
10.6	Determination of starting torque . . . . .	215
10.7	Calculation motor parameters and slip and pullout torque . . . . .	216
10.8	Determination ratio of starting current to full load current . . . . .	219
10.9	Calculation of starting torque and starting current . . . . .	220
10.10	Calculation of plugging torque . . . . .	222
10.11	Calculation of external resistance . . . . .	223
10.12	Calculation of speed and power ratio and frequency . . . . .	224
11.1	Determination of motor parameters and stator current and power factor and speed and torque . . . . .	227
11.2	Calculation of developed power and copper loss . . . . .	229
11.3	Calculation of motor speed and torque . . . . .	230
11.4	Calculation of magnetic flux . . . . .	231
12.1	Calculation of line current of load and alternator . . . . .	234
12.2	Determination of phase and line current of the load . . . . .	236
12.3	Calculation of total KVA of capacitors and capacitance value . . . . .	238

12.4	Calculation of total KVA of capacitors and capacitance value	239
12.5	Calculation of line current and neutral current . . . . .	241
12.6	Determination of complex power and line current . . . . .	243
12.7	Calculation of line current and phase current and total power dissipated . . . . .	245
12.8	Calculation of total power and reactive power . . . . .	249
12.9	Calculation of neutral current and power taken by each phase	251
12.10	Determination of phase voltage and current . . . . .	254
12.11	Calculation of each branch voltage and current . . . . .	256
12.12	Calculation of line current or star phase current . . . . .	259
12.13	Calculation of line current . . . . .	260
13.1	Calculation of resistance . . . . .	263
13.2	Determination of current and time . . . . .	263
13.3	Determination of time constant and damping ratio and current	265
13.4	Determination of current values . . . . .	266
13.5	Calculation of current ratio . . . . .	267
13.6	Determination of current . . . . .	269
14.1	Calculation of average load and energy consumption and load factor . . . . .	272
14.2	Determination of diversity factor and load factor and com- bined average load . . . . .	273
14.3	Calculation of annual bill of the consumer . . . . .	275
14.4	Calculation of overall cost per kWh . . . . .	277
14.5	Calculation of monthly bill of the consumer . . . . .	278
14.6	Calculation of annual bill of the consumer . . . . .	280
15.1	Calculation of lamp efficiency and luminous intensity and MSCP	283
15.2	Calculation of average luminance of the sphere . . . . .	284
15.3	Determination of illumination . . . . .	285
15.4	Calculation of distance between two lamps . . . . .	286
15.5	Determination of size of the conductor . . . . .	288

# Chapter 1

## Fundamentals of Electrical Energy

Scilab code Exa 1.1 Determination of Energy consumed and Electricity charge

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_1.sce.
7
8 clc;
9 clear;
10 P=200;           //power rating of lamp in watts
11 V=110;          //voltage rating of lamp in volts
12
13 //case1
14 printf("\n(a)")
15 I=(P/V);
16 printf("\nCurrent in the lamp=%f A",I)
17
```

```
Scilab 5.5.2 Console ? ↗ ✕

(a)
Current in the lamp=1.818182 A
(b)
Electric charge flowing through the lamp for one hour=6545.454545 coulomb
(c)
Charge for electricity=74.400000 rupees
-->
```

Figure 1.1: Determination of Energy consumed and Electricity charge

```
18 //case2
19 printf("\n(b)")
20 T=1; //time in hour for electric
    charge flow through the lamp
21 t=T*60*60; //time in seconds for electric
    charge flow through the lamp
22 q=I*t;
23 printf("\nElectric charge flowing through the lamp
    for one hour=%f coulomb",q)
24
25 //case3
26 printf("\n(c)")
27 Numberofdaysinmay=31;
28 time=10; //on time of lamp in
    hour per day
29 unitcharge=1.20; //electricity charge in
    rupees (1kwhr = 1unit)
30 t1=time*Numberofdaysinmay; //on time of lamp in
    hour per month
31 Energyconsumed=P*t1; //consumption of energy
```

```
Scilab 5.5.2 Console
The resistance value for the resistor(copper wire)=133.683 ohms
-->
```

Figure 1.2: Determination of resistance value of the resistor

```
in watt-hour
32 Energyconsumedinkwhr=Energyconsumed/(1e3);//
    consumption of energy in kilowatt-hour
33 charges=Energyconsumedinkwhr*unitcharge;
34 printf("\nCharge for electricity=%f rupees",charges)
```

---

**Scilab code Exa 1.2** Determination of resistance value of the resistor

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_2.sce.
7
8 clc;
9 clear;
10 R25=120; //resistance of copper wire at 25
    degree celsius
11 T1=25; //temperature1 in degree celsius
12 T2=55; //temperature in degree celsius
```



```
Scilab 5.5.2 Console
The value of resistance=100 ohms
Power rating or heat dissipated=4 watts
-->
```

Figure 1.3: Determination of resistance value of the resistor and its power rating

```
13 alphazero=4.2e-3; //temperature coefficient
14 R55=(R25*(1+(T2*alphazero)))/(1+(T1*alphazero));
    //resistance of the copper wire at a
    temperature of 55 degree celsius
15 printf("The resistance value for the resistor(copper
    wire)=%3.3 f ohms",R55)
```

---

Scilab code Exa 1.3 Determination of resistance value of the resistor and its power rating

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```
Scilab 5.5.2 Console ? ↗ ✕

The series equivalent resistance=45 ohms

The parallel equivalent resistance=4.615 ohms

Power dissipated in series connection=5 watts

Power dissipated in parallel connection=48.75 watts

-->
```

Figure 1.4: Calculation of equivalent resistances and power dissipation

```
4 //Edition:Third ,2014
5
6 //Ex1_3.sce.
7
8 clc;
9 clear;
10 V=20; //voltage rating of the battery
    in volts
11 I=0.2; //current rating of the battery
    in ampere
12 R=V/I; //from ohm's law
13 P=(I^2)*R;
14 printf("\nThe value of resistance=%d ohms",R)
15 printf("\nPower rating or heat dissipated=%d watts",
    P)
```

---



**Scilab code Exa 1.4** Calculation of equivalent resistances and power dissipation

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_4.sce.
7
8 clc;
9 clear;
10 R1=10;           //resistance value in ohms
11 R2=15;           //resistance value in ohms
12 R3=20;           //resistance value in ohms
13 V=15;           //supply voltage in volts
14 Rs=R1+R2+R3;
15 Rp=(R1*R2*R3)/((R2*R3)+(R3*R1)+(R1*R2));
16 printf("\nThe series equivalent resistance=%2.0f
        ohms \n",Rs)
17 printf("\nThe parallel equivalent resistance=%1.3f
        ohms \n ",Rp)
18 Ps=(V^2)/Rs;
19 Pp=(V^2)/Rp;
20 printf("\nPower dissipated in series connection=%1.0
        f watts \n",Ps)
21 printf("\nPower dissipated in parallel connection=%2
        .2f watts \n",Pp)
```

---

**Scilab code Exa 1.5** Sketch the capacitance current and voltage and charge and power

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

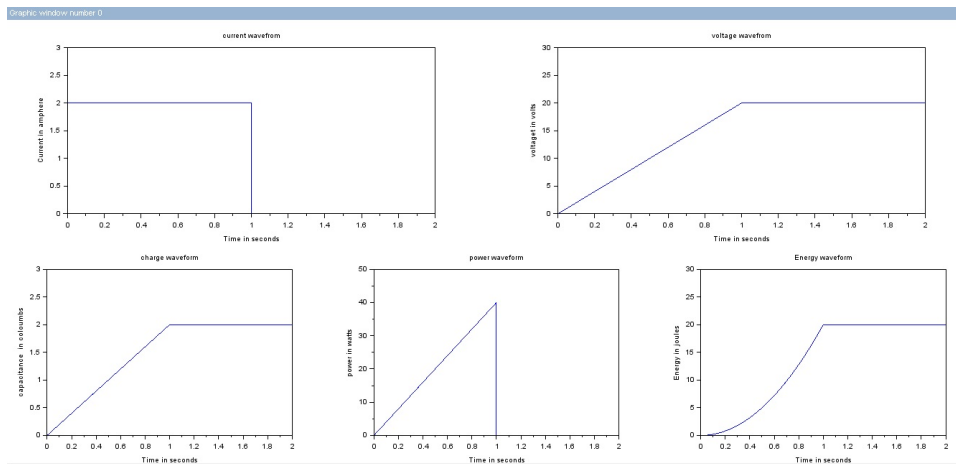


Figure 1.5: Sketch the capacitance current and voltage and charge and power and stored energy

```

4 //Edition:Third ,2014
5
6 //Ex1_5.sce.
7
8 clc;
9 clear;
10 subplot(2,2,1)
11 t=[0:0.00001:2];
12 x=length(t);
13 i=ones(1,x);
14 for n=1:x;
15 if t(n)<=1
16     i(n)=2
17 else
18     i(n)=0
19 end
20 end
21 xlabel("Time in seconds")
22 ylabel("Current in ampere")
23 title("current wavefrom")
24 plot(t,i)

```

```

25 subplot(2,2,2)
26 t=[0:0.00001:2];
27 x=length(t);
28 v=ones(1,x);
29 c=0.1;
30 for n=1:x;
31     i(n)=2;
32 if t(n)<=1
33     v(n)=i(n)*t(n)/c;
34 else
35     v(n)=i(n)/c;
36 end
37 end
38 xlabel("Time in seconds")
39 ylabel("voltage in volts")
40 title("voltage waveform")
41 plot(t,v)
42 subplot(2,3,4)
43 t=[0:0.00001:2];
44 x=length(t);
45 q=ones(1,x);
46 c=0.1;
47 for n=1:x;
48     v(n)=20;
49 if t(n)<=1
50     q(n)=v(n)*t(n)*c;
51 else
52     q(n)=v(n)*c;
53 end
54 end
55 xlabel("Time in seconds")
56 ylabel("capacitance in coulombs")
57 title("charge waveform")
58 plot(t,q)
59 subplot(2,3,5)
60 t=[0:0.00001:2];
61 x=length(t);
62 p=ones(1,x);

```

```

63 for n=1:x;
64     v(n)=20;
65 if t(n)<=1
66     i(n)=2;
67     p(n)=v(n)*t(n)*i(n);
68 else
69     i(n)=0;
70     p(n)=v(n)*i(n);
71 end
72 end
73 xlabel("Time in seconds")
74 ylabel("power in watts")
75 title("power waveform")
76 plot(t,p)
77 subplot(2,3,6)
78 t=[0:0.00001:2];
79 x=length(t);
80 e=ones(1,x);
81 c=0.1;
82 for n=1:x;
83     v(n)=20;
84 if t(n)<=1
85     e(n)=((v(n)*t(n))^2*c)/2;
86 else
87     e(n)=((v(n)^2)*c)/2;
88 end
89 end
90 xlabel("Time in seconds")
91 ylabel("Energy in joules")
92 title("Energy waveform")
93 plot(t,e)

```

---

Scilab code Exa 1.6 Plotting power waveform and calculate dissipated power

1 //Book Name: Fundamentals of Electrical Engineering

```

2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_6.sce.
7
8 clc;
9 clear;
10 t=[0:0.0001:4];
11 x=length(t);
12 p=ones(1,x);
13 for n=1:x;
14     if t(n)<=2
15         v(n)=3;
16         i(n)=10;
17         p(n)=v(n)*t(n)*i(n);
18     else if t(n)>2
19         v(n)=12;
20         i(n)=-5;
21         p(n)=(v(n)-(3*t(n)))*i(n);
22     else
23         p(n)=0;
24     end
25 end
26 end
27 xlabel("Time in seconds")
28 ylabel("Power in watts")
29 title("Power waveform")
30 plot(t,p)
31
32
33 //Case(b)
34 printf("\n (b)")
35 area_OAB=(1/2)*max(p)*max(t)/2;
36 area_BCD=(1/2)*abs(min(p))*max(t)/2;
37 energy=area_OAB-area_BCD;
38 avg_power=energy/max(t);
39 printf("\n The average power=%1.1f W \n",avg_power)

```

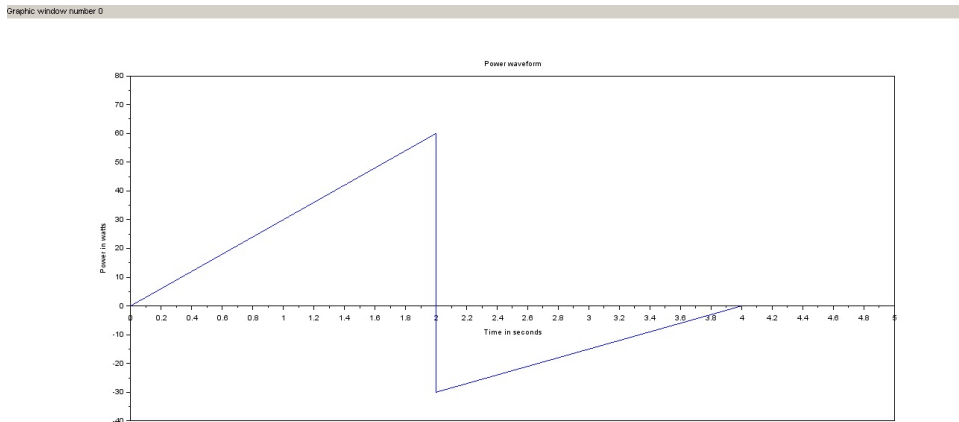


Figure 1.6: Plotting power waveform and calculate dissipated power

---

**Scilab code Exa 1.7** Identification of electric device from the given plot

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_7.sce
7
8 clc;
9 clear;
10 printf("\n From the given plots the waveform of
        voltage is the time integral of the current wave.

```

```
Scilab 5.5.2 Console ? ↻ ✕  
  
(b)  
The average power=7.5 W  
-->
```

Figure 1.7: Plotting power waveform and calculate dissipated power

```
Scilab 5.5.2 Console  
  
From the given plots the waveform of voltage is the time integral of the current wave. So the electric device must be capacitor  
So the value of capacitance=0.1 farads  
-->
```

Figure 1.8: Identification of electric device from the given plot

```

(a)
The voltage across capacitor when k1 is opened=162.225 V
(b)
Initial value of discharge current=0.32445 mA
(c)
The value of discharge current at 2.5 seconds=-0.197 mA
(d)
Initial rate of decay of capacitor voltage=32.445 V/s
(e)
The energy dissipated in resistor=0.1316 J
-->

```

Figure 1.9: Calculation of capacitor voltage and current and energy dissipated

```

So the electric device must be capacitor\n")
11
12 t=2;           //time in seconds
13 V=100;        //voltage of electric device(capacitor)
                in volts
14 I=5;          //capacitance (electric device) current
                in ampere
15 C=(I*t)/V;
16 printf("\n So the value of capacitance=%1.1f farads
        ",C)

```

---



Scilab code Exa 1.8 Calculation of capacitor voltage and current and energy dissip

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_8.sce.
7
8 clc;
9 clear;
10 V=200; //suply voltage in volts
11 R1=0.3e6; //resistance value in ohms
12 R2=0.5e6; //resistance value in ohms
13 C=10e-6; //capacitance value in farad
14 t1=5; //time seconds
15 t2=2.5; //time in seconds
16
17 //case1
18 printf("\n (a)")
19 v=V*(1-exp(-(t1/(R1*C))));
20 printf("\n The voltage across capacitor when k1 is
    opened=%3.3 f V",v)
21 //case2
22 printf("\n (b)")
23 Im=(v/R2);
24 printf("\n Initial value of discharge current=%1.5 f
    mA",Im*1e3)
25 //case3
26 printf("\n (c)")
27 i=-Im*exp(-(t2/(R2*C)));
28 printf("\n The value of discharge current at 2.5
    seconds=%1.3 f mA",i*1e3)
29 //case4
30 printf("\n (d)")
31 Vc=v/(R2*C);
32 printf("\n Initial rate of decay of capacitor
    voltage=%2.3 f V/s",Vc)
```

```
Scilab 5.5.2 Console
(a)
The equivalent capacitance in series connection=46.154 microfarad
(b)
The equivalent capacitance in parallel connection=450 microfarad
-->
```

Figure 1.10: Determination of equivalent capacitance value

```
33 // case5
34 printf("\n (e)")
35 E=(1/2)*(C*v^2);
36 printf("\n The energy dissipated in resistor=%1.4 f
    J",E)
```

---

**Scilab code Exa 1.9** Determination of equivalent capacitance value

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_9.sce.
7
8 clc;
9 clear;
```

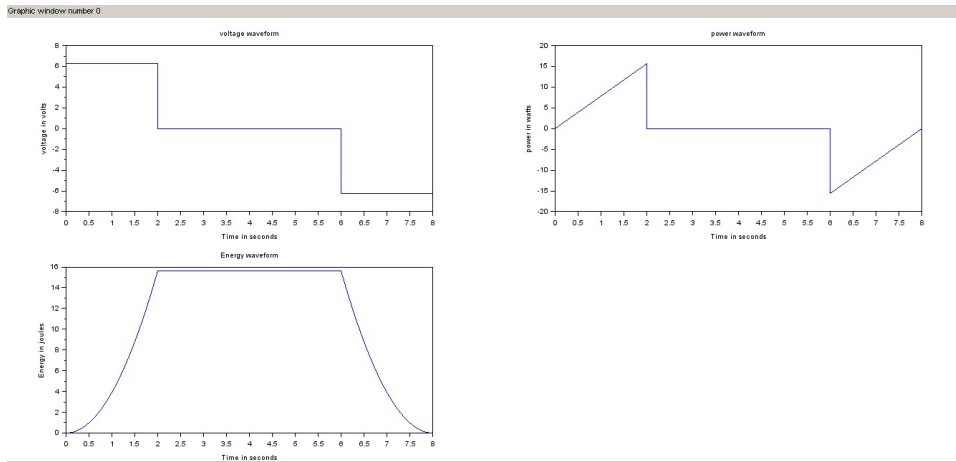


Figure 1.11: Plotting voltage and power and energy waveform

```

10 C1=100;           //capacitance value in microfarad
11 C2=150;           //capacitance value in microfarad
12 C3=200;           //capacitance value in microfarad
13
14 //CASE1
15 printf("\n (a)")
16 Cs=(C1*C2*C3)/((C2*C3)+(C1*C2)+(C3*C1));
17 printf("\n The equivalent capacitance in series
    connection=%2.3 f microfarad",Cs)
18
19 //CASE2
20 printf("\n (b)")
21 Cp=C1+C2+C3;
22 printf("\n The equivalent capacitance in parallel
    connection=%3.0 f microfarad",Cp)

```

---

Scilab code Exa 1.10 Plotting voltage and power and energy waveform

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_10.sce.
7
8 clc;
9 clear;
10 subplot(2,2,1)
11 t=[0:0.001:8];
12 x=length(t);
13 v=ones(1,x);
14 for n=1:x;
15     L=5;
16     if t(n)<=2
17         v(n)=6.25;
18     else if t(n)>=6 & t(n)<8
19         v(n)=-6.25;
20     else
21         v(n)=0;
22     end
23 end
24 end
25 xlabel("Time in seconds")
26 ylabel("voltage in volts")
27 title("voltage waveform")
28 plot(t,v)
29 subplot(2,2,2)
30 t=[0:0.001:8];
31 x=length(t);
32 p=ones(1,x);
33 for n=1:x;
34     if t(n)<=2
35         v(n)=6.25;
36         i(n)=1.25;
37         p(n)=v(n)*t(n)*i(n);
38     else if t(n)>=6 & t(n)<8

```

```

39         v(n)=-6.25;
40         i(n)=10;
41         p(n)=(i(n)-(1.25*t(n)))*v(n);
42     else
43         v(n)=0;
44         i(n)=2.5;
45         p(n)=v(n)*t(n)*i(n);
46     end
47 end
48 end
49 xlabel("Time in seconds")
50 ylabel("power in watts")
51 title("power waveform")
52 plot(t,p)
53 subplot(2,2,3)
54 t=[0:0.001:8];
55 x=length(t);
56 e=ones(1,x);
57 L=5;
58 for n=1:x;
59     if t(n)<=2
60         i(n)=1.25;
61         e(n)=(1/2)*L*(t(n)*i(n))^2;
62     else if t(n)>=6 & t(n)<8
63         i(n)=10;
64         e(n)=(1/2)*L*(i(n)-(1.25*t(n)))^2;
65     else
66         i(n)=2.5;
67         e(n)=(1/2)*L*(i(n))^2;
68     end
69 end
70 end
71 xlabel("Time in seconds")
72 ylabel("Energy in joules")
73 title("Energy waveform")
74 plot(t,e)

```

---

```
Scilab 5.5.2 Console

(a)
The inductive current at the time k1 is opened=9.82 A
(b)
The voltage across the inductor at t=2second=1.83 V
(c)
The voltage across the inductor at t=3 second=0.2479 V
(d)
The initial value of rate of decay of inductor current=20 A/s
(e)
The energy dissipated in the resistor=250 J
-->
```

Figure 1.12: Determination of current and voltage and dissipated energy

**Scilab code Exa 1.11** Determination of current and voltage and dissipated energy

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex1_11.sce.
7 clc;
8 clear;
9 R=10; //resistance in ohms
10 L=5; //inductance in henry
11 V=100; //supply voltage in volts
12 t1=2; //time at which k1 switch opened in
```

```

        seconds
13 //CASE1
14 printf("\n (a)")
15 i=(V*(1-exp(-((R*t1)/L)))/R;
16 printf("\n The inductive current at the time k1 is
        opened=%1.2 f A",i)
17
18 //CASE2
19 printf("\n (b)")
20 v1=V*exp(-((R*t1)/L);
21 printf("\n The voltage across the inductor at t=2
        second=%1.2 f V",v1)
22
23 //CASE3
24 printf("\n (c)")
25 t2=3; //time in seconds
26 Imax=(V/R);
27 v2=Imax*R*(exp(-((R*t2)/L));
28 printf("\n The voltage across the inductor at t=3
        second=%1.4 f V",v2)
29 //For v2 calculation ,the answer in the book is
        wrong
30
31 //CASE4
32 printf("\n (d)")
33 t3=0; //initial time in seconds
34 it=(-R*(-Imax)*exp(-((R*t3)/L))/L; //rate of decay
        of inductor current in ampere per seconds
35 printf("\n The initial value of rate of decay of
        inductor current=%d A/s",it)
36
37 //CASE5
38 printf("\n (e)")
39 Energy=(1/2)*L*Imax^2;
40 printf("\n The energy dissipated in the resistor=%d
        J",Energy)

```

---

## Chapter 2

# Circuit Analysis Resistive Network

Scilab code Exa 2.1 Determination of unknown currents and voltages

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_1.sce.
7
8 clc;
9 clear;
10 R1=3; //Resistance in ohm
11 R2=5; //Resistance in ohm
12 R3=4; //Resistance in ohm
13 R4=8; //Resistance in ohm
14
15 I2=1/3;
16 I1=4*I2;
17 I3=I1-I2;;
```



```
Scilab 5.5.2 Console ? ? X

The unknown voltages:
  V1=4 V
  V2=6.67 V
  V3=1.33 V
  V4=8 V

The unknown currents:
  I1=1.33 A
  I2=0.33 A
  I3=1 A
-->
```

Figure 2.1: Determination of unknown currents and voltages

```

18 V1=R1*I1; //Applying ohm's law (V
    =IR)
19 V2=R2*I1;
20 V3=R3*I2;
21 V4=R4*I3;
22 printf("\n The unknown voltages:")
23 printf("\n\t V1=%d V",V1)
24 printf("\n\t V2=%1.2 f V",V2)
25 printf("\n\t V3=%1.2 f V",V3)
26 printf("\n\t V4=%d V \n",V4)
27 printf("\n The unknown currents:")
28 printf("\n\t I1=%1.2 f A",I1)
29 printf("\n\t I2=%1.2 f A",I2)
30 printf("\n\t I3=%d A",I3)

```

---

### Scilab code Exa 2.2 Determination of currents in the given network

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_2.sce.
7
8 clc;
9 clear;
10 a1=2;b1=1;c1=5;d1=1; //these
    are the coefficient values of I1,I2,I3 and source
    obtained from loop ABDA in the given circuit
11 a2=4;b2=-5;c2=-3;d2=0; //these
    are the coefficient values of I1,I2,I3 and source
    obtained from loop ABCA in the given circuit
12 a3=4;b3=1;c3=-9;d3=0; //these

```

```
Scilab 5.5.2 Console ? ? x
The current values are,
    I1=0.2 A
    I2=0.1 A
    I3=0.1 A
-->
```

Figure 2.2: Determination of currents in the given network

```

    are the coefficient values of I1,I2,I3 and source
    obtained from loop BCDB in the given circuit
13
14 del=det([a1 b1 c1;a2 b2 c2;a3 b3 c3]);
15 del1=det([d1 b1 c1;d2 b2 c2;d3 b3 c3]);
16 del2=det([a1 d1 c1;a2 d2 c2;a3 d3 c3]);
17 del3=det([a1 b1 d1;a2 b2 d2;a3 b3 d3]);
18
19 I1=del1/del; //Using
    Cramer's rule
20 I2=del2/del; //Using
    Cramer's rule
21 I3=del3/del; //Using
    Cramer's rule
22
23 printf("\n The current values are,")
24 printf("\n\t I1=%1.1 f A",I1)
25 printf("\n\t I2=%1.1 f A",I2)
26 printf("\n\t I3=%1.1 f A",I3)

```

---

**Scilab code Exa 2.3** Conversion of current source into a voltage source and voltage

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_3.sce.
7
8 clc;
9 clear;
10 //case1
11 //voltage source series with the resistance

```

```
Scilab 5.5.2 Console ? ↕ ✕  
  
(a)  
Is1=20 A  
  
Gs1=0.20 mho  
  
(b)  
Vs2=50 V  
  
Rs2=100 ohm  
  
-->
```

Figure 2.3: Conversion of current source into a voltage source and voltage source into a current source

```

        converted into current source parallel to the
        conductance
12 printf("\n (a)")
13 Rs1=5;
14 Vs1=100;
15 Is1=Vs1/Rs1;
16 Gs1=1/Rs1;
17 printf("\n    Is1=%d A \n",Is1)
18 printf("\n    Gs1=%1.2 f mho \n",Gs1)
19
20 //case2
21 //current source parallel to the conductance
        converted into voltage source series with the
        resistance
22 printf("\n (b)")
23 Gs2=10e-3;
24 Is2=500e-3;
25 Vs2=Is2/Gs2;
26 Rs2=1/Gs2;
27 printf("\n    Vs2=%d V \n",Vs2)
28 printf("\n    Rs2=%d ohm \n",Rs2)

```

---

**Scilab code Exa 2.4** Determination of voltage and current using nodal analysis meth

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_4.sce.
7
8 clc;
9 clear;

```

```
Scilab 5.5.2 Console ? ↗ ✕  
  
Vba=4.315 V  
  
Current through the 60 ohm resistor=0.279 A  
  
-->
```

Figure 2.4: Determination of voltage and current using nodal analysis method

```

10 R5=60;
11 a1=9;b1=-5;c1=0;d1=80;           //these are
    the coefficient values of VA,VB,VC and the
    source obtained from node A in the given circuit
12 a2=-1;b2=7;c2=-2;d2=24;        //these are
    the coefficient values of VA,VB,VC and the
    source obtained from node B in the given circuit
13 a3=0;b3=-3;c3=4;d3=36;        //these are
    the coefficient values of VA,VB,VC and the
    source obtained from node C in the given circuit
14
15 del=det([a1 b1 c1;a2 b2 c2;a3 b3 c3]);
16 del1=det([d1 b1 c1;d2 b2 c2;d3 b3 c3]);
17 del2=det([a1 d1 c1;a2 d2 c2;a3 d3 c3]);
18 del3=det([a1 b1 d1;a2 b2 d2;a3 b3 d3]);
19
20 VA=del1/del;                    //Using
    Cramer's rule
21 VB=del2/del;                    //Using
    Cramer's rule
22 VC=del3/del;                    //Using
    Cramer's rule
23 Vba=VA-VB;
24 I5=VC/R5;                       // from Ohm's
    law
25 printf("\n Vba=%1.3 f V \n",Vba)
26 //Answer vary dueto round off error
27 printf("\n Current through the 60 ohm resistor=%1.3
    f A \n",I5)

```

---

Scilab code Exa 2.5 Determination of voltage and current using nodal method

1 //Book Name: Fundamentals of Electrical Engineering



```
Scilab 5.5.2 Console ? ? x
Vba=5 V
Current through the 30 ohm resistor=-0.2333 A
-->
```

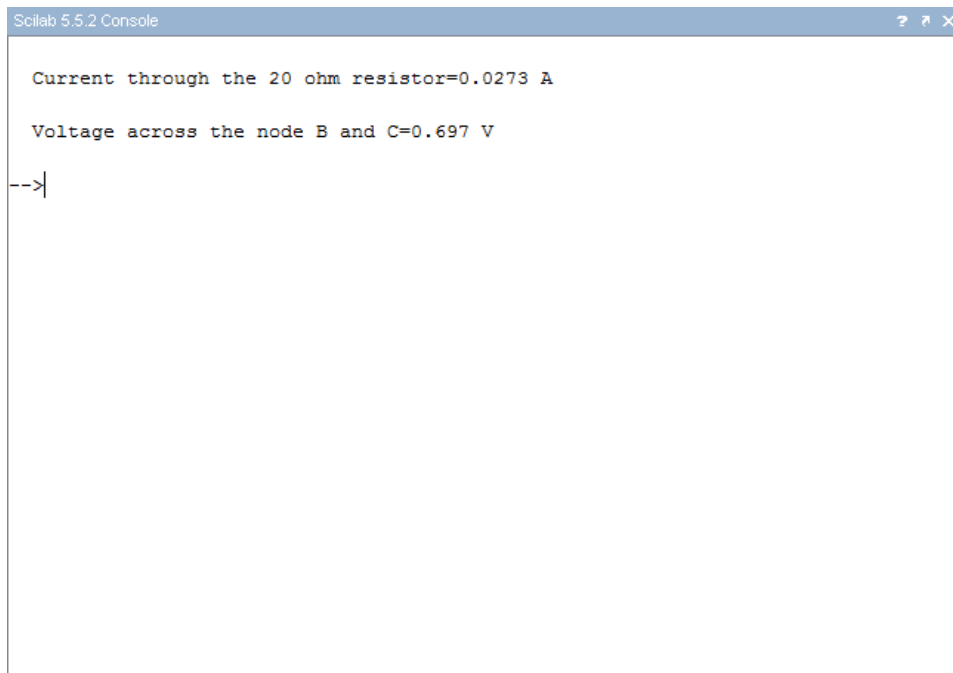
Figure 2.5: Determination of voltage and current using nodal method

```

2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_5.sce.
7
8 clc;
9 clear;
10 R1=10;
11 R2=30;
12 R3=15;
13 R4=45;
14
15 a1=3;b1=-1;c1=-9;
    //these are the coefficient values of VA,VB and
    the source obtained from node A in the given
    circuit
16 a2=-3;b2=4;c2=-27;
    //these are the coefficient values of VA,VB and
    the source obtained from node B in the given
    circuit
17 del=det([a1 b1;a2 b2]);
18 del1=det([c1 b1;c2 b2]);
19 del2=det([a1 c1;a2 c2]);
20
21 VA=del1/del; //
    Using Cramer's rule
22 VB=del2/del; //Using
    Cramer's rule
23 Vba=VA-VB;
24 I2=VA/R2; // from
    Ohm's law
25 printf("\n Vba=%d V \n",Vba)
26 printf("\n Current through the 30 ohm resistor=%1.4
    f A \n",I2)

```

---



```
Scilab 5.5.2 Console
Current through the 20 ohm resistor=0.0273 A
Voltage across the node B and C=0.697 V
-->|
```

Figure 2.6: Determination of voltage and current using mesh analysis method

**Scilab code Exa 2.6** Determination of voltage and current using mesh analysis method

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_6.sce.
7
8 clc;
9 clear;
10 R1=15;
```

```

11 R2=20;
12 R3=10;
13 R4=5;
14
15 a1=35;b1=-20;c1=2; //
    these are the coefficient values of I1,I2 and
    source obtained from loop ABDA in the given
    circuit
16 a2=-20;b2=35;c2=0.5; //
    these are the coefficient values of I1,I2 and
    source obtained from loop BCDB in the given
    circuit
17 del=det([a1 b1;a2 b2]);
18 del1=det([c1 b1;c2 b2]);
19 del2=det([a1 c1;a2 c2]);
20
21 I1=del1/del; //
    Using Cramer's rule
22 I2=del2/del; //
    Using Cramer's rule
23 I20=I1-I2;
24 Vcb=R3*I2;
25 printf("\n Current through the 20 ohm resistor=%1.4
    f A \n",I20)
26 printf("\n Voltage across the node B and C=%1.3 f V
    \n",Vcb)

```

---

**Scilab code Exa 2.7** Determination of voltage using nodal analysis method

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```
Scilab 5.5.2 Console ? ? x
Voltage across the 2 ohm resistor=8 V
-->
```

Figure 2.7: Determination of voltage using nodal analysis method

```

5
6 //Ex2_7.sce.
7
8 clc;
9 clear;
10 R1=5; //Resistance in ohm
11 R2=2; //Resistance in ohm
12 R3=3; //Resistance in ohm
13
14 a1=7;b1=-5;c1=50; //
    these are the coefficient values of VA,VB and the
    source obtained from node A in the given circuit
15 a2=3;b2=5;c2=0; //
    these are the coefficient values of VA,VB and the
    source obtained from node B in the given circuit
16 del=det([a1 b1;a2 b2]);
17 del1=det([c1 b1;c2 b2]);
18 del2=det([a1 c1;a2 c2]);
19
20 VA=del1/del; //
    Using Cramer's rule
21 VB=del2/del; //
    Using Cramer's rule
22 Vba=VA-VB;
23 printf("\n Voltage across the 2 ohm resistor=%d V \
    n",Vba)

```

---

**Scilab code Exa 2.8** Determination of current using mesh voltage method

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```
Scilab 5.5.2 Console ? ? x
Current through the 4 ohm resistor=1.67 A(upward)
-->
```

Figure 2.8: Determination of current using mesh voltage method

```

5
6 //Ex2_8.sce.
7
8 clc;
9 clear;
10 R1=3;
11 R2=4;
12 R3=2;
13 R4=1;
14
15 a1=7;b1=-4;c1=2; //
    these are the coefficient values of I1,I2 and
    source obtained from the first loop in the given
    circuit
16 a2=-10;b2=7;c2=3; //
    these are the coefficient values of I1,I2 and
    source obtained from the second loop in the
    given circuit
17 del=det([a1 b1;a2 b2]);
18 del1=det([c1 b1;c2 b2]);
19 del2=det([a1 c1;a2 c2]);
20
21 I1=del1/del; //Using
    Cramer's rule
22 I2=del2/del; //Using
    Cramer's rule
23 I=I2-I1;
24 printf("\n Current through the 4 ohm resistor=%1.2 f
    A(upward) \n",I)

```

---

**Scilab code Exa 2.9** Determination of current using a principle of superposition

```
1 //Book Name:Fundamentals of Electrical Engineering
```



```
Scilab 5.5.2 Console ? ↗ ✕  
  
Current through the 4 ohm resistor=1.67 A  
  
-->
```

Figure 2.9: Determination of current using a principle of superposition

```

2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_9.sce.
7
8 clc;
9 clear;
10 R1=3;
11 R2=4;
12 R3=2;
13 R4=1;
14
15 //case (a)
16 a1=13;b1=-6;c1=20;
    //these are the coefficient values of VA,VB and
    source obtained from the node A in the given
    circuit
17 a2=-5;b2=3;c2=-20;
    //these are the coefficient values of VA,VB and
    source obtained from the node B in the given
    circuit
18 del=det([a1 b1;a2 b2]);
19 del1=det([c1 b1;c2 b2]);
20 VA1=del1/del;
21 Idash=-VA1/R2;
22
23 //case (b)
24 Vs=3;
25 a1=13;b1=-6;c1=9;
    //these are the coefficient values of VA,VB and
    source obtained from the node A in the given
    circuit
26 a2=-5;b2=3;c2=0;
    //these are
    the coefficient values of VA,VB and source
    obtained from the node B in the given circuit
27 del=det([a1 b1;a2 b2]);

```

```
Scilab 5.5.2 Console

Current in 4 ohm resitance=17.4 A

Current in 3 ohm resitance=6.84 A

Current in 5 ohm resitance=2 A

Current in 6 ohm resitance=11.6 A

-->
```

Figure 2.10: Determination of current in all resistance using superposition principle

```
28 del1=det([c1 b1;c2 b2]);
29 VA2=del1/del;
30 I_doubledash=(Vs-VA2)/R2;
31 I=Idash+I_doubledash;
32 printf("\n Current through the 4 ohm resistor=%1.2 f
        A \n",I)
```

---

**Scilab code Exa 2.10** Determination of current in all resistance using superpositio

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
```

```

3 //Publisher: PHI Learning Private Limited
4 //Edition: Third ,2014
5
6 //Ex2_10.sce.
7
8 clc;
9 clear;
10 R1=4;
11 R2=3;
12 R3=5;
13 R4=6;
14
15 //CASE (a)
16 Vs1=80;
17 VA1=(Vs1/R3)/((1/R1)+(1/R2)+(1/R3)+(1/R4));
18 I1dash=VA1/R1; //From ohm's law (V=IR)
19 I2dash=VA1/R2;
20 I3dash=(Vs1-VA1)/R3;
21 I4dash=VA1/R4;
22
23 //CASE (b)
24 Vs2=90;
25 VA2=(Vs2/R2)/((1/R1)+(1/R2)+(1/R3)+(1/R4));
26 I1doubledash=VA2/R1;
27 I2doubledash=(Vs2-VA2)/R2;
28 I3doubledash=VA2/R3;
29 I4doubledash=VA2/R4;
30
31 //CASE (c)
32 Is=20;
33 VA3=Is/((1/R1)+(1/R2)+(1/R3)+(1/R4));
34 I1triplashedash=VA3/R1;
35 I2triplashedash=VA3/R2;
36 I3triplashedash=VA3/R3;
37 I4triplashedash=VA3/R4;
38 I1=I1dash+I1doubledash+I1triplashedash;
39 I2=-I2dash+I2doubledash-I2triplashedash;
40 I3=I3dash-I3doubledash-I3triplashedash;

```

```
Scilab 5.5.2 Console ? ? x
Current through the 50 ohm resistor=0.015 A
-->
```

Figure 2.11: Determination of current using Thevenins theorem

```
41 I4=I4dash+I4doubledash+I4triplodash;
42 printf("\n Current in 4 ohm resitance=%2.1 f A \n",
    I1)
43 printf("\n Current in 3 ohm resitance=%1.2 f A \n",
    I2)
44 printf("\n Current in 5 ohm resitance=%d A \n",I3)
45 printf("\n Current in 6 ohm resitance=%2.1 f A \n",
    I4)
46
47 //The answer vary dueto roundoff error
```

---

**Scilab code Exa 2.11** Determination of current using Thevenins theorem

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_11.sce
7
8 clc;
9 clear;
10 R1=30; //Resistance in ohm
11 R2=60; //Resistance in ohm
12 R3=60; //Resistance in ohm
13 R4=30; //Resistance in ohm
14 R5=10; //Resistance in ohm
15 R=50; //Resistance in ohm
16 I1=5/110; //Loop1 current in Ampere
17 I2=5/110; //Loop2 current in Ampere
18 Voc=(I2*R2)-(I1*R1); //Open circuit voltage in
    Volt
19 Isc=1/30; //Open circuit current in
    Ampere
20 Rs=Voc/Isc; //Series resistance in ohm
21 I=Voc/(Rs+R);
22 printf("\\n Current through the 50 ohm resistor=%1.3
    f A \\n",I)
```

---

**Scilab code Exa 2.12** Determination of current using Norton theorem

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```
Scilab 5.5.2 Console ? ? X
Current through the 50 ohm resistor=0.015 A
-->
```

Figure 2.12: Determination of current using Norton theorem

```

4 //Edition:Third ,2014
5
6 //Ex2_12.sce
7
8 clc;
9 clear;
10 R=50; //Resistance in ohm
11 Is=1/30; //Source current in Ampere
12 Rs=40.92; //Parallel resistance in ohm
13 Gs=1/Rs; //Parallel conductance in mho
14 I=(Is*Rs)/(Rs+R);
15 printf("\n Current through the 50 ohm resistor=%1.3
        f A \n",I)

```

---

**Scilab code Exa 2.13** Determination of load resistance

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_13.sce.
7
8 clc;
9 clear;
10 R1=4; //Resistance in ohm
11 R2=4; //Resistance in ohm
12 R3=8; //Resistance in ohm
13 R4=10; //Resistance in ohm
14 R5=3; //Resistance in ohm
15 R6=8; //Resistance in ohm
16 R7=2; //Resistance in ohm
17 R12=1/((1/R1)+(1/R2)); //R1 and R2 are in

```



```
Scilab 5.5.2 Console ? ↗ ✕  
  
Load resitance to the 10 volt source=6 ohm  
  
-->
```

Figure 2.13: Determination of load resistance



Figure 2.14: Determination of driving point resistance of the voltage source

```
parallel
18 R34=1/((1/R4)+(1/(R3+R12))); //R12 and R3 are in
parallel with R4
19 R56=1/((1/R6)+(1/(R5+R34))); //R34 and R5 are in
parallel with R6
20 Rab=R7+R56; //R56 and R7 are in series
21 RL=Rab;
22 printf("\n Load resitance to the 10 volt source=%d
ohm \n",RL )
```

---

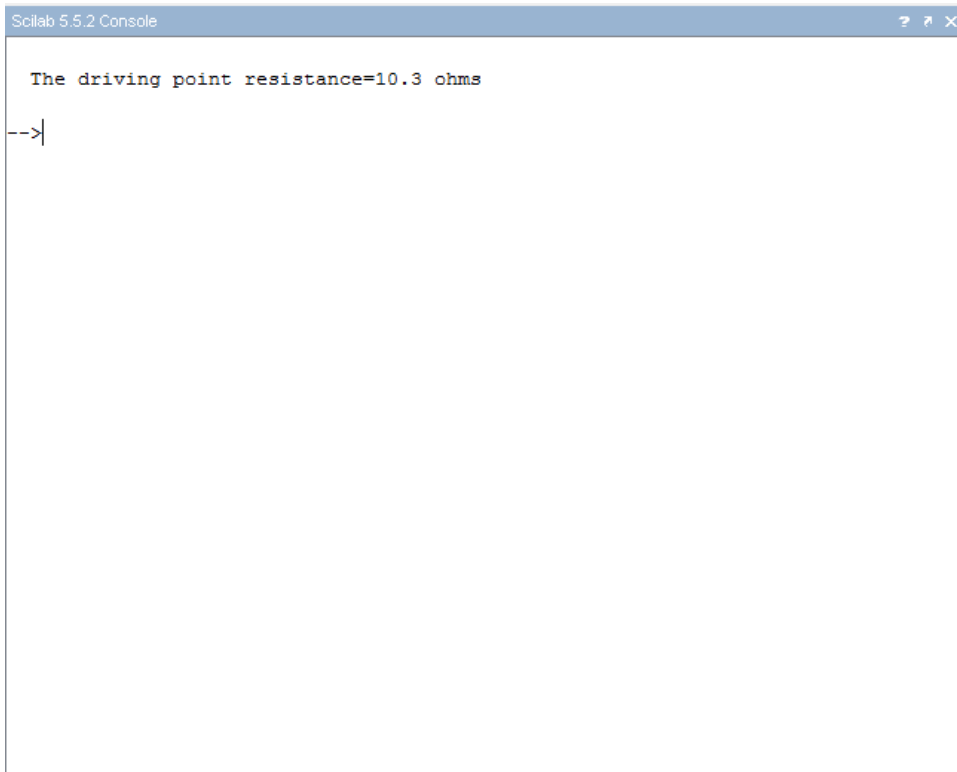
Scilab code Exa 2.14 Determination of driving point resistance of the voltage source

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_14.sce
7
8 clc;
9 clear;
10 I=5/31; //Circuit current in ampere
11 Vs=5; //Source voltage in volt
12 R1=3; //Resistance in ohm
13 R2=4; //Resistance in ohm
14 driving_point_resistance=Vs/I;
15 printf("\\n The driving point resistance of the
    voltage source=%d ohm \\n",
    driving_point_resistance)
```

---

Scilab code Exa 2.15 Determination of driving point resistance at the pair of terminals

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex2_15.sce.
7
8 clc;
```



```
Scilab 5.5.2 Console ? ? x
The driving point resistance=10.3 ohms
-->|
```

Figure 2.15: Determination of driving point resistance at the pair of terminals

```

9  clear;
10 R_aB=5;
11 R_AB=6;
12 R_BC=6;
13 R_CD=5;
14 R_AE=25;
15 R_ED=10;
16 R_DA=5;
17 R_EC=50;
18
19 //For triangle AED
20 R_OA=(R_AE*R_DA)/(R_AE+R_ED+R_DA);
21 R_OD=(R_ED*R_DA)/(R_AE+R_ED+R_DA);
22 R_OE=(R_AE*R_ED)/(R_AE+R_ED+R_DA);
23
24 //For triangle OCD
25 R_OC=R_OE+R_EC;
26 R_OdashO=(R_OC*R_OD)/(R_OC+R_OD+R_CD);
27 R_OdashD=(R_CD*R_OD)/(R_OC+R_OD+R_CD);
28 R_OdashC=(R_OC*R_CD)/(R_OC+R_OD+R_CD);
29
30 R_OB=R_OA+R_AB;
31 R_BOdash=((R_OB+R_OdashO)*(R_BC+(R_OdashC)))/(R_OB+
    R_OdashO+R_BC+R_OdashC);
32 Rab=(R_aB+(R_BOdash)+(R_OdashD));
33 printf("\n The driving point resistance=%2.1f ohms
    \n", Rab)

```

---

**Scilab code Exa 2.16** Determination of resistance value and amount of power

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited

```

```
Scilab 5.5.2 Console ? ? X  
  
(a)  
The value of R which absorbs maximum power from the circuit=7.5 ohm  
  
(b)  
The amount of power=38 W  
  
-->|
```

Figure 2.16: Determination of resistance value and amount of power

```

4 //Edition:Third ,2014
5
6 //Ex2_16.sce.
7
8 clc;
9 clear;
10 R1=10;
11 I1=2.5;
12 V2=60;
13 R2=30;
14 I2=V2/R2; //Ohm's law
15 Gs=(1/R1)+(1/R2);
16 Rs=1/Gs;
17 Isc=I1+I2;
18 Voc=Isc*Rs;
19
20 //case (a)
21 printf("\n (a)")
22 R=Rs;
23 printf("\n The value of R which absorbs maximum
    power from the circuit=%1.1f ohm \n",R)
24
25 //case (b)
26 printf("\n (b)")
27 Pm=Voc^2/(4*Rs);
28 printf("\n The amount of power=%2.0f W \n",Pm)

```

---

# Chapter 3

## Circuit Analysis Time Varying Excitation

Scilab code Exa 3.1 Calculation of impedance and admittance

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_1.sce
7
8 clc;
9 clear;
10 L=2.5;
11 s=-1; //complex frequency , which is taken from the
        coefficient value of time in the given
        exponential term
12 Z=L*s;
13 printf("\n Impedence=%0.1 f ohm \n",Z)
14 Y=1/Z;
15 printf("\n Admittance=%0.1 f mho \n",Y)
```



```
Scilab 5.5.2 Console
Impedance=-2.5 ohm
Admittance=-0.4 mho
-->
```

Figure 3.1: Calculation of impedance and admittance

```
16 //Voltage cannot be determined since it involves
    equation in the result
```

---

**Scilab code Exa 3.3** Determination of voltage across resistance and inductance and

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_3(b).sce.
7
8 clc;
9 clear;
10 R=1;
11 L=1;
12 C=0.1;
13 //case (b)
```

```
Scilab 5.5.2 Console
Voltage across the capacitance=10 volt
-->
```

Figure 3.2: Determination of voltage across resistance and inductance and capacitance

```
14 s=0;
15 //Z=R+(L*s)+(1/(C*s))
16 Z=0; //Z=s/(s^2+s+10)
17 //voltage across the resistance and inductance are
    zero
18
19 Vc=100/(s^2+s+10); //simplified form of (10s/(s^2+s
    +10))/(0.1s)
20 printf("\n Voltage across the capacitance=%d volt",
    Vc)
```

---

Scilab code Exa 3.4 Determination of current through conductance and capacitance a

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```
Scilab 5.5.2 Console
Current through conductance=0 A
Current through capacitance=0 A
Current through inductance=10 A
-->
```

Figure 3.3: Determination of current through conductance and capacitance and inductance

```
4 //Edition:Third ,2014
5
6 //Ex3_4(b).sce
7
8
9 //case(b)
10 clc;
11 clear;
12 R=1;
13 L=0.1;
14 C=1;
15 I=10;
16 s=0; //complex frequency
17 V=(10*s)/(s^2+s+10); //voltage across the
    parallel circuit
18 iG=V*R;
19 printf("\n Current through conductance=%d A \n",iG)
20 iC=V*C;
21 printf("\n Current through capacitance=%d A \n",iC)
22 iL=100/(s^2+s+10); //simplified form of V/Ls=(10s
```

```
Scilab 5.5.2 Console ? ↶ ✕

Current flow through the given circuit=6 angle:-15 degree

Voltage across the inductance=36 angle:75 degree

-->
```

Figure 3.4: Determination of current and voltage across inductance

```
23 /(s^2+s+10)/(0.1 s)  
printf("\n Current through inductance=%d A \n", iL)
```

---

**Scilab code Exa 3.5** Determination of current and voltage across inductance

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex3_5.sce
```

```

7
8  clc;
9  clear;
10 R=2;
11 L=2;
12 C=1/12;
13 omega=3;
14 XL=omega*L;
15 XC=1/(omega*C);
16 Z=complex(R,XL-XC);
17 V1=12*sqrt(2);
18 theta=30;
19 V=complex(V1*cosd(theta),V1*sind(theta));
20 I=V/Z;
21 I_mag=sqrt(real(I)^2+imag(I)^2);
22 I_angle=atand(imag(I)/real(I));
23 printf("\n Current flow through the given circuit=%d
        angle:%d degree \n",I_mag,I_angle)
24
25 XL=complex(0,6);
26 V_L=I*XL;
27 V_L_mag=sqrt(real(V_L)^2+imag(V_L)^2);
28 V_L_angle=atand(imag(V_L)/real(V_L));
29 printf("\n Voltage across the inductance=%d angle:%2
        .0f degree \n",V_L_mag,V_L_angle)
30 //result:Vl(t)=36 sin(wt+75) , i(t)=6 sin(wt-15)

```

---

### Scilab code Exa 3.6 Determination of forced component of current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```
Scilab 5.5.2 Console ? ↗ ✕  
  
The current through inductor=6 angle:-143.1 degree  
-->|
```

Figure 3.5: Determination of forced component of current

```

5
6 //Ex3_6.sce
7
8 clc;
9 clear;
10 G=3; //conductance in mho
11 L=1/4; //Inductor value in henry
12 C=3; //capacitor value in farad
13 omega=2; //taken from i(t)
14 XL=1/(omega*L);
15 XC=(omega*C);
16 Y=complex(G,XC-XL);
17 I=complex(15,0);
18 V=I/Y;
19 BL= complex(0,-2);
20 I_L=V*BL;
21 I_L_mag=sqrt(real(I_L)^2+imag(I_L)^2);
22 I_L_angle=atand(imag(I_L)/real(I_L))-180;
23 printf("\n The current through inductor=%d angle:%2
    .1f degree \n",I_L_mag,I_L_angle)
24 //result: iL(t)=6 cos(2t-143.1)

```

---

**Scilab code Exa 3.7** Determination of average and RMS value of voltage

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_7.sce
7
8 clc;
9 clear;

```

```

(a)
Average value=4.075 volt

(b)
RMS value=7.15 volt

-->|

```

Figure 3.6: Determination of average and RMS value of voltage

```

10
11 printf("\n (a)")
12 T=(2*%pi); //Time value for one cycle
13 V=15; //Maximum voltage in volt
14 t0=%pi/4;t1=%pi; //time values for particular period
    which is taken from the given voltage wave form
15 Vav=(1/T)*integrate('V*sin(t)', 't', t0, t1);
16 printf("\n Average value=%1.3 f volt \n", Vav)
17
18 printf("\n (b)")
19 Vrms=sqrt(((V^2)/T)*integrate('(1-cos(2*t))/2', 't',
    t0, t1)); //sin^2(t)=(1-cos(2t))/2
20 printf("\n RMS value=%1.2 f volt \n", Vrms)
21 //Answer given in the book for Vrms is wrong

```

---



```
Scilab 5.5.2 Console ? ↗ ✕  
  
Circuit current=3 angle:-15 degree  
Voltage across the resistance=6 angle:-15 degree  
Voltage across the inductance=18 angle:75 degree  
Voltage across the capacitance=12 angle:-105 degree  
-->|
```

Figure 3.7: Determination of circuit current and voltage using phasor method

Scilab code Exa 3.8 Determination of circuit current and voltage using phasor meth

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //EX3_8.sce
7
8 clc;
9 clear;
10 R=2; //Resistance in ohm
11 L=2; //Inductor value in henry
12 C=1/12; //capacitor value in farad
13 omega=3; //Taken from v(t) value
14 //given v(t)=12 sin(3t+30);
15 Vm=12;
16 Vrms=Vm/sqrt(2);
17 theta=30;
18
19 Z=complex(R,(omega*L)-(1/(omega*C)));
20 V=complex(Vrms*cosd(theta),Vrms*sind(theta));
21 I=V/Z;
22 I_mag=sqrt(real(I)^2+imag(I)^2);
23 I_ang=atand(imag(I)/real(I));
24 printf("\n Circuit current=%1.0f angle:%d degree \n"
        ,I_mag,I_ang)
25
26 Vr=I*R;
27 Vr_mag=sqrt(real(Vr)^2+imag(Vr)^2);
28 Vr_ang=atand(imag(Vr)/real(Vr));
29 printf("\n Voltage across the resistance=%1.0f angle
        :%d degree \n",Vr_mag,Vr_ang)
30
31 theta1=90;
32 Xl=complex(omega*L*cosd(theta1),omega*L*sind(theta1)
        );
33 Vl=I*Xl;
```

```

34 V1_mag=sqrt(real(V1)^2+imag(V1)^2);
35 V1_ang=atand(imag(V1)/real(V1));
36 printf("\n Voltage across the inductance=%1.0f angle
      :%1.0f degree \n",V1_mag,V1_ang)
37
38 theta2=-90;
39 Xc=complex(cosd(theta2)/(omega*C),sind(theta2)/(
      omega*C));
40 Vc=I*Xc;
41 Vc_mag=sqrt(real(Vc)^2+imag(Vc)^2);
42 Vc_ang=atand(imag(Vc)/real(Vc))-180;
43 printf("\n Voltage across the capacitance=%1.0f
      angle:%d degree \n",Vc_mag,Vc_ang)

```

---

**Scilab code Exa 3.9** Determination of current through different elements and voltage

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_9.sce
7
8 clc;
9 clear;
10 G=3; //Conductance in mho
11 L=1/4; //Inductor value in henry
12 C=3; //capacitor value in farad
13 //Given i(t)=15 cos 2t;
14 Im=15;
15 Irms=Im/sqrt(2);
16 omega=2;
17 theta=0;

```

```
Scilab 5.5.2 Console ? ? X
Voltage across the elements=2.12 angle:-53.1 degree
Current through the conductor=6.36 angle:-53.1 degree
Current through the inductor=4.24 angle:-143.1 degree
Current through the capacitor=12.728 angle:36.9 degree
-->
```

Figure 3.8: Determination of current through different elements and voltage

```

18
19 Y=complex(G,(omega*C)-(1/(omega*L)));
20 I=complex(Irms*cosd(theta),Irms*sind(theta));
21 V=I/Y;
22 V_mag=sqrt(real(V)^2+imag(V)^2);
23 V_ang=atand(imag(V)/real(V));
24 printf("\n Voltage across the elements=%1.2f angle:
      %2.1f degree \n",V_mag,V_ang)
25
26 Ig=V*G;
27 Ig_mag=sqrt(real(Ig)^2+imag(Ig)^2);
28 Ig_ang=atand(imag(Ig)/real(Ig));
29 printf("\n Current through the conductor=%1.2f angle
      :%2.1f degree \n",Ig_mag,Ig_ang)
30
31 theta1=-90;
32 B1=complex(cosd(theta1)/(omega*L),sind(theta1)/(
      omega*L));
33 I1=V*B1;
34 I1_mag=sqrt(real(I1)^2+imag(I1)^2);
35 I1_ang=atand(imag(I1)/real(I1))-180;
36 printf("\n Current through the inductor=%1.2f angle:
      %3.1f degree \n",I1_mag,I1_ang)
37
38 theta2=90;
39 Bc=complex(cosd(theta1)*omega*C,sind(theta1)*omega*C
      );
40 Ic=V*Bc;
41 Ic_mag=sqrt(real(Ic)^2+imag(Ic)^2);
42 Ic_ang=atand(imag(Ic)/real(Ic));
43 printf("\n Current through the capacitor=%2.3f angle
      :%2.1f degree \n",Ic_mag,Ic_ang)

```

---

Scilab 5.5.2 Console

```
circuit current is  
2.8977775 - 0.7764571i  
Voltage across the resistance is  
5.795555 - 1.5529143i  
Voltage across the inductance is  
4.6587428 + 17.386665i  
Voltage across the capacitance is  
- 3.1058285 - 11.59111i  
The sum of three element voltages is  
7.3484692 + 4.2426407i  
-->|
```

Figure 3.9: Determination of voltage and current using complex method

Scilab code Exa 3.10 Determination of voltage and current using complex method

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_10.sce
7
8 clc;
9 clear;
10 //datas are taken from example 3.8
11 R=2; //Resistance in ohm
12 L=2; //Inductor value in henry
13 C=1/12; //capacitor value in farad
14 omega=3; //Taken from v(t) value
15 //given v(t)=12 sin(3t+30);
16 Vm=12;
17 Vrms=Vm/sqrt(2);
18 theta=30;
19
20 Z=complex(R,(omega*L)-(1/(omega*C)));
21 V=complex(Vrms*cosd(theta),Vrms*sind(theta));
22 I=V/Z; //from Ohm's law
23 disp(I,' circuit current is ')
24
25 Vr=I*R;
26 disp(Vr,'Voltage across the resistance is ')
27
28 theta1=90;
29 Xl=complex(omega*L*cosd(theta1),omega*L*sind(theta1)
30 );
31 V1=I*Xl;
32 disp(V1,'Voltage across the inductance is ')
33
34 theta2=-90;
35 Xc=complex(cosd(theta2)/(omega*C),sind(theta2)/(
36 omega*C));
```

```
Scilab 5.5.2 Console

Resonance frequency=1 MHz

Quality factor=0.03184

Lower half power frequency=31.8 kHz

Upper half power frequency=31423.3 kHz

Bandwidth=31392 kHz

-->
```

Figure 3.10: Calculation of resonance frequency and quality factor and bandwidth

```
35 Vc=I*Xc;
36 disp(Vc, 'Voltage across the capacitance is ')
37
38 Vsum=Vr+Vl+Vc;
39 disp(Vsum, 'The sum of three element voltages is ')
40
41 //Answers are displayed in a complex mode(real and
    imaginary) because it is solved in complex
    method
```

---

Scilab code Exa 3.11 Calculation of resonance frequency and quality factor and bandwidth

```
1 //Book Name: Fundamentals of Electrical Engineering
```



```

2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_11.sce
7
8 clc;
9 clear;
10 R=10e3; //Resistance in ohm
11 L=50.7e-6; //Inductor value in henry
12 C=500e-12; //capacitor value in farad
13
14 fr=1/(2*%pi*sqrt(L*C));
15 printf("\n Resonance frequency=%1.0 f MHz \n",fr*1e
-6)
16
17 Q=(1/R)*sqrt(L/C);
18 printf("\n Quality factor=%1.5 f \n",Q)
19
20 f1=(-fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
21 printf("\n Lower half power frequency=%2.1 f kHz \n",
f1*1e-3)
22
23 f2=(fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
24 printf("\n Upper half power frequency=%5.1 f kHz \n",
f2*1e-3)
25
26 BW=f2-f1;
27 printf("\n Bandwidth=%5.0 f kHz \n",BW*1e-3)
28
29 //Answer vary dueto round off error in fr , Q
Calculation

```

---

Scilab 5.5.2 Console

```
Resonance frequency=1 MHz  
Quality factor=31.4  
Lower half power frequency=984 kHz  
Upper half power frequency=1016 kHz  
Bandwidth=32 kHz  
-->
```

Figure 3.11: Calculation of resonance frequency and quality factor and bandwidth

Scilab code Exa 3.12 Calculation of resonance frequency and quality factor and band

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_12.sce
7
8 clc;
9 clear;
10 R=10e3; //Resistance in ohm
11 L=50.7e-6; //Inductor value in henry
12 C=500e-12; //capacitor value in farad
13
14 fr=1/(2*pi*sqrt(L*C));
15 printf("\n Resonance frequency=%1.0 f MHz \n",fr*1e
    -6)
16
17 Q=(R)*sqrt(C/L);
18 printf("\n Quality factor=%2.1 f \n",Q)
19
20 f1=(-fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
21 printf("\n Lower half power frequency=%3.0 f kHz \n",
    f1*1e-3)
22
23 f2=(fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
24 printf("\n Upper half power frequency=%4.0 f kHz \n",
    f2*1e-3)
25
26 BW=f2-f1;
27 printf("\n Bandwidth=%2.0 f kHz \n",BW*1e-3)
```

---

```
Scilab 5.5.2 Console ? ↗ ✕  
  
V3=105 angle:5.40 degree  
  
I1=5.56 angle:-116.14 degree  
  
I2=10 angle:-16 degree  
  
I3=10.54 angle:-47.7 degree  
  
-->
```

Figure 3.12: Determination of current using nodal method

Scilab code Exa 3.13 Determination of current using nodal method

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_13.sce
7
8 clc;
9 clear;
10
11 //from the figure 3.25 the below values are taken
12 Z1=complex(1.2,1.6);
13 Z2=complex(1.0,-1.75);
14 Z12=complex(6,8);
15
16 V1=complex(110,0);
17 V2=complex(110*cosd(-5),110*sind(-5));
18
19 //VA is calculated from the nodal equation of node A
20 VA=((V1/Z1)+(V2/Z2))/(1/Z1 + 1/Z2 + 1/Z12);
21 VA_mag=sqrt(real(VA)^2+imag(VA)^2);
22 VA_ang=atand(imag(VA)/real(VA));
23 printf("\n V3=%3.0f angle:%1.2f degree \n",VA_mag,
        VA_ang)
24
25 I1=(V1-VA)/Z1;
26 I1_mag=sqrt(real(I1)^2+imag(I1)^2);
27 I1_ang=atand(imag(I1)/real(I1))-180;
28 printf("\n I1=%1.2f angle:%3.2f degree \n",I1_mag,
        I1_ang)
29
30 I2=(V2-VA)/Z2;
31 I2_mag=sqrt(real(I2)^2+imag(I2)^2);
32 I2_ang=atand(imag(I2)/real(I2));
33 printf("\n I2=%2.0f angle:%2.0f degree \n",I2_mag,
        I2_ang)
```

```
Scilab 5.5.2 Console ? ↗ ✕  
  
Vo=1.5 angle:157.7 degree  
-->
```

Figure 3.13: Determination of voltage using nodal method

```
34  
35 I3=(VA)/Z12;  
36 I3_mag=sqrt(real(I3)^2+imag(I3)^2);  
37 I3_ang=atand(imag(I3)/real(I3));  
38 printf("\n I3=%2.2f angle:%2.1f degree \n",I3_mag,  
I3_ang)  
39  
40 //Answer vary dueto round off error
```

---

**Scilab code Exa 3.14** Determination of voltage using nodal method

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad
```

```

3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_14.sce
7
8 clc;
9 clear;
10
11 //i(t)=sqrt(2)*1e-4*cos(4*10^7*t);
12 a1=complex(5,4.04);b1=complex(0,-0.04);c1=1/10;
//these are the
    coefficient values of VA,VB and source obtained
    from the node A in the given circuit
13 a2=complex(200,-0.04);b2=complex(1.2,-1.56);c2=0;
//these are the
    coefficient values of VA,VB and source obtained
    from the node B in the given circuit
14 del=det([a1 b1;a2 b2]);
15 delB=det([a1 c1;a2 c2]);
16 VB=delB/del;
17
18 VB_mag=sqrt(real(VB)^2+imag(VB)^2);
19 VB_ang=atand(imag(VB)/real(VB))+180;
20 printf("\n Vo=%1.1f angle:%3.1f degree \n",VB_mag,
    VB_ang)
21
22 //Answer vary due to roundoff error
23 //Result:Vo(t)=sqrt(2)*1.5*cos(4*10^7*t+157.7)

```

---

**Scilab code Exa 3.15** Determination of current using mesh analysis

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad

```

```
Scilab 5.5.2 Console ? ↗ ✕
Current through the 3 ohm resistor=2.262 angle:114.11 degree
-->
```

Figure 3.14: Determination of current using mesh analysis

```
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_15.sce
7
8 clc;
9 clear;
10 V1=complex(12,0);
11 //current source and its parallel impedance gives
    the voltage source
12 V2=complex(5*cosd(-30),5*sind(-30))*complex(6,-3);
13 //for loop1 , the coefficient of I1 ,I2 and source
    is given below
14 a1=complex(10+6,15);
15 b1=-complex(10,15);
16 c1=V1;
17 //for loop2 , the coefficient of I1 ,I2 and source
    is given below
18 a2=-complex(10,15);
```



```
Scilab 5.5.2 Console
V2=4.87 angle:-66.04 degree
-->
```

Figure 3.15: Determination of voltage using mesh analysis

```
19 b2=complex(19,12);
20 c2=-V2;
21 del2=det([a1 c1;a2 c2]);
22 del=det([a1 b1;a2 b2]);
23 I2=del2/del;
24 I2_mag=sqrt(real(I2)^2+imag(I2)^2);
25 I2_ang=atand(imag(I2)/real(I2))+180;
26 printf("\n Current through the 3 ohm resistor=%1.3 f
    angle:%3.2 f degree \n",I2_mag,I2_ang)
```

---

**Scilab code Exa 3.16** Determination of voltage using mesh analysis

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
```

```

3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //EX3_16.sce
7
8 clc;
9 clear;
10 //from the mesh equations coefficient of I1,I2,and
    source is given below
11 a1=complex(4,-2);
12 b1=-complex(3,-2);
13 c1=complex(12,0);
14 a2=-complex(3,4);
15 b2=complex(5,3);
16 c2=complex(0);
17
18 del1=det([c1 b1;c2 b2]);
19 del2=det([a1 c1;a2 c2]);
20 del=det([a1 b1;a2 b2]);
21 I2=del2/del;
22 I1=del1/del;
23
24 V2=(2*I2)+((3*(-2*i))*(I1-I2));
25 V2_mag=sqrt(real(V2)^2+imag(V2)^2);
26 V2_ang=atand(imag(V2)/real(V2));
27 printf("\n V2=%1.2f angle:%2.2f degree \n",V2_mag,
    V2_ang)
28 //Anawer vary dueto round off error
29 //Result:v2(t)=4.87*sqrt(2) sin(2t-66.04)

```

---

Scilab code Exa 3.17 Determination of voltage using Thevenins theorem

```

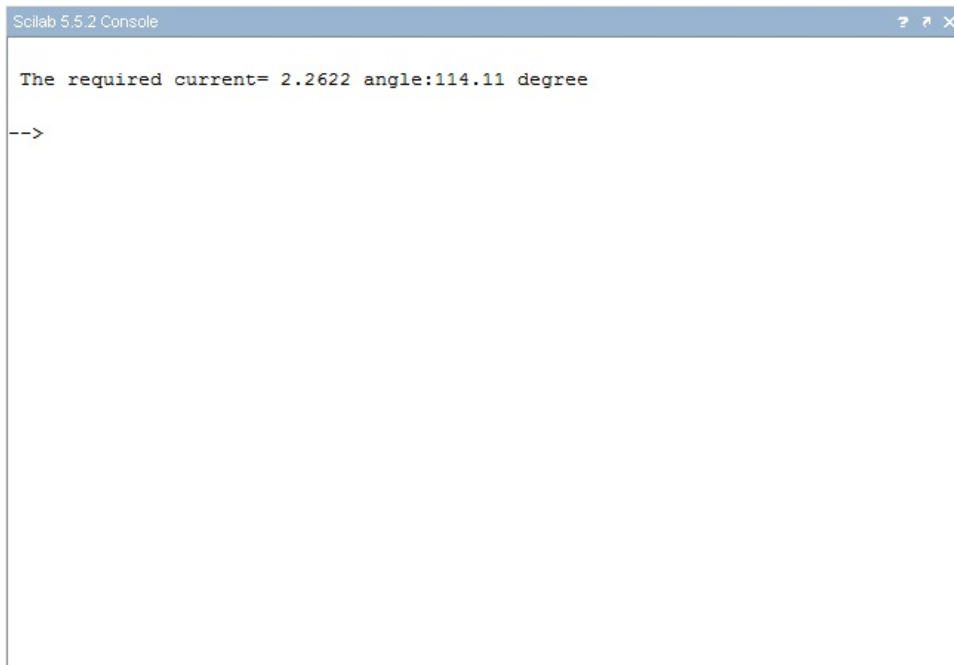
1 //Book Name:Fundamentals of Electrical Engineering

```

```
Scilab 5.5.2 Console
V_AB=34.30 angle:-30.96 degree
-->
```

Figure 3.16: Determination of voltage using Thevenins theorem

```
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_17.sce
7
8 clc;
9 clear;
10 //Below values are taken from the given circuit (fig
    .3.29)
11 Z1=complex(5,-5);
12 Z2=complex(5,-5);
13 Z3=complex(10,10);
14 V=complex(100,0);
15
16 I=V/(Z1+Z2);
17 Vab=I*Z2;
18 Zs=(Z1*Z2)/(Z1+Z2)+Z3;
```



```
Scilab 5.5.2 Console
The required current= 2.2622 angle:114.11 degree
-->
```

Figure 3.17: Determination of current using Thevenins theorem

```
19 V_AB=(Vab*real(Z3))/Zs;
20 V_AB_mag=sqrt(real(V_AB)^2+imag(V_AB)^2);
21 V_AB_ang=atand(imag(V_AB)/real(V_AB));
22 printf("\n V_AB=%2.2 f angle:%2.2 f degree \n",
    V_AB_mag , V_AB_ang)
```

---

**Scilab code Exa 3.18** Determination of current using Thevenins theorem

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
```

```

6 //Ex3_18.sce
7
8 clc;
9 clear;
10 //Below values are taken from the given circuit (fig
    .3.27)
11 Z1=complex(6,0);
12 Z2=complex(10,15);
13 Z3=complex(6,-3);
14
15 Zs=(Z1*Z2)/(Z1+Z2)+Z3;
16 V=12;
17 Va=V-(V/(Z1+Z2))*real(Z3);
18 Is=complex(5*cosd(-30),5*sind(-30));
19 Vb=Is*Z3;
20 Voc=Va-Vb;
21 I=Voc/(Zs+3);
22 I_mag=sqrt(real(I)^2+imag(I)^2);
23 I_ang=atand(imag(I)/real(I))+180;
24 printf("\n The required current= %1.4f angle:%3.2f
    degree \n",I_mag,I_ang)

```

---

**Scilab code Exa 3.19** Determination of current using Norton theorem

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_19.sce
7
8 clc;
9 clear;

```

```
Scilab 5.5.2 Console ? ↗ ✕  
  
Current through the 3 ohm resistor= 2.2622 angle:114.11 degree  
-->|
```

Figure 3.18: Determination of current using Norton theorem

```
10 //Below values are taken from the given circuit (fig  
    .3.27)  
11 Z1=complex(6,0);  
12 Z2=complex(10,15);  
13 Z3=complex(6,-3);  
14 Zs=(Z1*Z2)/(Z1+Z2)+Z3;  
15 Vs=complex(12,0);  
16 Is=complex(5*cosd(-30),5*sind(-30));  
17  
18 //for loop1 , the coefficient of I2 ,Isc and source  
    is given below  
19 a1=Z1+Z2;  
20 b1=Z1;  
21 c1=Vs;  
22 //for loop2 , the coefficient of I1 ,I2 and source  
    is given below  
23 a2=Z2;  
24 b2=-Z3;
```

```
Scilab 5.5.2 Console ? ↗ ✕  
  
(a)  
  Z_I=1.09 angle:-51.34 degree  
  
(b)  
  Maximum power=57.14 watt  
  
-->
```

Figure 3.19: Calculation of impedance and maximum power

```
25 c2=Is*Z3;  
26 del2=det([a1 c1;a2 c2]);  
27 del=det([a1 b1;a2 b2]);  
28  
29 Isc=del2/del;  
30 Ys=1/Zs;  
31 I=(Isc/Ys)/((1/Ys)+3);  
32 I_mag=sqrt(real(I)^2+imag(I)^2);  
33 I_ang=atand(imag(I)/real(I))+180;  
34 printf("\n Current through the 3 ohm resistor= %1.4 f  
    angle:%3.2 f degree \n",I_mag,I_ang)
```

---

**Scilab code Exa 3.20** Calculation of impedance and maximum power

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_20.sce.
7
8 clc;
9 clear;
10
11 Vm=16*sqrt(2); //Maximum voltage value in volt
12 Vrms=Vm/sqrt(2); //RMS voltage in volt
13 R=1; //resistance in ohm
14 C=-%i; //capacitance in ohm
15 R1=2; //resistance in ohm
16 R2=3; //resistance in ohm
17 C1=-%i; //capacitance in ohm
18 //After simplification of the network by star-delta
    transformation
19 Za=complex(2,-10)/26;
20 Zb=complex(3,-15)/26;
21 Zc=complex(30,6)/26;
22 Voc=(Vrms*(Zc+C))/(R+Za+Zc+C);
23 Zs=(1/((1/(Za+R))+(1/(Zc+C))))+Zb;
24
25 printf("\\n (a)")
26 Z1=Zs;
27 Z1_mag=sqrt(real(Z1)^2+imag(Z1)^2);
28 Z1_ang=atand(imag(Z1)/real(Z1));
29 printf("\\n Z_L=%1.2 f angle:%2.2 f degree \\n",
    Z1_mag,Z1_ang)
30
```



```
Scilab 5.5.2 Console

V_L=415.4 V

V2=436.8 V

Reactive power:P2=3462.4 W      Q2=2812.3 Var

-->
```

Figure 3.20: Determination of voltage and power and reactive power

```
31 printf("\n (b)")
32 Voc_mag=sqrt(real(Voc)^2+imag(Voc)^2);
33 Pmax=Voc_mag^2/(2*real(Z1));
34 printf("\n      Maximum power=%2.2f watt \n",Pmax)
35 //There is a mistake in Zs calculation .Zs
    =0.7555-0.8539i is wrong .the correct value of
    Zs=0.6829-0.8536i
36 //So the answer vary
```

---

**Scilab code Exa 3.21** Determination of voltage and power and reactive power

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```

4 //Edition:Third ,2014
5
6 //Ex3_21.sce
7
8 clc;
9 clear;
10 P1=7e3; //supplied power in watt
11 pf1=0.8; //lagging power factor
12 //below values are taken from the given circuit (fig
    .3.39)
13 Z1=complex(0.8,1);
14 Z2=complex(1.4,1.6);
15 V1=440; //terminal voltage in volt
16 PL=10e3; //power required by the load in watt
17 pf2=0.8; //lagging power factor
18
19 I1=P1/(V1*pf1);
20 Pr1=P1-(I1^2*real(Z1));
21 Q1=P1*tand(acosd(pf1));
22 Qr1=Q1-(I1^2*imag(Z1));
23 VA=sqrt(Pr1^2+Qr1^2);
24 VL=VA/I1;
25 printf("\n V_L=%3.1 f V \n",VL)
26
27 QL=PL*tand(acosd(pf2));
28 Pr2=PL-Pr1;
29 Qr2=QL-Qr1;
30 VA_load=sqrt(Pr2^2+Qr2^2);
31 I2=VA_load/VL;
32
33 P2=Pr2+(I2^2*real(Z2));
34 Q2=Qr2+(I2^2*imag(Z2));
35 V2=sqrt(P2^2+Q2^2)/I2;
36 printf("\n V2=%3.1 f V \n",V2)
37 printf("\n Reactive power:P2=%4.1 f W \t Q2=%4.1 f Var
    \n",P2,Q2)

```

---

```
Scilab 5.5.2 Console

(a)
  The value of capacitance=1135.0 micro-farad

(b)  (i)
      Magnitude alternator current without capacitor=104.8 A

      (ii)
      Magnitude alternator current with capacitor=65.2 A

-->|
```

Figure 3.21: Determination of capacitance and current of alternator

**Scilab code Exa 3.22** Determination of capacitance and current of alternator

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex3_22.sce.
7
8 clc;
9 clear;
10 V=230; //Supply voltage in volt
11 PL1=10E3; //supply power to load 1 in watt
12 pf1=0.7; // lagging power factor value of load 1
```

```

13 P2=10E3; //supply power to load 2 in watt
14 pf2=0.5; //lagging power factor value of load 2
15
16 printf("\n (a)")
17 PL2=P2*pf2;
18 QL1=PL1*tand(acosd(pf1));
19 QL2=PL2*tand(acosd(pf2));
20 PL=PL1+PL2;
21 QL=QL1+QL2;
22 QC=-QL;
23 IC=QC/V;
24 XC=QC/IC^2;
25 f=50;
26 C=1/(2*pi*f*XC);
27 printf("\n The value of capacitance=%4.1f micro-
    farad \n",C*1e6)
28
29 printf("\n (b)\t(i)")
30 kVA=sqrt(PL^2+QL^2);
31 Ig=kVA/V;
32 printf("\n Magnitude alternator current without
    capacitor=%3.1f A \n",Ig)
33 printf("\n\t(ii)")
34 kVA=PL;
35 Ig=kVA/V;
36 printf("\n Magnitude alternator current with
    capacitor=%2.1f A \n",Ig)
37 //Answer vary dueto roundoff error

```

---

**Scilab code Exa 3.27** Plotting the four components from the given circuit

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad

```

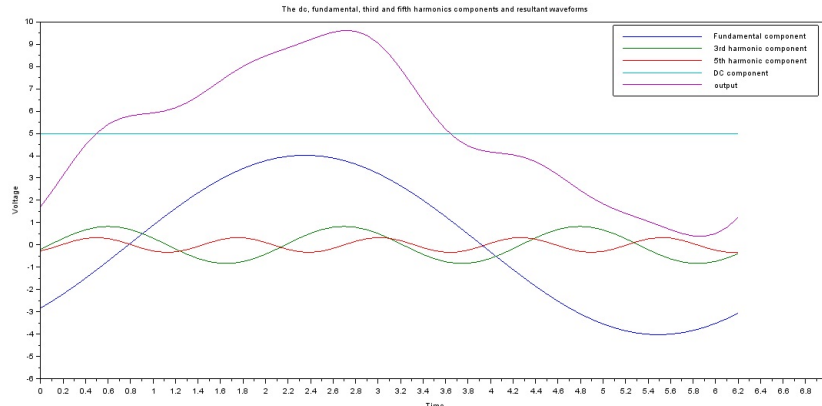


Figure 3.22: Plotting the four components from the given circuit

```

3 //Publisher: PHI Learning Private Limited
4 //Edition: Third ,2014
5
6 //Ex3_27(b).sce
7
8 clc;
9 clear;
10 //case(b)
11 //from case(a) result  $v(t)=5+6.36 \sin(t)+2.12 \sin(3t)$ 
     $+1.27 \sin(5t)$ 
12 V0=5
13 V1=6.36/sqrt(2);
14 V3=2.12/sqrt(2);
15 V5=1.27/sqrt(2);
16
17 omega0=0;
18 omega1=1;
19 omega3=3;
20 omega5=5;
21
22 Vdc=(2*V0)/(2+%i*omega0);
23 V1=(2*V1)/(2+%i*omega1)

```

```

24 V3=(2*V3)/(2+%i*omega3)
25 V5=(2*V5)/(2+%i*omega5)
26
27 Vdc_mag=sqrt(real(Vdc)^2+imag(Vdc)^2);
28 Vdc_ang=atand(imag(Vdc)/real(Vdc));
29 V1_mag=sqrt(real(V1)^2+imag(V1)^2);
30 V1_ang=atand(imag(V1)/real(V1))-180;
31 V3_mag=sqrt(real(V3)^2+imag(V3)^2);
32 V3_ang=atand(imag(V3)/real(V3));
33 V5_mag=sqrt(real(V5)^2+imag(V5)^2);
34 V5_ang=atand(imag(V5)/real(V5));
35
36
37 t=[0:0.1:2*%pi];
38
39 Vc1=V1_mag*sin(t-V1_ang);
40 Vc3=V3_mag*sin((3*t)-V3_ang);
41 Vc5=V5_mag*sin((5*t)-V5_ang);
42 for tt=1:length(t)
43     V(tt)=Vdc_mag*sin(%pi/2);
44 end
45 V=V';
46 Vc=V+Vc1+Vc3+Vc5;
47
48 plot(t,[Vc1; Vc3; Vc5; V ;Vc])
49
50 title('The dc, fundamental, third and fifth
        harmonics components and resultant waveforms')
51 xlabel('Time')
52 ylabel('Voltage')
53 legend('Fundamental component','3rd harmonic
        component','5th harmonic component','DC component
        ','output')

```

---

# Chapter 4

## Electrostatics

Scilab code Exa 4.1 Determination of force between two spheres

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_1.sce.
7
8 clc;
9 clear;
10 Q1=2e-9; //Sphere 1 charges in coulomb
11 Q2=-0.5e-9; //Sphere 2 charges in coulomb
12 r=4e-2; //Distance between the two spheres in m
13 epsilon_not=1/(36e9*%pi);
14 printf("\n(a)")
15 F=-(Q1*Q2)/(4*%pi*epsilon_not*r^2);
//Coulomb's law
16 printf("\n Force between two spheres when they are
displaced 4cm apart=%1.4f*10^-5 N Attractive\n",F
*1e5)
```

```

(a)
Force between two spheres when they are displaced 4cm apart=0.5625*10-5 N Attractive

(b)
Force between two spheres if they are brought into contact and separated by 4cm =0.3164*10-5 N repulsive
-->

```

Figure 4.1: Determination of force between two spheres

```

17
18 printf("\n(b)")
19 q=(Q1+Q2)/2;
20 F=(q^2)/(4*%pi*epsilon_not*r^2)
21 printf("\n Force between two spheres if they are
    brought into contact and separated by 4cm =%1.4f
    *10-5 N repulsive\n",F*1e5)

```

---

#### Scilab code Exa 4.3 Calculation of force

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_3.sce
7
8 clc;
9 clear;

```



```

SciLab 5.5.2 Console

The force on Q2=10.6 N

Force interms of i,j,k vector coefficient is
- 5.7570248 - 6.7165289  5.7570248

-->

```

Figure 4.2: Calculation of force

```

10 r=[-0.03 0.01 0.04];
11 r_dash=[0.03 0.08 -0.02];
12 Q1=129e-9;
13 Q2=110e-6;
14 epsilon_not=1/(36*%pi*1e9);
15
16 a=r-r_dash; //r and r_dash are the position of two
    charges
17 b=a.^2;
18 c=b(1,1)+b(1,2)+b(1,3);
19 d=sqrt(c); //b,c,d are assumed alphabets for
    calculating magnitude of difference of r and r'
20
21 F=(Q1*Q2)/(4*%pi*epsilon_not*d^2);
22 printf("\n The force on Q2=%2.1f N \n",F)
23 Ir=a/d;
24 F1=Ir*F;
25 printf("\n Force interms of i,j,k vector coefficient
    is")
26 disp(F1)
27
28 //There is a error in the book for calculating F

```

```
Magnitude of electric field intensity E=5.6*10^-11 N/C  
-->|
```

Figure 4.3: Determination electric field intensity

```
value  
29 //So answer given in the book is wrong
```

---

#### Scilab code Exa 4.4 Determination electric field intensity

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex4_4.sce.  
7  
8 clc;  
9 clear;  
10 q=1.6e-19;  
11 m=9.1e-31;  
12 g=9.8;
```

```
Scilab 5.5.2 Console
```

```
The resultant field intensity in N/C is  
- 57600.i  
-->|
```

Figure 4.4: Calculation of electric field intensity

```
13 F=m*g;  
14 E=F/q;  
15 printf("\n Magnitude of electric field intensity E=  
    %1.1f*10-11 N/C",E*1e11)
```

---

#### Scilab code Exa 4.5 Calculation of electric field intensity

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex4_5.sce.
```

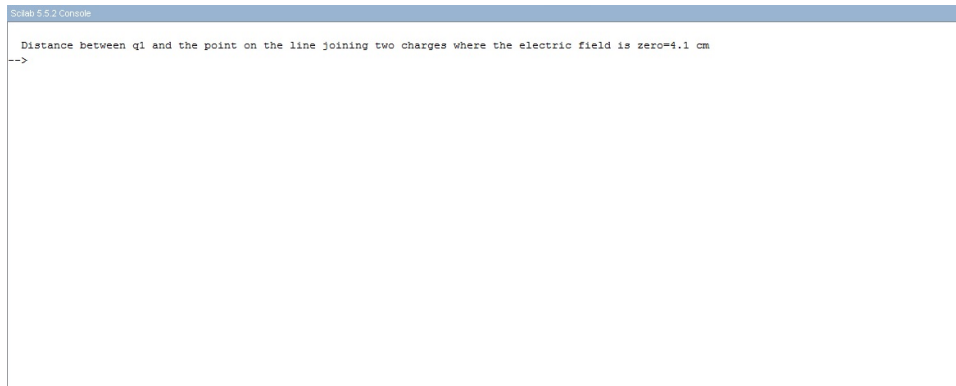


Figure 4.5: Determination of distance between two charges at which electric field strength is zero

```

7
8 clc;
9 clear;
10 //from the given figure
11 q=1e-8;
12 OB=sqrt(5^2-4^2); //Distance between point O and B
13 cos_theta=3/5;
14 sin_theta=4/5;
15 r=5e-2;
16
17 epsilon_not=1/(36e9*%pi);
18 modulus_E=q/(4*%pi*epsilon_not*r^2);
19 E1=((modulus_E*cos_theta)-(modulus_E*sin_theta*%i));
20 E2=((-modulus_E*cos_theta)-(modulus_E*sin_theta*%i))
    ;
21 E=E1+E2;
22 disp(E, 'The resultant field intensity in N/C is ')

```

---

Scilab code Exa 4.7 Determination of distance between two charges at which electric

```
Scilab 5.5.2 Console
(a)
The maximum torque=2.0*10^-3 Nm
(b)
The work done=4.0*10^-3 J
-->
```

Figure 4.6: Determination of maximum torque and work done

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_7.sce.
7
8 clc;
9 clear;
10 q1=1e-4;
11 q2=2e-4;
12 l=10e-2;
13 x=1*1e2/(1+sqrt(q2/q1));
14 printf("\n Distance between q1 and the point on the
    line joining two charges where the electric
    field is zero=%1.1f cm",x)
```

---

Scilab code Exa 4.11 Determination of maximum torque and work done

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_11.sce.
7
8 clc;
9 clear;
10 q=1e-6;
11 l=2e-2;
12 E=1e5;
13
14 printf("\n (a)")
15 theta=90;
16 p=l*q;
17 T_max=p*E*sind(theta);
18 printf("\n The maximum torque=%1.1f*10^-3 Nm\n",
    T_max*1e3)
19
20 printf("\n (b)")
21 U_180=-p*E*cosd(180); //U is
    the potential energy for theta=180 degree and 0
    degree
22 U_0=-p*E*cosd(0);
23 W=(U_180)-(U_0);
24 printf("\n The work done=%1.1f*10^-3 J",W*1e3)

```

---

#### Scilab code Exa 4.14 Determination of charge

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited

```

```
Magnitude value of isolated positive charge=1.1*10^-9 coulomb  
-->|
```

Figure 4.7: Determination of charge

```
4 //Edition:Third ,2014  
5  
6 //Ex4_14.sce.  
7  
8 clc;  
9 clear;  
10 V=100;  
11 epsilon_not=8.854e-12;  
12 r=10e-2;  
13 q=4*pi*epsilon_not*r*V;  
14 printf("\n Magnitude value of isolated positive  
    charge=%1.2g*10^-9 coulomb",q*1e9)
```

---

Scilab code Exa 4.15 Calculation of potential difference between two points

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014
```

```
Scilab 5.5.2 Console
The potential difference between the two points=45 volt
-->
```

Figure 4.8: Calculation of potential difference between two points

```
5
6 //Ex4_15.sce.
7
8 clc;
9 clear;
10 q=1e-9;
11 r_p=10e-2;
12 r_q=20e-2;
13 epsilon_not=8.854e-12;
14 V=(q/(4*%pi*epsilon_not))*((1/r_p)-(1/r_q));
15 printf("\n The potential difference between the two
    points=%2.0f volt",V)
```

---

#### Scilab code Exa 4.16 Calculation of net potential

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```



```
Potential at the centre of the square=50.84 volt  
-->
```

Figure 4.9: Calculation of net potential

```
4 //Edition:Third ,2014  
5  
6 //Ex4_16.sce.  
7  
8 clc;  
9 clear;  
10 q1=-2e-9;  
11 q2=3e-9;  
12 q3=2e-9;  
13 q4=1e-9;  
14 AB=1; //Given square side as 1 metre  
15 BC=1;  
16 epsilon_not=8.854e-12;  
17 AP=sqrt(AB^2+BC^2)/2; //formula derived  
    from the figure  
18 Vp=(1/(4*pi*epsilon_not*AP))*(q1+q2+q3+q4);  
19 printf("\n Potential at the centre of the square=%2  
    .2f volt",Vp)  
20  
21 //Answer vary due to roundoff error
```

---

```

Scilab 5.5.2 Console
E=(0i)+(-3949j)+(11194k) V/m
-->|

```

Figure 4.10: Calculation of electric field

**Scilab code Exa 4.18** Calculation of electric field

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_18.sce.
7 clc;
8 clear;
9 Q1=3e-6;
10 Q2=2e-6;
11 a=9e9; //a=(1/(4*%pi*epsilon_not))
12
13 x=1;y=2;z=3;
14
15 //V=-a*((Q1/(sqrt((x-1)^2+(y-1)^2+(z-1)^2)))+(Q2/(

```

```

    sqrt((x-1)^2+(y-3)^2+(z-2)^2));
16
17 dV_dx=-a*((Q1*(x-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))
    +(Q2*(x-1)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));
    //differentiation of potential with respect to x
18
19 dV_dy=-a*((Q1*(y-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))
    +(Q2*(y-3)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));
    //differentiation of potential with respect to y
20
21 dV_dz=-a*((Q1*(z-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))
    +(Q2*(z-2)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));
    //differentiation of potential with respect
    to z
22
23 //E=-(del_V)
24 printf("\n E=(%gi)+(4.0 fj)+(5.0 fk) V/m",-dV_dx,-
    dV_dy,-dV_dz)

```

---

#### Scilab code Exa 4.19 Calculation of potential and field strength

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_19.sce.
7
8 clc;
9 clear;
10 r1=3e-2;
11 r2=6e-2;
12 r3=9e-2;

```

```

Field strength and potentials for point a,b,c,d are ,
Ea=0 N/C
Va=2.1 V

Eb=50.625 N/C
Vb=1.425 V

Ec=5.51 N/C
Vc=0.686 V

Ed=3.75 N/C
Vd=0.45 V
-->

```

Figure 4.11: Calculation of potential and field strength

```

13 q1=9e-12;
14 q2=-6e-12;
15 q3=3e-12;
16 d1=2e-2;
17 d2=4e-2;
18 d3=7e-2;
19 d4=12e-2;
20 epsilon_not=8.854e-12;
21 a=9e9; //a=1/(4*%pi*epsilon_not);
22
23 printf("\n Field strength and potentials for point a
    ,b,c,d are ,")
24 Ea=0;
25 printf("\n\t Ea=%g N/C" ,Ea)
26 Va=a*((q1/r1)+(q2/r2)+(q3/r3));
27 printf("\n\t Va=%g V \n" ,Va)
28
29 Eb=a*(q1/d2^2);
30 printf("\n\t Eb=%g N/C" ,Eb)
31 Vb=a*((q1/d2)+(q2/r2)+(q3/r3));
32 printf("\n\t Vb=%g V \n" ,Vb)

```

```
Scilab 5.5.2 Console

Electric field strength in air , E1=37.88 kV/cm

Electric field strength in the fibre , E2=7.576 kV/cm

The air will break.
-->
```

Figure 4.12: Determination of electric field strength

```
33
34 Ec=a*((q1/d3^2)+(q2/d3^2));
35 printf("\n\t Ec=%1.2 f N/C",Ec)
36 Vc=a*((q1/d3)+(q2/d3)+(q3/r3));
37 printf("\n\t Vc=%1.3 f V \n",Vc)
38
39 Ed=(a/d4^2)*(q1+q2+q3);
40 printf("\n\t Ed=%g N/C",Ed)
41 Vd=(a/d4)*(q1+q2+q3);
42 printf("\n\t Vd=%g V \n",Vd)
43 //There is a error in book calculation on Vc. In the
    book Vc=0.762 volt instead of 0.6857 volt
```

---

Scilab code Exa 4.22 Determination of electric field strength

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_22.sce.
7
8 clc;
9 clear;
10 V=2.5; //potential difference of the
    plates in kv
11 x=0.25; //distance between two
    parallel plates in cm
12 x1=0.02; //airgap in between the
    parallel plates in cm
13 x2=0.23; //thickness of fibre sheet in
    the gap in cm
14 epsilon_r=5;
15
16 //As the electric displacement is perpendicular to
    the boundary
17 //D=D1=D2; , D1=epsilon_not*E1; , D2=
    epsilon_not*epsilon_r*E2;
18 //from this E1=5*E2;
19
20 //V=V1+V2; V1=x1*E1; V2=x2*E2;
21 //from this we can find the equation of E2
22
23 E2=V/((x1*epsilon_r)+(x2));
24 E1=5*E2;
25
26 printf("\\n Electric field strength in air , E1=%2.2 f
    kV/cm \\n",E1)
27 printf("\\n Electric field strength in the fibre , E2
    =%1.3 f kV/cm \\n",E2)
28
29 E=30; //Dielectric strength of air in kV/cm
30 if (E1>E)

```

Scilab 5.5.2 Console

```
Capacitance=13.281 pF
Potential difference=56.5 volt
New capacitance=53.124 pF
New potential difference=14.118 volt
-->
```

Figure 4.13: Determination of capacitance of the capacitor and potential difference across the capacitor

```
31     printf("\n The air will break.")
32 else
33     printf("\n The air will not break.")
34 end
```

---

**Scilab code Exa 4.24** Determination of capacitance of the capacitor and potential d

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_24.sce.
7
8 clc;
9 clear;
```

```

10 d=1e-2;
11 l=15e-2;
12 h=10e-2;
13 Q=750e-12;
14 epsilon_not=8.854e-12;
15
16 A=l*h;
17 C=(epsilon_not*A)/d;
18 printf("\n Capacitance=%2.3f pF \n",C*1e12)
19 V=Q/C;
20 printf("\n Potential difference=%2.1f volt \n",V)
21
22 epsilon_r=4;
23 C=(epsilon_not*epsilon_r*A)/d;
24 printf("\n New capacitance=%2.3f pF \n",C*1e12)
25 V=Q/C;
26 printf("\n New potential difference=%2.3f volt \n",
    V)
27
28 //There is a error in the book calculation for
    finding new potential difference(V) ,the answer
    is given V=14.125 volt insteadof 14.118 volt

```

---

**Scilab code Exa 4.26** Calculation of electric field intensity and electric flux den

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_26.sce.
7
8 clc;

```



```

Scilab 5.5.2 Console

Capacitance of the cable=202.55 pF/m

(a)
The electric flux density at the surface of inner conductor=6.447 micro_C/m^2
The electric field intensity at the surface of inner conductor=182 kV/m

(b)
The electric flux density at the inner surface of outer conductor=2.149 micro_C/m^2
The electric field intensity at the inner surface of outer conductor=60.683 kV/m

-->

```

Figure 4.14: Calculation of electric field intensity and electric flux density

```

9 clear;
10 d_i=5e-3; //Diameter of inner cylinder
    in metre
11 d_o=15e-3; //Diameter of outer cylinder
    in metre
12 epsilon_r=4;
13 V=500;
14 epsilon_not=8.854e-12;
15 epsilon=epsilon_r*epsilon_not;
16 a=d_i/2;
17 b=d_o/2;
18 C=(2*pi*epsilon)/(log(b/a));
19 printf("\n Capacitance of the cable=%3.2 f pF/m \n",C
    *1e12)
20
21 printf("\n(a)")
22 p_l=C*V; //Electric displacement
    through a cylindrical area of unit length in C/m
23 D=p_l/(2*pi*a);
24 E=D/epsilon;
25 printf("\n The electric flux density at the surface

```

```
Capacitance of the transmission line=0.0272 micro farad
-->
```

Figure 4.15: Calculation of capacitance of the line

```

of inner conductor=%1.3 f micro_C/m^2",D*1e6)
26 printf("\n The electric field intensity at the
    surface of inner conductor=%3.0 f kV/m \n",E*1e-3)
27
28 printf("\n(b)")
29 D=p_l/(2*pi*b);
30 E=D/epsilon;
31 printf("\n The electric flux density at the inner
    surface of outer conductor=%1.3 f micro_C/m^2",D*1
    e6)
32 printf("\n The electric field intensity at the
    inner surface of outer conductor=%2.3 f kV/m \n",E
    *1e-3)
33 //Answer vary dueto round off error

```

---

Scilab code Exa 4.27 Calculation of capacitance of the line

```
1 //Book Name:Fundamentals of Electrical Engineering
```

```
Insulation thickness of the cable if insulation resistance is 700 megaohm=2.742 cm  
-->
```

Figure 4.16: Calculation of thickness of the dielectric

```
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex4_27.sce.  
7  
8 clc;  
9 clear;  
10 l=4e3;  
11 b=2*75e-2;  
12 a=2.5e-2;  
13 epsilon_not=8.854e-12;  
14 C=(%pi*epsilon_not*l)/log(b/a);  
15 printf("\n Capacitance of the transmission line=%1.4  
    f micro farad",C*1e6)
```

---

Scilab code Exa 4.28 Calculation of thickness of the dielectric

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex4_28.sce.
7
8 clc;
9 clear;
10 t1=1.5; //Insulation thickness of
    conductor in cm
11 d_c=1.5; //Diameter of conductor in cm
12 a1=d_c/2;
13 b1=a1+t1;
14 R1=500; //Insulation resistance in
    megaohm for a given thickness
15 R2=700; //Insulation resistance in
    megaohm for a unknown thickness
16
17 //R=(p/(2*%pi*l))*log(b/a) R1=(p/(2*%pi*l))*
    log(b1/a1) R2=(p/(2*%pi*l))*log(b2/
    a2)
18
19 a2=d_c/2;
20 b2=a2; //b2 is the sum of a2 and unknown
    thickness
21
22 t2=a2*(b1/a1)^(R2/R1)-b2; //thickness of 700
    megaohm resistance insulation in cm
23 printf("\n Insulation thickness of the cable if
    insulation resistance is 700 megaohm=%1.3f cm",t2
    )

```

---

Scilab 5.5.2 Console

```
Loss of energy=43.2*10^-4 joule  
-->
```

Figure 4.17: Determination of loss energy

**Scilab code Exa 4.29** Determination of loss energy

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex4_29.sce.  
7  
8 clc;  
9 clear;  
10 Q1=60e-6; //Capacitor charges in coulomb  
11 V1=180; //Volatge in volt  
12  
13 C1=Q1/V1;  
14 C2=4*C1;  
15 Q2=0;  
16 E1=(1/2)*C1*V1^2; //Before two
```

```

    capacitance are joined the energy stored in C1
17 E2=0; //Energy stored in C2
18 Ea=E1+E2; //Total energy before
    two capacitors are joined
19 V=(Q1+Q2)/(C1+C2); //Potential in volt
20
21 E1=(1/2)*C1*V^2; //Energy stored in C1 in
    joule
22 E2=(1/2)*C2*V^2; //Energy stored in C2 in
    joule
23 Eb=E1+E2; //Total energy after two
    capacitors are joined
24
25 E_loss=Ea-Eb;
26 printf("\n Loss of energy=%2.1f*10^-4 joule",E_loss
    *1e4)

```

---

## Chapter 5

# Electromagnetism and Electromechanical Energy Conversion

Scilab code Exa 5.5 Determination of mmf and total flux and flux density

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_5.sce.
7
8 clc;
9 clear;
10 N=200;
11 A=5e-4;
12 I=4;
13 l=60e-2;
14
15 printf("\\n\\t (a)")
```

```

      (a)
Magnetomotive force=800 AT

      (b)
Total flux=0.83776 microWb

      (c)
Flux density=1.6755 mWb/m^2
-->

```

Figure 5.1: Determination of mmf and total flux and flux density

```

16 F=N*I;
17 printf("\n Magnetomotive force=%d AT \n",F)
18
19 printf("\n\t (b)")
20 mew_r=1;
21 mew_not=4e-7*pi;
22 mew=mew_r*mew_not;
23 R=1/(mew*A);
24 phi=(F)/R;
25 printf("\n Total flux=%1.5 f microWb \n",phi*1e6)
26
27 printf("\n\t (c)")
28 B=phi/A;
29 printf("\n Flux density=%1.4 f mWb/m^2",B*1e3)
30 //Answer vary dueto round off error
31 //The unit for B(flux density) is Wbm/m^2

```

---



```
Scilab 5.5.2 Console
The Magnetomotive force=1492 AT
-->
```

Figure 5.2: Determination of mmf

**Scilab code Exa 5.6** Determination of mmf

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_6.sce.
7
8 clc;
9 clear;
10 l=2.5e-3;
11 A=200e-4;
```

```
(a)
Reluctance of the core=1.6753*10^6 AT/Wb

(b)
Magnetizing current=6.7013 A

-->
```

Figure 5.3: Calculation of reluctance and current

```
12 phi=0.015;           //flux in weber
13 mew_r=1;
14 mew_not=4e-7*%pi;
15 mew=mew_r*mew_not;
16 R=1/(mew*A);
17 F=phi*R;
18 printf("\n The Magnetomotive force=%d AT \n",F)
```

---

#### Scilab code Exa 5.7 Calculation of reluctance and current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_7.sce.
7
```

```

8  clc;
9  clear;
10 A=5e-4;
11 l=0.4;
12 N=200;
13 mew_r=380;
14 mew_not=4e-7*%pi;
15 mew=mew_r*mew_not;
16
17 printf("\n (a)")
18 R=(l*1e-6)/(mew*A);
19 printf("\n Reluctance of the core=%1.4f*10^6 AT/Wb
      \n",R)
20
21 printf("\n (b)")
22 phi=800e-6; //flux in weber
23 F=phi*1e6*R;
24 I=F/N;
25 printf("\n Magnetizing current=%1.4f A \n",I)
26 //Answer vary dueto round off error

```

---

### Scilab code Exa 5.8 Calculation of reluctance and current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_8.sce.
7
8 clc;
9 clear;
10 mew_rA=250;

```

```

(a)
  The total reluctance=3434.62*10^3 AT/Wb

(b)
  The magnetizing current=34.35 AT

-->|

```

Figure 5.4: Calculation of reluctance and current

```

11 mew_rB=320;
12 lA=40e-2;
13 lB=25e-2;
14 aA=5e-4;
15 aB=7e-4;
16 N=250;
17 printf("\n (a)")
18 mew_not=4e-7*pi;
19 mew_A=mew_rA*mew_not;
20 mew_B=mew_rB*mew_not;
21 R=((lA/(mew_A*aA))+(lB/(mew_B*aB)));
22 printf("\n   The total reluctance=%g*10^3 AT/Wb \n",
        R*1e-3)
23
24 printf("\n (b)")
25 phi=2.5e-3;
26 F=phi*R;
27 I=F/N;
28 printf("\n   The magnetizing current=%2.2 f AT \n",I)

```

```
Scilab 5.5.2 Console
Total mmf=2457.54 AT
-->
```

Figure 5.5: Calculation of mmf

29 //Answer vary dueto round\_off error

---

#### Scilab code Exa 5.9 Calculation of mmf

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_9.sce.
7
8 clc;
9 clear;
10 //from the given figure
11 l_not=350e-3;
12 lc=150e-3;
13 la=1e-3;
14 A_not=400e-6;
```

```
Magnetizing current=5 A
```

```
-->|
```

Figure 5.6: Calculation of magnetizing current

```
15 Ac=800e-6;
16 pi=1e-3;           //flux in weber
17 mew_r=340;
18 mew_not=4e-7*pi;
19
20 R_not=l_not/(mew_r*mew_not*A_not);
21 Rc=lc/(mew_r*mew_not*Ac);
22 Ra=la/(mew_not*Ac);
23 F=pi*(R_not/2+Rc+Ra);
24 printf("\n Total mmf=%4.2 f AT",F)
25 //Answer vary dueto round_off error
```

---

Scilab code Exa 5.10 Calculation of magnetizing current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_10.sce.
7
8 clc;
9 clear;
10 N=800;
11 Hi=50e-3;
12 Wi=40e-3;
13 l_not=2e-3;
14 A_not=2500e-6;
15 leakage_factor=1.2;
16 mew_not=4e-7*%pi;
17 mew_r=322;
18 pi_not=2.5e-3;
19 lc=600e-3; //from the figure
20
21 B_not=pi_not/A_not;
22 H_not=B_not/mew_not;
23 F_not=H_not*l_not;
24 pi_T=pi_not*leakage_factor;
25 Ac=Wi*Hi*0.92; //given 8 percent is
    taken for insulation . so (1-0.08=0.92)
26 Bc=pi_T/Ac;
27 Hc=Bc/(mew_r*mew_not);
28 Fc=Hc*lc;
29 F=Fc+F_not;
30 Im=F/N;
31 printf("\n Magnetizing current=%d A \n",Im)

```

---

```
(a)
Inductance of the coil=4.61 H

(b)
Time required for the current to reach pickup value=3.93 ms
-->|
```

Figure 5.7: Calculation of inductance and time at pickup value of current

**Scilab code Exa 5.12** Calculation of inductance and time at pickup value of current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_12.sce.
7
8 clc;
9 clear;
10 N=20000;
11 R=5e2;
12 V=250;
13 mmf=3471;
14 pi=0.04e-3;
15
16 printf("\n (a)")
17 I=mmf/N;
```



```

(a)
Cross sectional area of the core=500.5 cm^2

(b)
Magnetizing current=6.125 A
-->|

```

Figure 5.8: Calculation of cross sectional area of the core and magnetizing current

```

18 L=(N*pi)/I;
19 printf("\n Inductance of the coil=%1.2 f H \n",L)
20
21 printf("\n (b)")
22 t=log(1/(1-((I*R)/V)))*(L/R);
23 printf("\n Time required for the current to reach
    pickup value=%1.2 f ms",t*1E3)
24 //The book answer for t (=3.93 ms) is obtained only
    if R=500 ohm. Otherwise (R=5000) we cannot get the
    answer
25 //So there is a mistake in R value given

```

---

Scilab code Exa 5.13 Calculation of cross sectional area of the core and magnetizing current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_13.sce.
7
8 clc;
9 clear;
10 Bm=1.1;
11 V=2.2e3;
12 f=50;
13 N=200;
14
15 printf("\\n\\t (a)")
16 stack_factor=0.9;
17 pi_m=V/(4.44*f*N);
18 A=pi_m/(Bm*stack_factor);
19 printf("\\n Cross sectional area of the core=%3.1f
    cm^2 \\n",A*1e4)
20 //There is a small (printing) mistake in the final
    answer of A in the book
21
22 printf("\\n\\t (b)")
23 l=250e-2;
24 H=490; //from the graph 5.21 H value is
    taken which is corresponding to B=1.1 wb/m^2
25 mmf=H*l;
26 Im=mmf/N;
27 printf("\\n Magnetizing current=%1.3 f A",Im)

```

---

Scilab code Exa 5.14 Determination of steady state value of current and resistance

```
Scilab 5.5.2 Console

The final steady state value of current=0.316 A

Inductance=1.896 H

Resistance=632 ohm

Energy stored when current reached its final value=0.095 J
-->|
```

Figure 5.9: Determination of steady state value of current and resistance and inductance of the coil and stored energy

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_14.sce.
7
8 clc;
9 clear;
10 V=200;
11 i=0.2;
12 T=3e-3;
13 t=3e-3;
14
15 R=(V/i)*(1-exp(-t/T));
16 I=V/R;
17 printf("\n The final steady state value of current=
    %1.3f A \n",I)
```

```

(a)
Primary current=22.73 A

Secondary current=227.3 A

(b)
The load impedance for the secondary side=0.968 ohm

(c)
The load impedance for the primary side=96.8 ohm

-->

```

Figure 5.10: Calculation of load current and impedance referred to primary and secondary side

```

18
19 L=R*T;
20 printf("\n Inductance=%1.3 f H \n",L)
21 printf("\n Resistance=%3.0 f ohm \n",R)
22
23 E=(L*I^2)/2;
24 printf("\n Energy stored when current reached its
    final value=%1.3 f J",E)

```

---

Scilab code Exa 5.15 Calculation of load current and impedance referred to primary

```

1 //Book Name: Fundamentals of Electrical Engineering
2 //Author: Rajendra Prasad

```

```

3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex5_15.sce.
7
8 clc;
9 clear;
10 P=50e3;
11 V1=2.2e3;
12 V2=220;
13
14 printf("\n (a)")
15 I1=P/V1;
16 I2=P/V2;
17 printf("\n Primary current=%2.2 f A \n",I1)
18 printf("\n Secondary current=%3.1 f A \n",I2)
19
20 printf("\n (b)")
21 Z12=V2/I2;
22 printf("\n The load impedance for the secondary side
    =%1.3 f ohm \n",Z12)
23
24 printf("\n (c)")
25 Z11=V1/I1;
26 printf("\n The load impedance for the primary side=
    %2.1 f ohm \n",Z11)

```

---

**Scilab code Exa 5.16** Calculation of instantaneous values of induced emf

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```

(a)
The instantaneous value of induced emf when plane of the coil is right angle to the field=0 volt

(b)
The instantaneous value of induced emf when the plane of the coil is in the plane of the field=-62.8 volt
-->|

```

Figure 5.11: Calculation of instantaneous values of induced emf

```

5
6 // Ex5_16 . s c e .
7
8 clc ;
9 clear ;
10 N=100 ;
11 a=10e-2 ;
12 n=20 ;
13 B=0.5 ;
14
15 omega=2*%pi*n ;
16 A=a^2 ;
17 v=A*N*omega*B ;
18
19 printf("\n(a)")
20 //theta=40*180*t=n*180 where n=0,1,2,3.....
21 //if we take n=2
22 V=v*sind(180*2) ;
23 printf("\n The instantaneous value of induced emf
    when plane of the coil is right angle to the
    field=%d volt \n",V)
24
25 printf("\n(b)")
26 //theta=n*180/2 where n=1,3,5,7.....

```

Scilab 5.5.2 Console

```
Torque exerted on the coil=2.0625 Nm  
-->
```

Figure 5.12: Determination of torque exerted on the coil

```
27 //if we take n=3  
28 V=v*sind(180*3/2);  
29 printf("\n The instantaneous value of induced emf  
    when the plane of the coil is in the plane of the  
    field=%2.1f volt",V)
```

---

**Scilab code Exa 5.17** Determination of torque exerted on the coil

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex5_17.sce.
```

```
7
8 clc;
9 clear;
10 l=7.5e-2;
11 b=5e-2;
12 N=100;
13 B=1.1;
14 i=5;
15 T=N*B*l*b*i;
16 printf("\\n Torque exerted on the coil=%1.4f Nm",T)
```

---



# Chapter 7

## Transformer

Scilab code Exa 7.1 Calculation of current and number of turns and maximum flux va

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7_1.sce.
7
8 clc;
9 clear;
10 p=175e3; //power rating of
    transformer in KVA
11 Ep=6600; //primary voltage in
    volts
12 Es=440; //secondary voltage in
    volts
13 f=50;
14 Ns=100; //Number of secondary
    turns
15
```

Scilab 5.5.2 Console

```
(a)
Full load primary current=26.52 A
Full load secondary current=397.73 A

(b)
Number of primary turns=1500

(c)
The maximum value of flux=0.01982 Wb

-->
```

Figure 7.1: Calculation of current and number of turns and maximum flux value

```

16 //(a)
17 printf("\n (a)")
18 Ip=p/Ep;
19 Is=p/Es;
20 printf("\n Full load primary current=%2.2 f A ",Ip)
21 printf("\n Full load secondary current=%3.2 f A \n",
    Is)
22
23 //(b)
24 printf("\n (b)")
25 Np=Ns*Ep/Es;
26 printf("\n Number of primary turns=%d \n",Np)
27
28 //(c)
29 printf("\n (c)")
30 max_flux=Es/(4.44*f*Ns);
31 printf("\n The maximum value of flux=%1.5 f Wb \n",
    max_flux)

```

---

### Scilab code Exa 7.2 Calculation of primary current and power factor

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7_2.sce.
7
8 clc;
9 clear;
10 Np=1000; //number of
    Primary turns
11 Ns=200; //number of

```

```

Scilab 5.5.2 Console

Primary current=52.28 A

Power factor=0.777 lagging
-->|

```

Figure 7.2: Calculation of primary current and power factor

```

    secondary turns
12 Io=3; //No load current
    in A
13 cos_phi_not=0.2; //lagging
14 Is=250; //secondary
    current in A
15 cos_phi_s=0.8; //lagging
16
17 Is_dash=Ns*Is/Np;
18 phi_s=(acosd(0.8));
19 phi_not=(acosd(0.2));
20 Ip_cos_phi_p=(Is_dash*cos_phi_s)+(Io*cos_phi_not);
21 Ip_sin_phi_p=(Is_dash*(sind(phi_s)))+(Io*(sind(
    phi_not)));
22 Ip=sqrt((Ip_cos_phi_p)^2+(Ip_sin_phi_p)^2);
23 printf("\n Primary current=%2.2f A\n",Ip)
24
25 phi_p=atand((Ip_sin_phi_p)/(Ip_cos_phi_p));
26 printf("\n Power factor=%1.3f lagging",cosd(phi_p))

```

```
Scilab 5.5.2 Console

Primary Current=52.28 A

Power factor=0.777 lagging

Secondary terminal voltage=417.7 V

-->
```

Figure 7.3: Determination of primary current and power factor and secondary terminal voltage

**Scilab code Exa 7.3** Determination of primary current and power factor and secondary terminal voltage

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7_3.sce.
7
8 clc;
9 clear;
```

```

10 T1=1000;
    //number of Primary turns
11 T2=200; //
    number of secondary turns
12 Is=250; //
    secondary load current in A
13 I0=3; //No
    load current in A
14 rp=0.72; //
    primary winding resistance in ohms
15 rs=0.025; //
    secondary winding resistance in ohms
16 xp=0.92; //
    primary winding leakage reactance in ohms
17 xs=0.036; //
    secondary winding leakage reactance in ohms
18 Vs=2.2e3; //
    supply voltage in volts
19
20 N=T1/T2;
    //turns ratio of transformer
21 Is_dash=Is/N;
22 rs_dash=N^2*rs;
23 xs_dash=N^2*xs;
24 cos_pi_s=0.8;
25 cos_pi_0=0.2;
26 sin_pi_s=sind(acosd(0.8));
27 sin_pi_0=sind(acosd(0.2));
28 Isdash=(Is_dash*cos_pi_s)-%i*(Is_dash*sin_pi_s);
29 Io=(I0*cos_pi_0)-%i*(I0*sin_pi_0);
30 Ip=Isdash+Io;
31 a=real(Ip);
32 b=imag(Ip);
33 Ip_mag=sqrt(a^2+b^2);
34 printf("\n Primary Current=%2.2 f A \n",Ip_mag)
35
36 pi_p=atand(b/a);
37 printf("\n Power factor=%1.3 f lagging \n",cosd(pi_p)

```

```

(a)
Equivalent impedance referred to primary side=2.775 ohms

(b).1
Voltage regulation for 0.8 power factor lagging=3.56 percentage

Secondary terminal voltage at FL 0.8 power factor lagging=424.352 V

(b).2
Voltage regulation for 0.8 power factor leading=-1.325 percentage

Secondary terminal voltage at FL 0.8 power factor leading=445.8295 V

-->|

```

Figure 7.4: Calculation of impedance and voltage regulation

```

    ))
38
39 VL_dash=Vs-(Ip*(rp+%i*xp))-(Isdash*(rs_dash+%i*
    xs_dash)); //secondary terminal
    voltage referred to primary
40 VL_dash_mag=real(VL_dash);
41 VL=VL_dash_mag/N;
42 printf("\n Secondary terminal voltage=%3.1f V \n",
    VL)

```

---

#### Scilab code Exa 7.4 Calculation of impedance and voltage regulation

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```

5
6 //Ex7_4.sce.
7
8 clc;
9 clear;
10 P=75e3; //power rating of
    transformer in KVA
11 Np=500; //number of
    Primary turns
12 Ns=100; //number of
    secondary turns
13 rp=0.4; //primary
    winding resistance in ohms
14 rs=0.02; //secondary
    winding resistance in ohms
15 xp=1.5; //primary winding
    leakage reactance in ohms
16 xs=0.045; //secondary
    winding leakage reactance in ohms
17 Vs=2200; //supply voltage
    in volts
18
19 //case1
20 printf("\n (a)")
21 Re=rp+(Np/Ns)^2*rs; //
    Equivalent resistance in ohms
22 Xe=xp+(Np/Ns)^2*xs; //
    Equivalent leakage reactance in ohms
23 Ze=sqrt(Re^2+Xe^2);
24 printf("\n Equivalent impedance referred to
    primary side=%1.3f ohms\n",Ze)
25
26 //case2
27 printf("\n (b).1")
28 I1=P/Vs; //
    full load primary current in A
29 cos_pi2=0.8;
30 sin_pi2=sind(acosd(0.8));

```



```

31 percentage_voltage_reg=((I1*((Re*cos_pi2)+(Xe*
    sin_pi2)))/Vs)*100;
32 printf("\n Voltage regulation for 0.8 power factor
    lagging=%1.2f percentage \n",
    percentage_voltage_reg)
33 NL_secondary_voltage=(Ns/Np)*Vs;

    //NL means "no load"
34 del_V=(NL_secondary_voltage*percentage_voltage_reg)
    /100;
35 FL_secondary_voltage=(NL_secondary_voltage)-(del_V);
36 printf("\n Secodary terminal voltage at FL 0.8
    power factor lagging=%3.3f V \n",
    FL_secondary_voltage)
37
38 //case3
39 printf("\n (b).2")
40 percentage_voltage_reg=((I1*((Re*cos_pi2)-(Xe*
    sin_pi2)))/Vs)*100;
41 printf("\n Voltage regulation for 0.8 power factor
    leading=%1.3f percentage \n",
    percentage_voltage_reg)
42 del_V=(NL_secondary_voltage*percentage_voltage_reg)
    /100;
43 FL_secondary_voltage=(NL_secondary_voltage)-(del_V);
44 printf("\n Secodary terminal voltage at FL 0.8
    power factor leading=%4.4f V \n",
    FL_secondary_voltage)
45 //The anwser vary dueto roundoff error

```

---

### Scilab code Exa 7.5 Calculation of efficiency

```

1 //Book Name: Fundamentals of Electrical Engineering

```

```
(a)
Full load efficiency=98.18 percentsge

(b)
Half load efficiency=98.0248 percentsge

-->
```

Figure 7.5: Calculation of efficiency

```
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7_5.sce.
7
8 clc;
9 clear;
10 P=500e3; //KVA rating of
    the transformer
11 Vp=6600; //primary
    voltage in V
12 Vs=440; //secondary
    voltage in V
13 rp=0.45; //primary
    winding resistance in ohms
14 rs=0.0015; //secondary
    winding resistance in ohms
15 iron_loss=2.9e3;
```

```

16 pf=0.8; //power factor
    lagging
17
18 //case1
19 printf("\n (a)")
20 Ip=P/Vp; //primary
    current in A
21 Is=P/Vs; //
    secondary current in A
22 Ip_square_rp=Ip^(2)*rp;
//primary
    copper loss
23 Is_square_rs=Is^(2)*rs;
//secondary
    copper loss
24 FL_copper_loss=Ip_square_rp+Is_square_rs;
//FL means "full load"
25 FL_total_loss=iron_loss+FL_copper_loss;
26 FL_output_power=P*pf;
27 FL_input_power=FL_output_power+FL_total_loss;
28 FL_efficiency=(FL_output_power/FL_input_power)*100;
29 printf("\n Full load efficiency=%2.2f percentage \n
    ",FL_efficiency)
30
31 //case2
32 printf("\n (b)")
33 HL_copper_loss=FL_copper_loss*(0.5^2);
//HL means "
    half load"
34 HL_total_loss=iron_loss+HL_copper_loss;
35 HL_output_power=FL_output_power/2;
36 HL_input_power=HL_output_power+HL_total_loss;
37 HL_efficiency=(HL_output_power/HL_input_power)*100;
38 printf("\n Half load efficiency=%2.4f percentage \n
    ",HL_efficiency)

```

---

Scilab 5.5.2 Console

```
Maximum Efficiency=98.22 percentage  
-->|
```

Figure 7.6: Calculation of maximum efficiency

**Scilab code Exa 7.6** Calculation of maximum efficiency

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex7_6.sce.  
7  
8 clc;
```

```

9 clear;
10 //the given data are taken from previous example(
    Ex7_5)
11
12 Vp=6600;                                //
    primary voltage in V
13 Vs=440;                                  //
    secondary voltage in V
14 rp=0.45;                                 //primary
    winding resistance in ohms
15 rs=0.0015;                               //secondary
    winding resistance in ohms
16 Wi=2.9e3;                                //iron
    loss in watt
17 pf=0.8;                                  //power
    factor lagging
18
19 Re=rp+(Vp/Vs)^2*rs;                      //equivalent
    resistance referred to primary
20 Ip=sqrt(Wi/Re);
21 P_max=Vp*Ip*pf;
22 total_loss=2*Wi;
23 Max_efficiency=(P_max/(P_max+total_loss))*100;
24 printf("\n Maximum Efficiency=%2.2f percentage \n",
    Max_efficiency)

```

---

**Scilab code Exa 7.7** Calculation of efficiency and voltage regulation and secondary

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5

```

```

Scilab 5.5.2 Console

(a)
Full load efficiency for 0.7 power factor=97.34 percentage

Half load Efficiency for 0.7 power factor=96.89 percentage

(b)
The voltage regulation for 0.7 lagging power factor=3.3 percentage

The voltage regulation for 0.7 leading power factor=-1.85 percentage

(c)
The secondary terminal voltage corresponding to 0.7 pf lagging=386.8 V

The secondary terminal voltage corresponding to 0.7 pf leading=407.4 V

-->|

```

Figure 7.7: Calculation of efficiency and voltage regulation and secondary terminal voltage

```

6 //Ex7_7.sce
7 clc;
8 clear;
9 KVA=50e3;
10
11 printf("\n (a)")
12 PF=0.7;
13 iron_loss=430; //primary power of
    transformer on open circuit test in watt is
    called iron loss
14 copper_loss_FL=525; //primary power of
    transformer on short circuit test in watt is
    called copper loss
15 total_loss_FL=iron_loss+copper_loss_FL;
16 eta_FL=(KVA*PF)/((KVA*PF)+total_loss_FL)*100;
    //full load efficiency
17 printf("\n Full load efficiency for 0.7 power
    factor=%2.2f percentage \n",eta_FL)
18 copper_loss_HL=(0.5^2)*copper_loss_FL;
19 total_loss_HL=iron_loss+copper_loss_HL;
20 eta_HL=(KVA*PF*0.5)/((KVA*0.5*PF)+total_loss_HL)

```

```

    *100;
21 printf("\n Half load Efficiency for 0.7 power
    factor=%2.2f percentage \n",eta_HL)
22
23 printf("\n (b)")
24 Vsc=124; //primary
    voltage on short circuit test in volts
25 Isc=15.3; //primary
    current on short circuit test in ampere
26 Psc=525; //primary power
    of transformer on open circuit test in watt
27 pi_e=acosd(Psc/(Vsc*Isc));
28 pi_2=acosd(PF);
29 Voc=3300;
30 voltage_regulation1=Vsc*cosd(pi_e-pi_2)/(Voc)*100;
31 printf("\n The voltage regulation for 0.7 lagging
    power factor=%1.1f percentage \n",
    voltage_regulation1)
32 pi_2=-acosd(PF);
33 voltage_regulation2=Vsc*cosd(pi_e-pi_2)/(Voc)*100;
34 printf("\n The voltage regulation for 0.7 leading
    power factor=%1.2f percentage \n",
    voltage_regulation2)
35
36 printf("\n (c)")
37 Voc=400;
38 decrease_in_voltage=voltage_regulation1*Voc/100;
39 Vs1=Voc-decrease_in_voltage;
40 increase_in_voltage=voltage_regulation2*Voc/100;
41 Vs2=Voc-increase_in_voltage;
42 printf("\n The secondary terminal voltage
    corresponding to 0.7 pf lagging=%3.1f V \n",Vs1)
43 printf("\n The secondary terminal voltage
    corresponding to 0.7 pf leading=%3.1f V \n",Vs2)

```

---

Scilab 5.5.2 Console

```
(a)
Delta star connection:

Primary line current=27.3 A
Primary line voltage=2540 V
Transformation ratio =5.8

(b)
star delta connection:

Primary line current=9.1 A
Primary line voltage=7621 V
Transformation ratio =17.32
-->
```

Figure 7.8: Calculation of primary line current and voltage and line to line transformation ratio



Scilab code Exa 7.8 Calculation of primary line current and voltage and line to line

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7-8.sce.
7
8 clc;
9 clear;
10 Np=1000; //number of
    Primary turns
11 Ns=100; //number of
    secondary turns
12 KVA=120e3; //KVA
    rating of the transformer
13 V_SL=440; //supply
    voltage in V
14
15 K=Np/Ns; //transformer
    turns ratio
16 I_SL=KVA/(sqrt(3)*V_SL);
17
18 printf("\n (a)")
19 V_PL=(V_SL*K)/sqrt(3);
20 I_PL=(sqrt(3)*I_SL)/K;
21 transformation_ratio=V_PL/V_SL;
22 printf("\n Delta star connection:\n")
23 printf("\n Primary line current=%2.1f A ",I_PL)
24 printf("\n Primary line voltage=%d V ",V_PL)
25 printf("\n Transformation ratio =%2.1f \n",
    transformation_ratio)
26
```

```

(a)
The position of tapping point=240 turns

(b)
The approximate value of current in each part of the winding:
    Is=40 A
    Ip=45.45 A
    Ip-Is=5.45 A

(c)
copper saved=0.88 p.u
-->|

```

Figure 7.9: Determination of position of tapping point and current in each part of winding and copper saved

```

27 printf("\n(b)")
28 V_PL=V_SL*K*sqrt(3);
29 I_PL=I_SL/(sqrt(3)*K);
30 transformation_ratio=V_PL/V_SL;
31 printf("\n star delta connection:\n")
32 printf("\n Primary line current=%1.1f A ",I_PL)
33 printf("\n Primary line voltage=%d V ",V_PL)
34 printf("\n Transformation ratio =%2.2f ",
    transformation_ratio)

```

---

**Scilab code Exa 7.9** Determination of position of tapping point and current in each

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5

```

```

6 //Ex7_9.sce.
7
8 clc;
9 clear;
10 Vp=220; //
    primary voltage in V
11 Vs=250; //
    secondary voltage in V
12 Ns=2000; //
    number of secondary turns
13
14 printf("\n (a)")
15 Np=(Vp/Vs)*Ns; //
    number of Primary turns
16 tapping_point=Ns-Np; //
    number of turns from C to A in figure
17 printf("\n The position of tapping point=%d turns \
n",tapping_point)
18
19 printf("\n (b)")
20 Po=10e3; //output
    power in KVA
21 Is=Po/Vs; //
    secondary current in A
22 Ip=(Vs/Vp)*Is; //
    primary current in A
23 approximate_current=Ip-Is;
24 printf("\n The approximate value of current in each
part of the winding:\n")
25 printf("\t Is=%d A\n",Is)
26 printf("\t Ip=%2.2 f A\n",Ip)
27 printf("\t Ip-Is=%1.2 f A\n",approximate_current)
28
29 printf("\n (c)")
30 copper_saved=Vp/Vs;
31 printf("\n copper saved=%1.2 f p.u",copper_saved)

```

---

```
(a)
Ratio error when turns ratio equal to nominal ratio=-0.695 percentage

(b)
Ratio error when secondary turns are reduced by 0.5 percentage=-0.2 percentage
-->
```

Figure 7.10: Determination of ratio error

#### Scilab code Exa 7.10 Determination of ratio error

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex7_10.sce.
7
8 clc;
9 clear;
10 Ip=1000; //primary current
    in A
11 Is=5; //secodary current
    in A
12 Tp=1; //number of
    Primary turns
13
14 printf("\n (a)")
```

```

15 nominal_ratio=Ip/Is;
16 Ie=7; //loss component
    of current in A
17 actual_ratio=nominal_ratio+(Ie/Is);
18 epsilon_r=((nominal_ratio-actual_ratio)/actual_ratio
    )*100;
19 printf("\n Ratio error when turns ratio equal to
    nominal ratio=%1.3f percentage \n",epsilon_r)
20
21 printf("\n (b)")
22 reducing_value=0.5/100;
23 Ts=nominal_ratio-(reducing_value*nominal_ratio);
24 n=Ts/Ip; //
    transformer turns ratio
25 actual_ratio=n+(Ie/Is);
26 epsilon_r=((nominal_ratio-actual_ratio)/actual_ratio
    )*100;
27 printf("\n Ratio error when secondary turns are
    reduced by 0.5 percentage=%1.1f percentage",
    epsilon_r)

```

---

# Chapter 8

## Direct Current Machines

Scilab code Exa 8.1 Calculation of design parameters for a dc machine

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_1.sce
7
8 clc;
9 clear;
10 p=4;
11 s=24;
12 com_seg=24;
13 //winding detail calculation
14 pole_pitch=s/p;
15 c=com_seg;
16 printf("\n Number of coils=%d \n",c)
17 Cs=2*c;
18 printf("\n Number of coil sides=%d \n",Cs)
19 Yb1=Cs/p+1;
```

```
Scilab 5.5.2 Console

Number of coils=24

Number of coil sides=48

Back pitch=13

Full pitch=11

Winding pitch=2

Commutator pitch=1

-->
```

Figure 8.1: Calculation of design parameters for a dc machine

```
20 Yb2=Cs/p-1;
21 Yb=Yb1; //choosing full pitch coil
22 printf("\n Back pitch=%d \n",Yb)
23 Yf1=Yb-2; //For progressive winding
24 Yf2=Yb+2; //For retrogressive winding
25 Yf=Yf1;
26 printf("\n Full pitch=%d \n",Yf)
27 //for progressive winding
28 Y=2;
29 Yc=1;
30 printf("\n Winding pitch=%d \n",Y)
31 printf("\n Commutator pitch=%d \n",Yc)
```

---

Scilab code Exa 8.2 Calculation of design parameters for a dc machine

```
Scilab 5.5.2 Console

Number of coil sides=180

Number of coil sides per slot=6

Back pitch=43

-->
```

Figure 8.2: Calculation of design parameters for a dc machine

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_2.sce
7
8 clc;
9 clear;
10 p=4;
11 s=30;
12 c=90;
13 Cs=2*c;
14 printf("\n Number of coil sides=%d \n",Cs)
15 Cs_per_slot=Cs/s;
16 printf("\n Number of coil sides per slot=%d \n",
    Cs_per_slot)
17 Yb1=Cs/p+2; //Winding is not split
18 Yb2=Cs/p-2; //Winding is split
```



```

Scilab 5.5.2 Console

Slots per pole=6

Number of coil sides=50

Number of coil sides per slot=2

Winding pitch=26

Back pitch=13

Full pitch=13

Commutator pitch=13

-->|

```

Figure 8.3: Calculation of design parameters for a dc machine

```

19 Yb=Yb2;
20 printf("\n Back pitch=%d \n",Yb)
21 Cs1=1+Yb;
22 Cs3=3+Yb;
23 Cs5=5+Yb;
24 //Top coil sides 1,3,5 are in in slot ,while all the
    corresponding bottom coil sides 44,46,48 are in
    slot 8.

```

---

**Scilab code Exa 8.3** Calculation of design parameters for a dc machine

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_3.sce
7

```

```

8  clc;
9  clear;
10 s=25;
11 c=25;
12 com_seg=25;
13 p=4;
14 Sp=s/p; //slot per pole
15 printf("\n Slots per pole=%d \n",Sp)
16 Cs=2*c;
17 printf("\n Number of coil sides=%d \n",Cs)
18 Cs_per_slot=Cc/s;
19 printf("\n Number of coil sides per slot=%d \n",
        Cs_per_slot)
20 Y1=((2*c)+2)/(p/2);
21 Y2=((2*c)-2)/(p/2);
22 Y=Y1; //For progressive winding
23 printf("\n Winding pitch=%d \n",Y)
24 Yb=Y/2;
25 printf("\n Back pitch=%d \n",Yb)
26 Yf=Yb;
27 printf("\n Full pitch=%d \n",Yf)
28 Yc=(c+1)/(p/2);
29 printf("\n Commutator pitch=%d \n",Yc)

```

---

**Scilab code Exa 8.4** Calculation of design parameters for a dc machine

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_4.sce
7

```

```
Scilab 5.5.2 Console

Number of coil sides=84

Number of coils=42

Commutator pitch=21

Winding pitch=42

Back pitch=21

Full pitch=21

-->
```

Figure 8.4: Calculation of design parameters for a dc machine

```
8  clc;
9  clear;
10 p=4;
11 s=21;
12 Cs_per_slot=4;
13 Cs=C_s_per_slot*s;
14 printf("\n Number of coil sides=%d \n",Cs)
15 C=Cs/2;
16 printf("\n Number of coils=%d \n",C)
17 Yc1=(C+1)/(p/2);
18 Yc2=(C-1)/(p/2);
19 C=41; //Simplex wave winding is not possible with 42
        coils.Therefore active coils are 42
20 Yc=(C+1)/(p/2);
21 printf("\n Commutator pitch=%d \n",Yc)
22 Y=((2*C)+2)/(p/2);
23 printf("\n Winding pitch=%d \n",Y)
24 Yb=Y/2;
25 printf("\n Back pitch=%d \n",Yb)
26 Yf=Yb;
27 printf("\n Full pitch=%d \n",Yf)
28 //This value of Yb also satisfies the condition to
```

```
Scilab 5.5.2 Console
```

```
Emf generated=300 volt  
-->
```

Figure 8.5: Calculation of generated emf

```
avoid split winding
```

---

#### Scilab code Exa 8.5 Calculation of generated emf

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex8_5.sce.  
7  
8 clc;  
9 clear;  
10 s=50;  
11 c=8;  
12 N=900;
```

```
Scilab 5.5.2 Console
```

```
Number of conductors per slot=8
```

```
Flux=0.04514 Wb/pole
```

```
-->
```

Figure 8.6: Calculation of number of conductors per slot

```
13 phi=25e-3;  
14 Z=s*c;  
15 a=2;  
16 p=2;  
17 n=N/60;  
18 E=(2*Z*phi*p*n)/a;  
19 printf("\n Emf generated=%d volt",E)
```

---

Scilab code Exa 8.6 Calculation of number of conductors per slot

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex8_6.sce.  
7  
8 clc;  
9 clear;  
10 N=360;  
11 phi=45e-3;  
12 s=120;
```

```
Scilab 5.5.2 Console
Demagnetizing AT per pole=204 AT/pole
Cross AT per pole=3480 AT/pole
-->
```

Figure 8.7: Calculation of number of demagnetizing and cross ampere turns per pole

```
13 E=260;
14 p=4;
15 n=N/60;
16 a=8;
17 Z=(E*a)/(2*phi*p*n);
18 conductors_per_slot=Z/s;
19 total_no_of_conductors=conductors_per_slot*s;
20 printf("\n Number of conductors per slot=%d \n",
        conductors_per_slot)
21
22 phi=(E*a)/(2*960*n*p)
23 printf("\n Flux=%1.5 f Wb/pole", phi)
```

---

Scilab code Exa 8.7 Calculation of number of demagnetizing and cross ampere turns

```
1 //Book Name: Fundamentals of Electrical Engineering
2 //Author: Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```

4 //Edition:Third ,2014
5
6 //Ex8_7.sce.
7
8 clc;
9 clear;
10 P=300e3;
11 V=500;
12 a=8;
13 p=4;
14 Z=786;
15 theta=5;
16
17 I=P/V;
18 armature_AT=(1/2)*(I/a)*(Z/(2*p)); //
    Total AT per pole
19 demagnetizing_AT=armature_AT*(4*theta/360); //
    demagnetizing AT per pole
20 distorting_AT=armature_AT-demagnetizing_AT;
    //distorting AT per pole
21 printf("\\n Demagnetizing AT per pole=%d AT/pole \\n
    ",demagnetizing_AT)
22 printf("\\n Cross AT per pole=%4.0f AT/pole \\n",
    distorting_AT)
23
24 //There is a error in the substitution of number of
    conductors (Z) in the book
25 //In the question Z=786 but problem is solved by
    substituting Z=768
26 //But I make the codes with the given data that is Z
    =786
27 //So the book answer vary

```

---

```
Scilab 5.5.2 Console

(a)
The armature resistance=0.1235 ohm

(b)
The generated emf=534.57 volt
-->|
```

Figure 8.8: Calculation of armature resistance and generated emf

**Scilab code Exa 8.8** Calculation of armature resistance and generated emf

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_8.sce.
7
8 clc;
9 clear;
10 R=200;
11 P=100e3;
12 V=500;
13 E=525;
14
15 printf(" \n (a)")
16 I1=P/V;
17 If=V/R;
18 Ia=I1+If;
19 Ra=(E-V)/Ia;
20 printf(" \n The armature resistance=%1.4 f ohm \n",Ra)
```



```
Armature generated voltage=282.66 volt  
-->
```

Figure 8.9: Calculation of armature generated voltage

```
21  
22 printf("\n (b)")  
23 P=60e3;  
24 V=520;  
25 I1=P/V;  
26 If=V/R;  
27 Ia=I1+If;  
28 E=V+(Ia*Ra);  
29 printf("\n The generated emf=%3.2f volt",E)
```

---

**Scilab code Exa 8.9** Calculation of armature generated voltage

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5
```

```
Scilab 5.5.2 Console
(a)
The generated emf when running as generator=238 volt
(b)
The generated emf when running as motor=224 volt
-->|
```

Figure 8.10: Calculation of generated emf

```
6 //Ex8_9.sce.
7
8 clc;
9 clear;
10 Ra=0.8;
11 Rsh=45;
12 Rse=0.6;
13 P=5e3;
14 V=250;
15 I1=P/V;
16 If=(V+(Rse*I1))/Rsh;
17 Ia=I1+If;
18 E=V+(I1*Rse)+(Ia*Ra);
19 printf("\n Armature generated voltage=%3.2f volt \n",E)
```

---

Scilab code Exa 8.10 Calculation of generated emf

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_10.sce.
7
8 clc;
9 clear;
10 Ra=0.1;
11
12 printf("\n      (a)")
13 Ia=80;
14 V=230;
15 E=V+(Ia*Ra);
16 printf("\n      The generated emf when running as
          generator=%3.0f volt \n",E)
17
18 printf("\n      (b)")
19 Ia=60;
20 V=230;
21 E=V-(Ia*Ra);
22 printf("\n      The generated emf when running as motor
          =%3.0f volt \n",E)

```

---

### Scilab code Exa 8.11 Calculation of motor speed

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_11.sce.

```

```
Scilab 5.5.2 Console

Motor Speed:          N1=600 r.p.m    N2=375 r.p.m

-->
```

Figure 8.11: Calculation of motor speed

```
7
8  clc;
9  clear;
10 V1=440;
11 V2=220;
12 Ia=50;
13 Ra=0.3;
14 a=2;
15 p=2;
16 Z=850;
17 phi_1=0.025;
18 phi_2=0.02;
19
20 E=V1-(Ia*Ra);
21 n1=(E*a)/(2*Z*p*phi_1);
22 N1=n1*60;
23 n1_by_n2=(V1*phi_2)/(V2*phi_1);
24 n2=n1/(n1_by_n2);
25 N2=n2*60;
26 printf(" \n    Motor Speed: \t N1=%d r.p.m \t N2=%d r.
```

```
Scilab 5.5.2 Console
(a)
Speed=636 r.p.m
(b)
Gross torque developed in the armature=756 Nm
-->
```

Figure 8.12: Calculation of motor speed and gross torque developed

p.m \n” ,N1 ,N2)

---

**Scilab code Exa 8.12** Calculation of motor speed and gross torque developed

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_12.sce.
7
8 clc;
9 clear;
10 V=480;
11 Ia=110;
12 Ra=0.2;
13 Z=864;
14 phi=0.05;
```

```
Scilab 5.5.2 Console

Motor speed at no load=1407 r.p.m

Motor current at full load torque=17.434 A

Motor speed at full load=1328 r.p.m

Speed regulation=5.978 percentage
-->
```

Figure 8.13: Calculation of motor speed and current and speed regulation

```
15 a=6;
16 p=3;
17
18 printf("\n (a)")
19 E=V-(Ia*Ra);
20 n=(E*a)/(2*Z*p*phi);
21 N=(n*60);
22 printf("\n Speed=%d r.p.m \n",N)
23
24 printf("\n (b)")
25 Pm=E*Ia;
26 T=Pm/(2*pi*n);
27 printf("\n Gross torque developed in the armature=
    %d Nm \n",T)
```

---

Scilab code Exa 8.13 Calculation of motor speed and current and speed regulation

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_13.sce.
7
8 clc;
9 clear;
10 I1=2;
11 Z=864;
12 If=0.6;
13 V=220;
14 Ra=0.8;
15 a=2;
16 p=2;
17 phi=5.4e-3;
18 T=25;
19
20 Ia=I1-If;
21 E1=V-(Ia*Ra);
22 n1=(E1*a)/(2*Z*phi*p);
23 N1=n1*60;
24 printf("\n Motor speed at no load=%4.0f r.p.m \n",
        N1)
25
26 Ia=(T*a*%pi)/(p*phi*Z);
27 I1=Ia+If;
28 printf("\n Motor current at full load torque=%2.3f
        A \n",I1)
29 E2=V-(Ia*Ra);
30 n2=(E2*a)/(2*Z*phi*p);
31 N2=n2*60;
32 printf("\n Motor speed at full load=%4.0f r.p.m \n"
        ,N2)
33
34 speed_reg=((N1-N2)/N2)*100;
35 printf("\n Speed regulation=%1.3f percentage",

```

```
Scilab 5.5.2 Console

(a)
Input power at 600 r.p.m=16 kW

Armature current Ia=30 A

R=4.07 ohm

(b)
New armature current Ia=35 A

New Input power=18.4 kW
-->
```

Figure 8.14: Calculation of current and kW input of the motor

```
speed_reg)
36 //There is a error in the regulation calculation in
    the book
37 //The book answer 9.95% is wrong
```

---

**Scilab code Exa 8.14** Calculation of current and kW input of the motor

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_14.sce.
7
8 clc;
9 clear;
```



```

10 N=600;
11 V=500;
12 I1=32;
13 Ra=0.4;
14 Rf=250;
15
16 printf("\n (a)")
17 P=(V*I1)/1e3;
18 N1=450;
19 Ia=I1-(V/Rf);
20 k_phi=(V-(Ia*Ra))/N;
21 R=(V-(k_phi*N1))/Ia-Ra;
22 printf("\n Input power at 600 r.p.m=%d kW \n",P)
23 printf("\n Armature current Ia=%d A \n",Ia)
24 printf("\n R=%1.2 f ohm \n",R)
25
26 printf("\n (b)")
27 //To increase the speed the field control is used.
28 If1_by_If=0.856;
29 If=I1-Ia;
30 If1=If1_by_If*If;
31 Rf1=V/If1;
32 R=Rf1-Rf;
33 Ia1=Ia/If1_by_If;
34 I1=Ia1+If1;
35 Pi=(V*I1)/1e3;
36 printf("\n New armature current Ia=%d A \n",Ia1)
37 printf("\n New Input power=%2.1 f kW",Pi)

```

---

Scilab code Exa 8.15 Calculation of external resistance and electric braking torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad

```

```
Armature circuit resistance=2.14 ohm  
The external resistance=2.054 ohm  
Initial braking torque=703.8 Nm  
Braking torque at half speed=532.8 Nm  
-->
```

Figure 8.15: Calculation of external resistance and electric braking torque

```
3 //Publisher: PHI Learning Private Limited  
4 //Edition: Third ,2014  
5  
6 //Ex8_15.sce.  
7  
8 clc;  
9 clear;  
10 P_in_HP=37.5;  
11 V=220;  
12 N=535;  
13 Ra=0.086;  
14 Ia1=140;  
15 I=200;  
16  
17 E=V-(Ia1*Ra);  
18 R=(V+E)/I;  
19 R_ext=R-Ra;  
20 P=(P_in_HP)*736;  
21 omega=(2*pi*N)/60;  
22 FL_T=P/omega;  
23 initial_braking_T=FL_T*(I/Ia1);  
24 Ia2=(V+(E/2))/R;  
25 halfspeed_braking_T=FL_T*(Ia2/Ia1);
```

Scilab 5.5.2 Console

Electrical input=18045.44 W

Mechanical input=17991.11 W

Desired speed=540 rpm

-->

Figure 8.16: Calculation of speed at full load torque

```
26 printf("\n Armature circuit resistance=%1.2f ohm \n
",R)
27 printf("\n The external resistance=%1.3f ohm \n",
R_ext)
28 printf("\n Initial braking torque=%3.1f Nm \n",
initial_braking_T)
29 printf("\n Braking torque at half speed=%3.1f Nm \n
",halfspeed_braking_T)
30 //Answer vary due to roundoff error
```

---

Scilab code Exa 8.16 Calculation of speed at full load torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_16.sce.
7
8 clc;
9 clear;
10 P_in_HP=20;
11 P=(P_in_HP)*736;
12 N=450;
13 Ra=0.18;
14 Rf=0.12;
15 R=8.7+Ra+Rf;
16 omega=(2*%pi*N)/60;
17 Tf=P/omega;
18
19 //The voltage developed for 450 rpm is 289 volt
    which is taken from the curve
20 E=289;
21 P_not=(E*E)/R;
22 Pi=(2*%pi*N*Tf)/60;
23
24 //The mechanical input is greater than electrical
    output , so the motor speed increases
25 //The voltage developed for 550 rpm is 403 volt
    which is taken from the curve
26 N=550;
27 E=403;
28 P_not=(E*E)/R;
29 Pi=(2*%pi*N*Tf)/60;
30
31 printf(" \n Electrical input=%5.2 f W \n",P_not)
32 printf(" \n Mechanical input=%5.2 f W \n",Pi)
33 if Pi<P_not then
34     N1=540;
35 else

```

```

(a)
Efficiency of the generator at half load=89.5 percentage

(b)
Efficiency of the generator at full load=91.05 percentage

-->|

```

Figure 8.17: Calculation of efficiency of generator at full load and half load

```

36      N1>N
37  end
38  printf("\n Desired speed=%d rpm \n",N1)
39  //Answer vary dueto roundoff error
40  //since mechanical input is less than electrical
    output the motor cannot attain a speed as 550 rpm
41  //So the speed is 540 rpm which is obtained using
    trial and error method

```

---

**Scilab code Exa 8.17** Calculation of efficiency of generator at full load and half

```

1  //Book Name:Fundamentals of Electrical Engineering
2  //Author:Rajendra Prasad
3  //Publisher: PHI Learning Private Limited
4  //Edition:Third ,2014
5
6  //Ex8_17.sce.
7
8  clc;

```

```

9  clear;
10 P=100e3;
11 V=460;
12 It=9.8;
13 If=2.7;
14 R=0.11;
15
16 printf("\n (a)")
17 I=(P/2)/V;
18 Ia=I+If;
19 Wa=Ia^2*R;
20 Wsh=V*If;
21 Ian=It-If;
22 W_not=V*Ian;
23 NL_armature_loss=Ian^2*R;
24 other_loss=W_not-NL_armature_loss; //
    other losses include iron ,friction ,windage losses
25 T_loss_HL=Wa+Wsh+other_loss;
26 Pi_HL=(P/2)+T_loss_HL;
27 efficiency=((P/2)/Pi_HL)*100;
28 printf("\n Efficiency of the generator at half load
    =%2.1f percentage \n",efficiency)
29
30 printf("\n (b)")
31 I=P/V;
32 Ia=I+If;
33 Wa=Ia^2*R;
34 Wsh=V*If;
35 Ian=It-If;
36 W_not=V*Ian;
37 NL_armature_loss=Ian^2*R;
38 other_loss=W_not-NL_armature_loss; //
    other losses include iron ,friction ,windage losses
39 T_loss_FL=Wa+Wsh+other_loss;
40 Pi_FL=P+T_loss_FL;
41 efficiency=(P/Pi_FL)*100;
42 printf("\n Efficiency of the generator at full load
    =%2.2f percentage \n",efficiency)

```

```
(a)
Efficiency at full load=91.3 percentage

(b)
Efficiency with considering losses=91.5 percentage

-->
```

Figure 8.18: Calculation of efficiency of the generator

---

**Scilab code Exa 8.18** Calculation of efficiency of the generator

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_18.sce.
7
8 clc;
9 clear;
10 P=1000e3;
11 V=500;
12 I1=2000;
13 I2=400;
14 Ig=21;           //shunt field current of generator
15 Im=17;           //shunt field current of motor
```

```

16 R=0.01;
17 I=P/V;
18
19 printf("\n (a)")
20 efficiency=sqrt(I1/(I1+I2))*100;
21 printf("\n Efficiency at full load=%2.1f percentage
    \n",efficiency)
22
23 printf("\n (b)")
24 Ia_G=I1+Ig;
25 copper_loss_G=Ia_G^2*R;
26 loss_G=V*Ig;
27
28 Ia_M=I1+I2-Im;
29 copper_loss_M=Ia_M^2*R;
30 loss_M=V*Im;
31
32 total_loss=V*I2;
33 other_loss=total_loss-(copper_loss_G+loss_G+
    copper_loss_M+loss_M); //other
    losses include iron ,friction ,windage losses
34 other_loss_each=other_loss/2;
35 total_loss_G=copper_loss_G+loss_G+other_loss_each;
36 Pi_G=P+total_loss_G;
37 efficiency=(P/Pi_G)*100;
38 printf("\n Efficiency with considering losses=%2.1
    f percentage \n",efficiency)
39 //There is a mistake in the (a) part calculation in
    the book.
40 //The efficiency is 91.3% not 89.1%

```

---

Scilab code Exa 8.20 Determination of time



```
Scilab 5.5.2 Console
Time for the motor to run with 2 percentage of its final speed=0.078 sec
-->
```

Figure 8.19: Determination of time

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex8_20(c).sce.
7
8 clc;
9 clear;
10 Ra=35;
11 J=6e-5;
12 K=0.325;
13
14 T=(J*Ra)/K^2;
15 t=-T*log(1-0.98); // (1-0.98)=0.02
16 printf("\n Time for the motor to run with 2
percentage of its final speed=%1.3f sec \n",t)
```

---

# Chapter 9

## Synchronous Machines

Scilab code Exa 9.1 Calculation of distribution factor

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_1.sce.
7
8 clc;
9 clear;
10 slots=24;
11 pole=4;
12
13 printf("\n      (a)")
14 //when all slots are wound
15 m=slots/pole;
16 alpha=180/m;
17 Kd=sind(m*alpha/2)/(m*sind(alpha/2));
18 printf("\n Distribution factor when all slots are
      wound=%1.3 f" ,Kd)
```

```
Scilab 5.5.2 Console
(a)
Distribution factor when all slots are wound=0.644
(b)
Distribution factor when only four slots per pole are wound=0.837
-->
```

Figure 9.1: Calculation of distribution factor

```
19
20 printf("\n (b)")
21 //only 4 adjacent slots are wound
22 m=4;
23 Kd=sind(m*alpha/2)/(m*sind(alpha/2));
24 printf("\n Distribution factor when only four slots
per pole are wound=%1.3 f",Kd)
```

---

**Scilab code Exa 9.2** Calculation of number of poles and flux per pole

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_2.sce
7
```

```
(a)
The number of poles=12
(b)
The useful flux per pole=0.055 Wb
-->
```

Figure 9.2: Calculation of number of poles and flux per pole

```
8  clc;
9  clear;
10 V=3.6e3;
11 phase=3
12 f=50;
13 N=500;
14 m=3;
15 c=10;
16
17 printf("\n (a)")
18 p=(120*f)/N;
19 printf("\n   The number of poles=%d",p)
20
21 printf("\n (b)")
22 slots_per_phase=m*p;
23 conductor_per_phase=(slots_per_phase)*c;
24 turns_per_phase=conductor_per_phase/2;
25 emf_per_phase=V/sqrt(3);
26 solts_per_pole=m*phase;
27 alpha=180/solts_per_pole;
28
29 Kd=sind(m*alpha/2)/(m*sind(alpha/2));
30 betta=alpha;
```

```

Scilab 5.5.2 Console

Unsaturated value of synchronous reactance= 0.9875 ohm    0.918 p.u
Saturated value of synchronous reactance= 0.809 ohm    0.752 p.u
Short circuit ratio=1.32
-->

```

Figure 9.3: Determination of short circuit ratio and synchronous reactance

```

31 Kp=cosd(betta/2);
32 phi=emf_per_phase/(4.44*f*Kd*Kp*turns_per_phase);
33 printf("\n    The useful flux per pole=%1.3 f Wb",phi)

```

---

**Scilab code Exa 9.3** Determination of short circuit ratio and synchronous reactance

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_3.sce
7
8 clc;
9 clear;
10 P=45e3;
11 E=220;
12 phase=3;
13 p=6;

```

```

14 f=50;
15
16 I=P/(E*sqrt(3));
17 //From SCC ,the excitation current is ,
18 Isc1=118.1;
19 If=2.2;
20 //For this If, the corresponding line voltage from
    the air gap line is ,
21 V1=202;
22 I1=1.0;
23 Vph=V1/sqrt(3);
24 Xs_unsat=Vph/Isc1;           //Unsaturated reactance
    in ohm
25 V=V1/E;
26 Xs_unsat_pu=V/I1;           //Unsaturated
    reactance in per unit
27 printf("\n Unsaturated value of synchronous
    reactance=\t %1.4f ohm \t %1.3f p.u \n",Xs_unsat ,
    Xs_unsat_pu)
28
29 //For 220 volt from figure ,
30 If=2.9;
31 Isc2=157;
32 Vph=E/sqrt(3);
33 Xs_sat=Vph/Isc2;
34 Xs_sat_pu=I1/(Isc2/Isc1);
35 printf("\n Saturated value of synchronous reactance
    =\t %1.3f ohm \t %1.3f p.u \n",Xs_sat,Xs_sat_pu)
36
37 Ie2=2.9;
38 Ie1=2.2;
39 SCR=Ie2/Ie1;
40 printf("\n Short circuit ratio=%1.2f \n",SCR)

```

---

```
Scilab 5.5.2 Console

Leakage reactance=0.1222 ohm

Field ampere current=1.925 A

-->|
```

Figure 9.4: Calculation of leakage reactance and field current

**Scilab code Exa 9.4** Calculation of leakage reactance and field current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_4.sce.
7
8 clc;
9 clear;
10 //From figure 9.26
11 EG=25;
12 P=45e3;
13 E=220;
14 I=P/(E*sqrt(3));
15 Xl=EG/(sqrt(3)*I);
16 printf("\n Leakage reactance=%1.4 f ohm \n",Xl)
17
18 //From fig 9.26 armature reaction ampere is equal
    to the field current
```

```
Scilab 5.5.2 Console

Magnitude excitation voltage in p.u is

    1.7750406

The rectangular value of double excited voltage in p.u is

    1.6 + 0.8i

The polar form of double excited voltage=1.79 angle26.565 degree

-->|
```

Figure 9.5: Determination of excitation voltage

```
19 If=1.925;
20 printf("\n Field ampere current=%01.3 f A \n",If)
```

---

#### Scilab code Exa 9.5 Determination of excitation voltage

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_5.sce
7
8 clc;
9 clear;
10 V=1+%i*0;
11 Xd=1.0;
```



```

12 Xq=0.6;
13 pf=0.8;
14 theta=acosd(pf);
15 Ia1=pf-%i*sind(acosd(pf));
16 Ia=1.0; //phase magnitude of Ia
17
18 tan_del=(Ia*Xq*cosd(theta))/(V+(Ia*Xq*sind(theta)));
19 del=atand(real(tan_del));
20 Ef_dash=((V+(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta)
    )^2)^(1/2);
21
22 Ef=real(Ef_dash)+(Ia*sind(theta+del)*(Xd-Xq));
23 disp(Ef,'Magnitude excitation voltage in p.u is ')
24
25 Ef_double_dash=V*(1+%i*0)+%i*((cosd(theta)-%i*sind(
    theta))*Xd);
26 disp(Ef_double_dash,'The rectangular value of double
    excited voltage in p.u is ')
27
28 Ef_double_dash_mag=sqrt(real(Ef_double_dash)^2+imag(
    Ef_double_dash)^2);
29 Ef_double_dash_ang=atand(imag(Ef_double_dash)/real(
    Ef_double_dash));
30 printf("\n The polar form of double excited voltage=
    %1.2f angle%2.3f degree \n",Ef_double_dash_mag,
    Ef_double_dash_ang)

```

---

### Scilab code Exa 9.6 Calculation of voltage regulation

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014

```

```

(a)
Voltage Regulation for unity power factor=3.65 percentage

(b)
Voltage Regulation for 0.8 lagging power factor=13.944 percentage

(c)
Voltage Regulation for 0.8 leading power factor=-8.6 percentage

-->

```

Figure 9.6: Calculation of voltage regulation

```

5
6 //Ex9_6.sce.
7
8 clc;
9 clear;
10 P=500e3;
11 V1=3.3e3
12 I1=P/(sqrt(3)*V1);
13 Vph=V1/sqrt(3);
14 Iph=I1;
15 Rph=0.4;
16 Xsyn=4.2;
17
18 printf("\n    (a)")
19 pf=1; //unity
20 Ef=((Vph+(Iph*Rph))^2+(Iph*Xsyn)^2)^(1/2);
21 reg=((Ef/Vph)-1)*100;
22 printf("\n Voltage Regulation for unity power
    factor=%1.2f percentage \n",reg)
23
24 printf("\n    (b)")

```

```

25 pf=0.8;                //lagging
26 theta=acosd(pf);
27 Ef=((Vph+(Iph*Rph*cosd(theta))+(Iph*Xsyn*sind(theta)
    ))^2+((Iph*Xsyn*cosd(theta))-(Iph*Rph*sind(theta)
    ))^2)^(1/2);
28 reg=((Ef/Vph)-1)*100;
29 printf("\n Voltage Regulation for 0.8 lagging power
    factor=%2.3f percentage \n",reg)
30
31 printf("\n (c)")
32 pf=0.8;                //leading
33 theta=acosd(pf);
34 Ef=((Vph+(Iph*Rph*cosd(theta))-(Iph*Xsyn*sind(theta)
    ))^2+((Iph*Xsyn*cosd(theta))+(Iph*Rph*sind(theta)
    ))^2)^(1/2);
35 reg=((Ef/Vph)-1)*100;
36 printf("\n Voltage Regulation for 0.8 leading power
    factor=%1.1f percentage \n",reg)

```

---

### Scilab code Exa 9.7 Calculation of voltage regulation

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_7.sce.
7
8 clc;
9 clear;
10 //input data are taken from example 9.5
11 V=1+%i*0;
12 Xd=1.0;

```

```

Scala 5.5.2 Console
(a)
Voltage Regulation for 0.8 lagging power factor=77 percentage

(b)
Voltage Regulation for 0.8 leading power factor=-20 percentage
-->|

```

Figure 9.7: Calculation of voltage regulation

```

13 Xq=0.6;
14 pf=0.8;
15 theta=acosd(pf);
16 Ia1=pf-%i*sind(acosd(pf));
17 Ia=1.0; //phase magnitude of Ia
18
19 printf("\n (a)")
20 //lagging power factor
21 tan_del=(Ia*Xq*cosd(theta))/(V+(Ia*Xq*sind(theta)));
22 del=atand(real(tan_del));
23 Ef_dash=((V+(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta)
24 ))^2)^(1/2);
25 Ef=real(Ef_dash)+(Ia*sind(theta+del)*(Xd-Xq));
26 reg=((Ef-V)/1.0)*100;
27 printf("\n Voltage Regulation for 0.8 lagging power
28 factor=%d percentage \n",reg)
29
30 printf("\n (b)")
31 tan_del=(Ia*Xq*cosd(theta))/(V-(Ia*Xq*sind(theta)));
32 del=atand(real(tan_del));
33 Ef=((V-(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta))^2)

```

```
The capacity of the synchronous condenser= 2.89 MVA
-->|
```

Figure 9.8: Determination of capacity of the condenser

```
^(1/2);
32 reg=((Ef-V)/1.0)*100;
33 printf("\n Voltage Regulation for 0.8 leading power
factor=%2.0f percentage",reg)
```

---

**Scilab code Exa 9.8** Determination of capacity of the condenser

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_8.sce.
7
```

```

Scilab 5.5.2 Console
The capacity of synchronous condenser which is desired to raise the power factor to unity=6.63 MVA
-->|

```

Figure 9.9: Determination of capacity of the synchronous condenser

```

8  clc;
9  clear;
10 VI1=10e6;
11 phi1=acosd(0.75);
12 phip=acosd(0.9);
13 phic=90-asind(7/100);           //given loss is 7%
    of KVA output
14 KVAc=VI1*(((sind(phi1)*cosd(phip))-cosd(phi1)*sind(
    phip)))/((sind(phic)*cosd(phip))+cosd(phic)*sind
    (phip)))*1e-3;
15 MVAc=KVAc*1e-3;
16 printf("\n The capacity of the synchronous
    condenser= %1.2 f MVA",MVAc)

```

---

**Scilab code Exa 9.9** Determination of capacity of the synchronous condenser

```

1 //Book Name: Fundamentals of Electrical Engineering
2 //Author: Rajendra Prasad

```

```
Resultant line current=96.34 A
Final power factor=1
The increase of current=10.1 percentage
The increase of power transmitted=37.3 percentage
-->
```

Figure 9.10: Determination of line current and power factor

```
3 //Publisher: PHI Learning Private Limited
4 //Edition: Third ,2014
5
6 //Ex9_9.sce.
7
8 //input data are taken from example 9.8
9 clc;
10 clear;
11 VI1=10e6;
12 pf1=0.75;
13 pfc=cosd(90-asind(7/100));
14 KVAc=VI1*((sqrt(1-pf1^2))/(sqrt(1-pfc^2)))*1e-3;
15 MVAc=KVAc*1e-3;
16 printf("\n The capacity of synchronous condenser
    which is desired to raise the power factor to
    unity=%1.2 f MVA", MVAc);
```

---

Scilab code Exa 9.10 Determination of line current and power factor

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_10.sce.
7
8 clc;
9 clear;
10 P1=1e6;
11 Pd=360; //developing power
12 Pi=600e3;
13 V1=6600;
14 pf=0.8;
15 Pin=800e3;
16 theta=acosd(pf);
17 I1=P1/(V1*sqrt(3));
18 Ps=(Pd*746)/0.9; // 1HP=746 watt and
    efficiency is assumed 90% (i.e 0.9)
19 phi_s=acosd(Ps/Pi);
20 Is=Pi/(V1*sqrt(3));
21 lag_reactive_crt_load=I1*sind(theta);
22 lead_reactive_crt_motor=lag_reactive_crt_load*sind(
    phi_s);
23 lag_reactive_crt_result=lag_reactive_crt_load-
    lead_reactive_crt_motor;
24 resultant_active_crt=(I1*pf)+(lag_reactive_crt_load*
    cosd(phi_s));
25
26 resultant_line_crt=sqrt(resultant_active_crt^2+
    lag_reactive_crt_result^2);
27 printf("\n Resultant line current=%2.2f A \n",
```



```
Scilab 5.5.2 Console

Resultant line current= 75.232 A

Power factor= 1

The increase of current= 14 percentage

The increase of power transmitted= 75 percentage
-->
```

Figure 9.11: Determination of increase in additional loss and decrease in line current and final line current

```
    resultant_line_crt);
28
29 final_power_factor=resultant_active_crt/
    resultant_line_crt;
30 printf("\n Final power factor=%1.0f \n",
    final_power_factor);
31
32 increase_of_crt=(resultant_line_crt-I1)*100/I1;
33 printf("\n The increase of current=%2.1f percentage
    \n",increase_of_crt)
34
35 increase_power_trans=((Pin+Ps)-Pin)*100/Pin;
36 printf("\n The increase of power transmitted=%2.1f
    percentage \n",increase_power_trans)
```

---

Scilab code Exa 9.11 Determination of increase in additional loss and decrease in

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex9_11.sce
7
8 clc;
9 clear;
10 //The input data are taken from the previous example
    9.10
11
12 P1=1e6;
13 Pd=360; //developing power
14 Pi=600e3;
15 V1=6600;
16 pf=0.1;
17 pf1=0.8;
18 Pin=800e3;
19 theta=acosd(pf);
20 I1=P1/(V1*sqrt(3));
21 Ps=(Pd*746)/0.9; // 1HP=746 watt and
    efficiency is assumed 90% (i.e 0.9)
22 phi_s=acosd(Ps/Pi);
23 Is=Pi/(V1*sqrt(3));
24 lag_reactive_crt_motor=52.5;
25 lead_reacitve_crt_motor=lag_reactive_crt_motor*sind(
    acosd(pf));
26 active_crt=lag_reactive_crt_motor*pf;
27 lag_reactive_crt_result=lag_reactive_crt_motor-
    lead_reacitve_crt_motor;
28 resultant_active_crt=(I1*pf1)+(active_crt);
29
30 resultant_line_crt=sqrt(resultant_active_crt^2+
    lag_reactive_crt_result^2);
31 printf("\n Resultant line current= %2.3f A \n",
    resultant_line_crt);
32

```

```
33 pf=resultant_active_crt/resultant_line_crt;
34 printf("\n Power factor= %1.0f \n",pf)
35
36 increase_of_crt=(I1-resultant_active_crt)*100/I1;
37 printf("\n The increase of current= %2.0f
    percentage \n",increase_of_crt)
38
39 increase_power_trans=(Pi*pf)*100/Pin;
40 printf("\n The increase of power transmitted= %2.0f
    percentage",increase_power_trans)
```

---

# Chapter 10

## Three Phase Induction Motor

Scilab code Exa 10.1 Calculation of synchronous speed and rotor speed and rotor fr

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_1.sce
7
8 clc;
9 clear;
10 f=50;
11 p=4;
12
13 printf("\n (a)")
14 Ns=(120*f)/p;
15 printf("\n Synchronous speed=%d r.p.m \n",Ns)
16
17 printf("\n (b)")
18 s=0.04;
19 N=Ns-(s*Ns);
```

```
Scilab 5.5.2 Console

(a)
Synchronous speed=1500 r.p.m

(b)
The rotor speed=1440 r.p.m

(c)
The rotor frequency=30 Hz
-->
```

Figure 10.1: Calculation of synchronous speed and rotor speed and rotor frequency

```
20 printf("\n The rotor speed=%d r.p.m \n",N)
21
22 printf("\n (c)")
23 N=600;
24 s=(Ns-N)/Ns;
25 fs=s*f;
26 printf("\n The rotor frequency=%d Hz",fs)
```

---

**Scilab code Exa 10.2** Calculation of flux per pole and rotor emf and phase angle

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_2.sce
```

```

Scilab 5.5.2 Console

(a)
The flux per pole=0.015641 Wb

(b)
The rotor emf induced at standstill on open circuit=80 V

(c)
Rotor emf at a slip=3.2 V
The rotor current=243.51 A

(d) (i)
The phase difference between rotor emf and current for 4 percentage slip=8.40 degree
(ii)
The phase difference between rotor emf and current for 100 percentage slip=74.85 degree
-->|

```

Figure 10.2: Calculation of flux per pole and rotor emf and phase angle

```

7
8 clc;
9 clear;
10 T1=120;
11 T2=24;
12 R2=0.013;
13 X2=0.048;
14 V=400;
15 kd=0.96;
16 kp=1.0;
17 f=50;
18
19 printf("\n (a)")
20 phi=V/(4.44*kd*kp*f*T1);
21 printf("\n The flux per pole=%1.6 f Wb \n",phi)
22
23 printf("\n (b)")
24 E2=4.44*kd*kp*phi*f*T2;
25 printf("\n The rotor emf induced at standstill on
open circuit=%d V \n",E2)

```

```

26
27 printf("\n (c)")
28 s=0.04;
29 Er=s*E2;
30 printf("\n Rotor emf at a slip=%1.1 f V",Er)
31 Ir=Er/sqrt(R2^2+(s*X2)^2);
32 printf("\n The rotor current=%3.2 f A \n",Ir)
33
34 printf("\n (d)\t(i)")
35 s=0.04;
36 phir=atand(s*(X2/R2));
37 printf("\n The phase difference between rotor emf
    and current for 4 percentage slip=%2.2 f degree",
    phir)
38 printf("\n\t(ii)")
39 s=1;
40 phir=atand(s*(X2/R2));
41 printf("\n The phase difference between rotor emf
    and current for 100 percentage slip=%2.2 f degree"
    ,phir)

```

---

**Scilab code Exa 10.3** Calculation of output power and mechanical power developed an

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_3.sce
7
8 clc;
9 clear;
10 Pin=40; // power in kW

```

```

(a)
Mechanical power developed by the rotor=36.96 kW
Rotor copper loss=1.54 kW

(b)
Output of the motor=36.16 kW

(c)
The motor efficiency=90.4 percentage

(d)
Total rotor copper loss when speed reduced to 40percentage of synchronous speed=23.1 kW

(e)
Efficiency of motor when speed reduced to 40percentage of synchronous speed=36.5 percentage
-->

```

Figure 10.3: Calculation of output power and mechanical power developed and rotor copper loss and efficiency

```

11 Ps=1.5;    // power in kW
12 Ns=100;    //speed percentage value
13 N=40;      //speed percentage value
14 power_loss=0.8;    // power in kW
15
16 printf("\n (a)")
17 rotor_input_power=Pin-Ps;
18 s=0.04;
19 rotor_copper_loss=s*rotor_input_power;
20 mec_power_developed=rotor_input_power-
    rotor_copper_loss;
21 printf("\n Mechanical power developed by the rotor=
    %2.2f kW",mec_power_developed)
22 printf("\n Rotor copper loss=%2.2f kW \n",
    rotor_copper_loss)
23
24 printf("\n (b)")
25 motor_output_power=mec_power_developed-power_loss;
26 printf("\n Output of the motor=%2.2f kW \n",
    motor_output_power)

```



```

27
28 printf("\n (c)")
29 motor_efficiency=(motor_output_power/Pin)*100;
30 printf("\n The motor efficiency=%2.1f percentage \n
    ",motor_efficiency)
31
32 printf("\n (d)")
33 new_slip=(Ns-N)/Ns;
34 total_rotor_copper_loss=new_slip*rotor_input_power;
35 printf("\n Total rotor copper loss when speed
    reduced to 40percentage of synchronous speed=%2.1
    f kW \n",total_rotor_copper_loss)
36
37 printf("\n (e)")
38 total_rotor_loss=total_rotor_copper_loss+power_loss;
39 motor_output_power=rotor_input_power-
    total_rotor_loss;
40 motor_efficiency=(motor_output_power/Pin)*100;
41 printf("\n Efficiency of motor when speed reduced
    to 40percentage of synchronous speed=%2.1f
    percentage",motor_efficiency)

```

---

Scilab code Exa 10.4 Determination of synchronous speed and slip and maximum torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_4.sce
7
8 clc;
9 clear;

```

```

(a)
Synchronous speed=1500 r.p.m

(b)
Slip at which maximum torque occurs=20 percentage

(c)
Maximum Torque=383.03 synchronous watt

(d)
Full load torque=191.52 synchronous watt
Full load slip=5.4 percentage
Speed at full load=1419 r.p.m
Power output=28.47 kW

(e)
The rotor frequency at full load=2.7 Hz
-->|

```

Figure 10.4: Determination of synchronous speed and slip and maximum torque and rotor frequency

```

10
11 f=50;
12 p=4;
13 V=400;
14 E2=190;
15 R1=0.5;
16 X1=2.5;
17 R2=0.06;
18 X2=0.3;
19
20 printf("\n (a)")
21 Ns=(120*f)/p;
22 printf("\n Synchronous speed=%d r.p.m \n",Ns)
23
24 printf("\n (b)")
25 s=(R2/X2)*100;
26 printf("\n Slip at which maximum torque occurs=%d
percentage \n",s)
27
28 printf("\n (c)")
29 E=E2/sqrt(3);

```

```

30 Ir=(s*E)/(sqrt(2)*R2*100);
31 pf=1/sqrt(2);
32 Pi=sqrt(3)*E2*Ir*pf;
33 P0=(1-s/100)*Pi;
34 Tm=Pi/(2*pi*Ns/60);
35 printf("\n Maximum Torque=%3.2f synchronous watt \n
      ",Tm)
36
37 printf("\n (d)")
38 Tf1=(1/2)*Tm;
39 //(2/1)=(R2^2+sf^2*X2^2)/(2*X2*R2*sf)
40 //From this equation we get sf^2-0.8*sf+0.04=0;
41 a=1;
42 b=-0.8;//a,b,c are coefficient values taken from the
      above second order equation
43 c=0.04;
44 sf=(-b-sqrt(b^2-(4*a*c)))/(2*a);
45 sf_percentage=sf*100;
46 Nf=Ns*(1-sf);
47 Pf=2*pi*(Nf/60)*Tf1;
48 printf("\n Full load torque=%3.2f synchronous watt"
      ,Tf1)
49 printf("\n Full load slip=%1.1f percentage",
      sf_percentage)
50 printf("\n Speed at full load=%d r.p.m",Nf)
51 printf("\n Power output=%2.2f kW \n",Pf/1000)
52 //Answer vary dueto round off error
53
54 printf("\n (e)")
55 f_at_fullload=sf*f;
56 printf("\n The rotor frequency at full load=%1.1f
      Hz",f_at_fullload)

```

---

```

(a)
Number of poles=20

(b)
Slip at full load=5 percentage

(c)
Slip at full load if rotor resistance is doubled=10 percentage

(d)
The new value of rotor copper loss=560 watt

-->

```

Figure 10.5: Calculation of number of poles and slip and rotor copper loss

#### Scilab code Exa 10.5 Calculation of number of poles and slip and rotor copper loss

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_5.sce
7
8 clc;
9 clear;
10 f=50;
11 N=285;
12 Ns=300; //which is near the value of N as slip lies
           b/w 0.03 to 0.05
13
14 printf("\n (a)")
15 p=(120*f)/Ns;
16 printf("\n Number of poles=%d \n",p)
17
18 printf("\n (b)")

```

```
Starting torque interms of full load torue=1.25*Tf  
-->
```

Figure 10.6: Determination of starting torque

```
19 s=(Ns-N)/Ns;  
20 s_percentage=s*100;  
21 printf("\n Slip at full load=%d percentage \n",  
        s_percentage)  
22  
23 printf("\n (c)")  
24 //slip is proportional to rotor resistance  
25 s=2*s_percentage;  
26 printf("\n Slip at full load if rotor resistance is  
        doubled=%d percentage \n",s)  
27  
28 printf("\n (d)")  
29 //copper loss=I^2*R; so copper loss doubles if rotor  
        resistance doubles  
30 Pcu=280;  
31 Pcu_new=2*Pcu;  
32 printf("\n The new value of rotor copper loss=%d  
        watt \n",Pcu_new)
```

---

Scilab code Exa 10.6 Determination of starting torque

```

(a)
R1=0.15 ohm
R0=88.889 ohm
X0=11.646 ohm
R2dash=0.132 ohm
X1=0.195 ohm
X2dash=0.195 ohm

(b)
Slip for pullout torque=0.679845
Magnitude of pullout torque=895.07 Nm
-->|

```

Figure 10.7: Calculation motor parameters and slip and pullout torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_6.sce
7
8 clc;
9 clear;
10 s=0.05; //Full load slip of 5 percentage
11 Iss_by_Isf=5; //Taken from question statement
12 Ts_by_Tf=s*(Iss_by_Isf)^2;
13 printf("\n Starting torque interms of full load
torque=%1.2 f*Tf",Ts_by_Tf)

```

---

Scilab code Exa 10.7 Calculation motor parameters and slip and pullout torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_7.sce
7
8 clc;
9 clear;
10 V1_not=400; //No load voltage in volt
11 V1_sc=50; //Blocked rotor voltage in volt
12 I_not=20; //No load current in Ampere
13 Isc=60; //Blocked rotor currnet in Ampere
14 W1_not=5e3; //watt meter readings for no load
    test in watt
15 W2_not=-3.2e3; //watt meter readings for no load
    test in watt
16 Wsc1=2.3e3; //watt meter readings for blocked
    rotor test in watt
17 Wsc2=0.75e3; //watt meter readings for blocked
    rotor test in watt
18 Vdc=18; //dc voltage in volt
19 Idc=60; //dc line current in Ampere
20
21 printf("\n (a)")
22 R1=(Vdc/Idc)/2;
23 printf("\n R1=%1.2 f ohm",R1)
24 P_not=W1_not+W2_not;
25 V_not=V1_not/sqrt(3);
26 cos_phi_not=P_not/(3*V_not*I_not);
27 R_not=V_not/(I_not*cos_phi_not);
28 printf("\n R0=%2.3 f ohm",R_not)
29 //R_not answer vary dueto round off error in v_not
    and cos_phi_not
30 X_not=V_not/(I_not*sqrt(1-cos_phi_not^2));
31 printf("\n X0=%2.3 f ohm",X_not)
32 Psc=Wsc1+Wsc2;
33 Vsc=V1_sc/sqrt(3);

```

```

34 cos_phi_sc=Psc/(3*Vsc*Isc);
35 R2_dash=((Vsc/Isc)*cos_phi_sc)-R1;
36 printf("\n R2dash=%1.3 f ohm",R2_dash)
37 X1=((Vsc/Isc)*sqrt(1-cos_phi_sc^2))/2;
38 printf("\n X1=%1.3 f ohm",X1)
39 X2_dash=X1;
40 printf("\n X2dash=%1.3 f ohm \n",X2_dash)
41
42 printf("\n (b)")
43 ns=25;
44 s=R2_dash/X2_dash; //Slip for maximum torque
45 pf_max=1/sqrt(2);
46 Ps=(3*V_not^2)/sqrt((R1+R2_dash/s)^2+(2*X1)^2);
47 Pc=(3*V_not^2*(R1+R2_dash))/((R1+R2_dash/s)^2+(2*X1)
^2); //Stator copper loss in kw
48 Pin=Ps-Pc;
49 T=Pin/(2*pi*ns);
50 printf("\n Slip for pullout torque=%g",s)
51 printf("\n Magnitude of pullout torque=%3.2 f Nm",T)
52 //There is a mistake in the book solution in part (b
)
53 //The calculated Ps value is wrong
54 //Hence T answer vary

```

---

**Scilab code Exa 10.9** Determination ratio of starting current to full load current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_9.sce
7

```



```
Scilab 5.5.2 Console
The ratio value of starting current to full load current=0.407
-->
```

Figure 10.8: Determination ratio of starting current to full load current

```
8 clc;
9 clear;
10 P_in_HP=10;
11 eta=0.9;
12 pf=0.8;
13 Vl=400;
14 Vsc=160;
15 Isc=7.2;
16 P_in_watt=P_in_HP*735.5;
17 If=P_in_watt/(sqrt(3)*Vl*pf*eta);
18 Isc_400=Isc*Vl/Vsc;
19 Ist=Isc_400/3;
20 Ist_by_If=Ist/If;
21 printf("\n The ratio value of starting current to
    full load current=%1.3f",Ist_by_If)
```

---

#### Scilab code Exa 10.10 Calculation of starting torque and starting current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
```

```

(i) Using Direct switching
    The starting current=247.44 A
    The starting torque=212.4 Nm

(ii) Using Star delta connector
    The starting current=82.48 A
    The starting torque=70.8 Nm

(iii) Using auto transformer
    The starting current=121.24 A
    The starting torque=104.1 Nm

-->|

```

Figure 10.9: Calculation of starting torque and starting current

```

3 // Publisher: PHI Learning Private Limited
4 // Edition: Third ,2014
5
6 // EX10_10.sce .
7 clc;
8 clear;
9 sf=0.04;
10 If=37.5;
11 f=50;
12 p=4;
13 V=400;
14 P_in_HP=25;
15 z=2.8;
16 P_in_watt=P_in_HP*735.5;
17 Nf=((120*f)/p)*(1-sf);
18 nf=Nf/60;
19 Tf=P_in_watt/(2*%pi*nf);
20 Isc_phase=V/z;
21 Isc=sqrt(3)*Isc_phase;

```

```

22
23 printf("\n (i) Using Direct switching")
24 Ist=Isc;
25 printf("\n \t The starting current=%3.2 f A",Ist)
26 Tst=(Isc/If)^2*sf*Tf;
27 printf("\n \t The starting torque=%3.1 f Nm \n",Tst)
28
29 printf("\n (ii) Using Star delta connector")
30 Ist=(1/3)*Isc;
31 printf("\n \t The starting current=%3.2 f A",Ist)
32 Tst=(1/3)*(Isc/If)^2*sf*Tf;
33 printf("\n \t The starting torque=%3.1 f Nm \n",Tst)
34
35 printf("\n (iii) Using auto transformer")
36 k=0.7;
37 Ist=k^2*Isc;
38 printf("\n \t The starting current=%3.2 f A",Ist)
39 Tst=k^2*(Isc/If)^2*sf*Tf;
40 printf("\n \t The starting torque=%3.1 f Nm \n",Tst)

```

---

#### Scilab code Exa 10.11 Calculation of plugging torque

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_11.sce
7
8 clc;
9 clear;
10
11

```

```
Plugging torque at full load=98.1 Nm  
-->|
```

Figure 10.10: Calculation of plugging torque

```
12 P_in_HP=25;  
13 s=0.04;  
14 p=4;  
15 f=50;  
16 Ns=(120*f)/p;  
17 ns=Ns/60;  
18 nf=(1-s)*ns;  
19 P_in_watt=P_in_HP*735.5;  
20 Tf=P_in_watt/(2*pi*nf);  
21 sf=s;  
22 sp=2-s;           //At the time of plugging the slip  
    is 200%  
23 a=4;  
24 X2_by_R2=a;  
25 Tp=(sp/sf)*((1+(sf^2*X2_by_R2^2))/(1+(sp^2*X2_by_R2  
    ^2)))*Tf;  
26 printf("\n Plugging torque at full load=%2.1f Nm",Tp  
    )
```

---

```
External resistance per phase=0.5 ohm per phase  
-->|
```

Figure 10.11: Calculation of external resistance

**Scilab code Exa 10.12** Calculation of external resistance

```
1 //Book Name:Fundamentals of Electrical Engineering  
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex10_12.sce  
7  
8 clc;  
9 clear;  
10 p=4;  
11 f=50;  
12 R2=0.25;  
13 N1=1425;  
14 N2=1275;  
15  
16  $N_s=(120*f)/p$ ;  
17  $s_1=(N_s-N_1)/N_s$ ;
```

```

Scilab 5.5.2 Console

(a)
  (i) Speed when cumulatively cascaded:
      N=300 r.p.m
  (ii) Speed when differentially cascaded:
      N=1500 r.p.m

(b)
  The ratio of power shared by the two motors=12/8

(c)
  (i) First motor:
  Required frequency of voltage to be injected in rotor of first motor=20 Hz
  (ii) Second motor:
  Required frequency of voltage to be injected in rotor of second motor=30 Hz
-->

```

Figure 10.12: Calculation of speed and power ratio and frequency

```

18 s2=(Ns-N2)/Ns;
19 R=(R2*(s2/s1))-R2;
20 printf("\n External resistance per phase=%1.1f ohm
    per phase",R)

```

---

**Scilab code Exa 10.13** Calculation of speed and power ratio and frequency

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex10_13.sce
7
8 clc;
9 clear;
10 p1=12;
11 p2=8;

```

```

12 f=50;
13 printf("\n (a)")
14 printf("\n \t (i)Speed when cumulatively cascaded:")
15 N1=(120*f)/(p1+p2);
16 printf("\n \t          N=%d r.p.m",N1)
17 printf("\n \t (ii)Speed when differentially cascaded
    :")
18 N2=(120*f)/(p1-p2);
19 printf("\n \t          N=%d r.p.m \n",N2)
20
21 printf("\n (b)")
22 printf("\n The ratio of power shared by the two
    motors=%d/%d \n",p1,p2)
23
24 printf("\n (c)")
25 printf("\n \t(i)First motor:")
26 Ns1=(120*f)/p1;
27 s1=(Ns1-N1)/Ns1;
28 sf1=s1*f;
29 printf("\n Required frequency of voltage to be
    injected in rotor of first motor=%d Hz",sf1)
30 printf("\n \t(ii)Second motor:")
31 Ns2=(120*f)/p2;
32 s2=(Ns2-N1)/Ns2;
33 sf2=s2*f;
34 printf("\n Required frequency of voltage to be
    injected in rotor of second motor=%d Hz",sf2)

```

---

# Chapter 11

## Special Purpose Electrical Machines

Scilab code Exa 11.1 Determination of motor parameters and stator current and power

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex11_1.sce
7
8 clc;
9 clear;
10 V_not=220;
11 I_not=4;
12 W_not=100;
13 Vsc=110;
14 Isc=10;
15 Wsc=400;
16 p=6;
17 V=220;
```



```

(a)
Parameters of the motor:
    r1=r2dash=2 ohm
    x1=x2dash=5.123 ohm
    R0/2=591.78 ohm
    X0/2=47.26 ohm

(b)
Stator current:
    magnitude=8.08 V,
    angle=-42.44 degree
Power factor=0.738 lagging
Power output=972.13 watt
Speed=960 r.p.m
Torque=9.67 Nm
Efficiency=74 percentage
-->

```

Figure 11.1: Determination of motor parameters and stator current and power factor and speed and torque

```

18 f=50;
19
20 printf("\n (a)")
21 r1=(Wsc/Isc^2)/2;
22 x1=sqrt((Vsc/Isc)^2-(2*r1)^2)/2;
23 r2_dash=r1;
24 x2_dash=x1;
25 phi_not=acosd(W_not/(V_not*I_not));
26 V_not_dash=V_not-((I_not*(cosd(phi_not)-%i*sind(
    phi_not)))*((r1+r2_dash/4)+%i*(x1+x2_dash/2)));
27 Wi=W_not-(I_not^2*(r1+r2_dash/4));
28 R_not_by_2=(V_not_dash^2)/Wi;
29 Y_not=(I_not)/(V_not_dash*2);
30 B_not=sqrt((2*Y_not)^2-(1/R_not_by_2)^2)/2;
31 X_not_by_2=1/(2*B_not);
32 printf("\n Parameters of the motor:")
33 printf("\n \t r1=r2dash=%d ohm",r1)
34 printf("\n \t x1=x2dash=%1.3 f ohm",x1)

```

```

35 printf("\n \t R0/2=%3.2 f ohm",sqrt(real(R_not_by_2)
    ^2+imag(R_not_by_2)^2))
36 printf("\n \t X0/2=%2.2 f ohm",sqrt(real(X_not_by_2)
    ^2+imag(X_not_by_2)^2))
37
38 printf("\n (b)")
39 //From the applied parameters of equivalent circuit
    of the motor stator current is simplified
40 I1=complex(1.096,-0.526)*complex(6.36,-1.92);
41 I1_mag=sqrt(real(I1)^2+imag(I1)^2);
42 I1_angle=atand(imag(I1)/real(I1));
43 pf=cosd(I1_angle);
44 P_input=1075;
45 P_loss=102.87;
46 P_not=P_input-P_loss;
47 Ns=1000;
48 s=0.04;
49 Nf1=(1-s)*Ns;
50 T_net=P_not/(2*pi*Nf1/60);
51 motor_input=V*I1_mag*pf;
52 efficiency=(P_not/motor_input)*100;
53 printf("\n Stator current: \n\t magnitude=%1.2 f V,\
    n\t angle=%2.2 f degree",I1_mag,I1_angle)
54 printf("\n Power factor=%0.3 f lagging",pf)
55 printf("\n Power output=%3.2 f watt",P_not)
56 printf("\n Speed=%d r.p.m",Nf1)
57 printf("\n Torque=%1.2 f Nm",T_net)
58 printf("\n Efficiency=%d percentage",efficiency)
59 //Answer vary dueto roundoff error

```

---

Scilab code Exa 11.2 Calculation of developed power and copper loss

1 //Book Name: Fundamentals of Electrical Engineering

```
Scilab 5.5.2 Console

The developed power by the motor=4500 kw

Secondary copper loss=500 kw

-->
```

Figure 11.2: Calculation of developed power and copper loss

```
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex11_2.sce
7
8 clc;
9 clear;
10 t=0.5;           //pole pitch
11 f=50;
12 vmp=162;
13 fd=100e3;
14 vm=vmp*1e3/(60*60);
15 pd=fd*vm;
16 vs=2*t*f;
17 s=(vs-vm)/vs;
18 pcu=s*fd*vs;
19 printf("\n The developed power by the motor=%d kw \
```

```
(a)
The speed of the motor=937 r.p.m

(b)
The blocked rotor torque=19 Nm

-->
```

Figure 11.3: Calculation of motor speed and torque

```
    n",pd/1000)
20 printf("\n Secondary copper loss=%d kw \n",pcu
    /1000)
```

---

### Scilab code Exa 11.3 Calculation of motor speed and torque

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex11_3.sce
7
8 clc;
```

```
The magnetic flux=7.255 mWb
```

```
-->|
```

Figure 11.4: Calculation of magnetic flux

```
9 clear;
10 Ra=0.8;
11 Va=40;
12 Td=1.2;
13 Ka=600;
14 phi_p=0.004;
15
16 printf("\n (a)")
17 n=(Va/(Ka*phi_p))-(2*pi*Ra*Td/(Ka*phi_p)^2);
18 N=n*60;
19 printf("\n The speed of the motor=%d r.p.m \n",N)
20 //The book answer for part(a) is wrong value
21
22 printf("\n (b)")
23 n=0;
24 Td=(Va*Ka*phi_p)/(2*pi*Ra);
25 printf("\n The blocked rotor torque=%d Nm \n",Td)
```

---

### Scilab code Exa 11.4 Calculation of magnetic flux

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex11_4.sce
7
8 clc;
9 clear;
10 P=200;
11 V=100;
12 N=1500;
13 Ka=525;
14 Ra=2;
15 P1=15;
16
17 Pd=P+P1;
18 n=N/60;
19 Td=Pd/(2*%pi*n);
20 //n=(Va/(Ka*phi_p))-(2*%pi*Ra*Td/(Ka*phi_p)^2);
21 //from this equation we get phi^2-o-0.0076*phi+2.5e
    -6=0;
22 a=1;
23 b=-0.0076;//a,b,c are coefficient values taken from
    the above second order equation
24 c=2.5e-6;
25 phi_p=(-b+sqrt(b^2-(4*a*c)))/(2*a);
26 printf("\\n The magnetic flux=%1.3f mWb \\n",phi_p
    *1000)
```

---

# Chapter 12

## Analysis of Three Phase Circuits

Scilab code Exa 12.1 Calculation of line current of load and alternator

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_1.sce
7
8 clc;
9 clear;
10 z=complex(3,4);
11 V1=120;
12 printf("\n Line current of load: Magnitude \t
        Angle(deg) \n")
13 I_R=complex(V1*cosd(0),V1*sind(0))/(sqrt(3)*z);
14 I_Y=complex(V1*cosd(-120),V1*sind(-120))/(sqrt(3)*z)
    ;
15 I_B=complex(V1*cosd(120),V1*sind(120))/(sqrt(3)*z);
```

```
Scilab 5.5.2 Console

Line current of load: Magnitude      Angle(deg)
      Ir in A:      13.86      -53.13
      Iy in A:      13.86     -173.13
      Ib in A:      13.86      66.87
Line current of alternator: Magnitude  Angle(deg)
      Ir in A:      13.86     -53.13
      Iy in A:      13.86     -173.13
      Ib in A:      13.86      66.87
-->|
```

Figure 12.1: Calculation of line current of load and alternator



```

16 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
17 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
18 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
19 I_R_angle=atand(imag(I_R)/real(I_R));
20 I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
21 I_B_angle=atand(imag(I_B)/real(I_B));
22 printf("\n\t Ir in A:\t %2.2f \t %2.2f",I_R_mag,
    I_R_angle)
23 printf("\n\t Iy in A:\t %2.2f \t %2.2f",I_Y_mag,
    I_Y_angle)
24 printf("\n\t Ib in A:\t %2.2f \t %2.2f",I_B_mag,
    I_B_angle)
25 //The line current of alternator is same as the
    line or phase current of load
26
27 printf("\n Line current of alternator: Magnitude
    Angle(deg) \n")
28 I_R=complex(V1*cosd(0),V1*sind(0))/(sqrt(3)*z);
29 I_Y=complex(V1*cosd(-120),V1*sind(-120))/(sqrt(3)*z)
    ;
30 I_B=complex(V1*cosd(120),V1*sind(120))/(sqrt(3)*z);
31 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
32 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
33 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
34 I_R_angle=atand(imag(I_R)/real(I_R));
35 I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
36 I_B_angle=atand(imag(I_B)/real(I_B));
37 printf("\n\t Ir in A: \t %2.2f \t %2.2f",
    I_R_mag,I_R_angle)
38 printf("\n\t Iy in A: \t %2.2f \t %2.2f",
    I_Y_mag,I_Y_angle)
39 printf("\n\t Ib in A: \t %2.2f \t %2.2f",
    I_B_mag,I_B_angle)

```

---

```

Scilab 5.5.2 Console

Phase current of the load:  Magnitude  Angle(deg)

      Iyr in A      11      -53.13
      Iby in A      11      -173.13
      Irb in A      11       66.87
Line current of the load:  Magnitude  Angle(deg)

      Ilr in A      19.05     -83.13
      Ily in A      19.05    -203.13
      Ilb in A      19.05     36.87

-->

```

Figure 12.2: Determination of phase and line current of the load

**Scilab code Exa 12.2** Determination of phase and line current of the load

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_2.sce
7
8 clc;
9 clear;
10 z=complex(6,8);
11 V1=110;
12 printf("\nPhase current of the load:  Magnitude \t
      Angle(deg) \n")
13 I_YR=complex(V1*cosd(0),V1*sind(0))/(z);
14 I_BY=complex(V1*cosd(-120),V1*sind(-120))/(z);
15 I_RB=complex(V1*cosd(120),V1*sind(120))/(z);
16 I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
17 I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
18 I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);

```

```

19 I_YR_angle=atand(imag(I_YR)/real(I_YR));
20 I_BY_angle=atand(imag(I_BY)/real(I_BY))-180;
21 I_RB_angle=atand(imag(I_RB)/real(I_RB));
22 printf("\n\t\t Iyr in A \t %d \t %2.2f",I_YR_mag ,
        I_YR_angle)
23 printf("\n\t\t Iby in A \t %d \t %2.2f",I_BY_mag ,
        I_BY_angle)
24 printf("\n\t\t Irb in A \t %d \t %2.2f",I_RB_mag ,
        I_RB_angle)
25
26 printf("\nLine current of the load:      Magnitude \t
        Angle(deg) \n")
27 I_LR_mag=sqrt(3)*I_YR_mag;
28 I_LY_mag=sqrt(3)*I_BY_mag;
29 I_LB_mag=sqrt(3)*I_RB_mag;
30 I_LR_angle=I_YR_angle-30;
31 I_LY_angle=I_BY_angle-30;
32 I_LB_angle=I_RB_angle-30;
33 printf("\n\t\t Ilr in A \t %2.2f \t %2.2f",I_LR_mag ,
        I_LR_angle)
34 printf("\n\t\t Ily in A \t %2.2f \t %2.2f",I_LY_mag ,
        I_LY_angle)
35 printf("\n\t\t Ilb in A \t %2.2f \t %2.2f",I_LB_mag ,
        I_LB_angle)

```

---

**Scilab code Exa 12.3** Calculation of total KVA of capacitors and capacitance value

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_3.sce

```

```
Total kVA of the capacitors for raising power factor to 0.95 is 11.77 kVAR

(a)
Required capacitance per phase for star connected capacitors=193.571 micro-farad

(b)
Required capacitance per phase for delta connected capacitors=64.52 micro-farad

-->
```

Figure 12.3: Calculation of total KVA of capacitors and capacitance value

```
7
8 clc;
9 clear;
10 P=36; //power in kilowatt
11 V1=440;
12 f=50;
13 efficiency=0.89;
14 pf1=0.85;
15 pf2=0.95;
16 P_not=P/3;
17 P_input=P_not/efficiency;
18 Q1=P_input*tand(acosd(pf1));
19 Q2=P_input*tand(acosd(pf2));
20 Qc=Q1-Q2;
21 kVA=3*Qc;
22 printf("\\n Total kVA of the capacitors for raising
    power factor to 0.95 is %2.2f kVAR \\n",kVA)
23 V=V1/sqrt(3);
24 Xc=V^2/(Qc*1e3);
25
26 printf("\\n(a)")
27 C_star=1/(2*%pi*f*Xc);
```

```
Scilab 5.5.2 Console

Total kVA of the capacitors for raising power factor to 0.95 is 11.77 kVAR

(a)
Required capacitance per phase for star connected capacitors=193.571 micro-farad

(b)
Required capacitance per phase for delta connected capacitors=64.524 micro-farad

-->
```

Figure 12.4: Calculation of total KVA of capacitors and capacitance value

```
28 printf("\n Required capacitance per phase for star
    connected capacitors=%3.3f micro-farad \n",C_star
    /1e-6)
29
30 printf("\n(b)")
31 C_delta=C_star/3;
32 printf("\n Required capacitance per phase for delta
    connected capacitors=%2.2f micro-farad \n",
    C_delta/1e-6)
33 //Answer vary dueto round off error
```

---

Scilab code Exa 12.4 Calculation of total KVA of capacitors and capacitance value

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
```

```

4 //Edition:Third ,2014
5
6 //Ex12_4.sce
7
8
9 //The input data taken from Example:12.3
10 clc;
11 clear;
12 P=36;
13 V1=440;
14 f=50;
15 efficiency=0.89;
16 pf1=0.85;
17 pf2=0.95;
18 Pm=P/efficiency;
19 Qm=Pm*tand(acosd(pf1));
20 Qs=Pm*tand(acosd(pf2));
21 Qc=Qm-Qs;
22 Qc_phase=Qc/3;
23 kVA=Qc_phase;
24 printf("\\n Total kVA of the capacitors for raising
        power factor to 0.95 is %2.2f kVAR \\n",Qc)
25
26 printf("\\n(a)")
27 Vph=V1/sqrt(3);
28 Iph=kVA*1e3/Vph;
29 C=Iph/(2*%pi*f*Vph);
30 printf("\\n Required capacitance per phase for star
        connected capacitors=%3.3f micro-farad \\n",C/1e
        -6)
31
32 printf("\\n(b)")
33 Vph=V1;
34 Iph=kVA*1e3/Vph;
35 C=Iph/(2*%pi*f*Vph);
36 printf("\\n Required capacitance per phase for delta
        connected capacitors=%3.3f micro-farad \\n",C/1e
        -6)

```

```
Scilab 5.5.2 Console

Line current of load:      Magnitude   Angle(deg)

      Ir in A             11           30.00
      Iy in A             11          -90.00
      Ib in A             11          150.00

The neutral current is 0 A
-->|
```

Figure 12.5: Calculation of line current and neutral current

37 //Answer vary dueto round off error

---

### Scilab code Exa 12.5 Calculation of line current and neutral current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_5.sce
7
8 clc;
9 clear;
10 V1=440;
```

```

11 z_mag=40;
12 z_angle=-30;
13 z=complex(z_mag*cosd(z_angle),z_mag*sind(z_angle));
14 Iph=Vl/z;
15 Iph_mag=sqrt(real(Iph)^2+imag(Iph)^2);
16 Iph_angle=atand(imag(Iph)/real(Iph));
17
18 printf("\nLine current of load:\t      Magnitude \t
      Angle(deg) \n")
19 I_R_mag=Iph_mag;
20 I_Y_mag=Iph_mag;
21 I_B_mag=Iph_mag;
22 I_R_angle=Iph_angle-0;
23 I_Y_angle=Iph_angle-120;
24 I_B_angle=Iph_angle+120;
25 printf("\n\t\t Ir in A \t%d \t %2.2f",I_R_mag,
      I_R_angle)
26 printf("\n\t\t Iy in A \t%d \t %2.2f",I_Y_mag,
      I_Y_angle)
27 printf("\n\t\t Ib in A \t%d \t %2.2f",I_B_mag,
      I_B_angle)
28
29 I_R=complex(I_R_mag*cosd(I_R_angle),I_R_mag*sind(
      I_R_angle))
30 I_Y=complex(I_Y_mag*cosd(I_Y_angle),I_Y_mag*sind(
      I_Y_angle))
31 I_B=complex(I_B_mag*cosd(I_B_angle),I_B_mag*sind(
      I_B_angle))
32 I_N=I_R+I_Y+I_B;
33 printf("\n The neutral current is %d A",I_N)

```

---

Scilab code Exa 12.6 Determination of complex power and line current



```

Scilab 5.5.2 Console

(a)
Complex power= magnitude      angle(deg)
                10           36.87
Line current=13.12 A

(b)
Total line current=16.4 A

-->|

```

Figure 12.6: Determination of complex power and line current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_6.sce
7
8 clc;
9 clear;
10 printf("\n (a)")
11 Pi=8; //power in kilowatt
12 pf=0.8;
13 V1=440;
14 Qi=Pi*tand(acosd(pf));
15 P=complex(Pi,Qi);
16 P_mag=sqrt(real(P)^2+imag(P)^2);
17 P_angle=atand(imag(P)/real(P));
18 I1=(P_mag*1e3)/(sqrt(3)*V1);

```

```

19 printf("\n Complex power= magnitude\tangle(deg) \n\
    t\t      %1.0f \t %2.2f",P_mag,P_angle)
20 printf("\n Line current=%2.2f A \n",I1)
21
22 printf("\n (b)")
23 P1=7.5;
24 pf=0.6;
25 P=Pi+(P1*pf);
26 Q=Qi-(P*sind(acosd(pf)));
27 kVA=P;
28 I1=(kVA*1e3)/(sqrt(3)*V1);
29 printf("\n Total line current=%2.1f A \n",I1)

```

---

Scilab code Exa 12.7 Calculation of line current and phase current and total power

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_7.sce
7
8 clc;
9 clear;
10 z1=complex(8,6);
11 z2=complex(6,8);
12 z3=complex(4,-3);
13 R_YR=z1;
14 R_BY=z2;
15 R_RB=z3;
16 V1=440;
17
18 printf("\n(a) Delta connected load of phase sequence

```

```

Scilab 5.5.2 Console

(a)Delta connected load of phase sequence RYB:
Phase current=      Magnitude      Angle(deg)

      Iyr in A      44      -36.87
      Iby in A      44      -173.13
      Irb in A      88      156.87
Line current=      Magnitude      Angle(deg)
      Ir in A      131.16     -27.70
      Iy in A      81.67      165.00
      Ib in A      54.53      133.08
Total power dissipated:

      W_YR=15488 W
      W_BY=11616 W
      W_RB=30976 W

(b)Delta connected load of phase sequence RBY:
Phase current=      Magnitude      Angle(deg)

      Iyr in A      44      -36.87
      Iby in A      44      66.87
      Irb in A      88      -83.13
Line current=      Magnitude      Angle(deg)
      Ir in A      65.77      67.97
      Iy in A      69.22      105.00
      Ib in A      128.01     -93.03
Total power dissipated:

      W_YR=15488 W
      W_BY=11616 W
      W_RB=30976 W
-->

```

Figure 12.7: Calculation of line current and phase current and total power dissipated

```

        RYB:")
19 theta1=0;
20 theta2=-120;
21 theta3=120;
22 V_YR=complex(V1*cosd(theta1),V1*sind(theta1));
23 V_BY=complex(V1*cosd(theta2),V1*sind(theta2));
24 V_RB=complex(V1*cosd(theta3),V1*sind(theta3));
25 I_YR=V_YR/z1;
26 I_BY=V_BY/z2;
27 I_RB=V_RB/z3;
28 I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
29 I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
30 I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);
31 I_YR_angle=atand(imag(I_YR)/real(I_YR));
32 I_BY_angle=atand(imag(I_BY)/real(I_BY))-180;
33 I_RB_angle=atand(imag(I_RB)/real(I_RB))+180;
34 printf("\nPhase current=      \tMagnitude\tAngle(deg)
        \n")
35 printf("\n\t Iyr in A \t %d \t      %2.2 f",I_YR_mag,
        I_YR_angle)
36 printf("\n\t Iby in A \t %d \t      %2.2 f",I_BY_mag,
        I_BY_angle)
37 printf("\n\t Irb in A \t %d \t      %2.2 f",I_RB_mag,
        I_RB_angle)
38
39 I_R=I_YR-I_RB;
40 I_Y=I_BY-I_YR;
41 I_B=I_RB-I_BY;
42 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
43 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
44 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
45 I_R_angle=atand(imag(I_R)/real(I_R));
46 I_Y_angle=atand(imag(I_Y)/real(I_Y))+180;
47 I_B_angle=atand(imag(I_B)/real(I_B))+180;
48 printf("\nLine current=      \tMagnitude\tAngle(deg)
        ")
49 printf("\n\t Ir in A \t %2.2 f      %2.2 f",I_R_mag,
        I_R_angle)

```

```

50 printf("\n\t Iy in A \t %2.2f \t      %2.2f", I_Y_mag,
      I_Y_angle)
51 printf("\n\t Ib in A \t %2.2f \t      %2.2f", I_B_mag,
      I_B_angle)
52
53 W_YR=(I_YR_mag)^2*real(z1);
54 W_BY=(I_BY_mag)^2*real(z2);
55 W_RB=(I_RB_mag)^2*real(z3);
56 printf("\n Toatal power dissipated:\n")
57 printf("\n\t W_YR=%d W", W_YR)
58 printf("\n\t W_BY=%d W", W_BY)
59 printf("\n\t W_RB=%d W", W_RB)
60
61
62 printf("\n\n(b) Delta connected load of phase
      sequence RBY:")
63 theta1=0;
64 theta2=120;
65 theta3=-120;
66 V_YR=complex(Vl*cosd(theta1),Vl*sind(theta1));
67 V_BY=complex(Vl*cosd(theta2),Vl*sind(theta2));
68 V_RB=complex(Vl*cosd(theta3),Vl*sind(theta3));
69 I_YR=V_YR/z1;
70 I_BY=V_BY/z2;
71 I_RB=V_RB/z3;
72 I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
73 I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
74 I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);
75 I_YR_angle=atand(imag(I_YR)/real(I_YR));
76 I_BY_angle=atand(imag(I_BY)/real(I_BY));
77 I_RB_angle=atand(imag(I_RB)/real(I_RB));
78 printf("\nPhase current=      \tMagnitude\tAngle(deg)
      \n")
79 printf("\n\t Iyr in A \t %d \t      %2.2f", I_YR_mag,
      I_YR_angle)
80 printf("\n\t Iby in A \t %d \t      %2.2f", I_BY_mag,
      I_BY_angle)
81 printf("\n\t Irb in A \t %d \t      %2.2f", I_RB_mag,

```

```

        I_RB_angle)
82
83 I_R=I_YR-I_RB;
84 I_Y=I_BY-I_YR;
85 I_B=I_RB-I_BY;
86 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
87 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
88 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
89 I_R_angle=atand(imag(I_R)/real(I_R));
90 I_Y_angle=atand(imag(I_Y)/real(I_Y))+180;
91 I_B_angle=atand(imag(I_B)/real(I_B))-180;
92 printf("\nLine current=          \tMagnitude\tAngle(deg)
        ")
93 printf("\n\t Ir in A \t %2.2f          %2.2f",I_R_mag,
        I_R_angle)
94 printf("\n\t Iy in A \t %2.2f \t          %2.2f",I_Y_mag,
        I_Y_angle)
95 printf("\n\t Ib in A \t %2.2f          %2.2f",I_B_mag,
        I_B_angle)
96
97 W_YR=(I_YR_mag)^2*real(z1);
98 W_BY=(I_BY_mag)^2*real(z2);
99 W_RB=(I_RB_mag)^2*real(z3);
100 printf("\n Toatal power dissipated:\n")
101 printf("\n\t W_YR=%d W",W_YR)
102 printf("\n\t W_BY=%d W",W_BY)
103 printf("\n\t W_RB=%d W",W_RB)

```

---

### Scilab code Exa 12.8 Calculation of total power and reactive power

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited

```

Scilab 5.5.2 Console

```
(a)  
Phase power=181.5 W  
  
(b)  
Reactive power=127.37 VAR  
-->|
```

Figure 12.8: Calculation of total power and reactive power

```

4 //Edition:Third ,2014
5
6 //Ex12_8.sce
7
8 clc;
9 clear;
10 V1=110;
11 f=50;
12
13 printf("\n (a)")
14 R_YR=0;
15 R_BY=100;
16 R_RB=200;
17 W_YR=0; //since R_YR value is zero
18 W_BY=V1^2/R_BY;
19 W_RB=V1^2/R_RB;
20 printf("\n Phase power=%3.1 f W \n",W_YR+W_BY+W_RB)
21
22
23 printf("\n (b)")
24 X_YR=95;
25 X_BY=0;
26 X_RB=0;
27 W_YR=V1^2/X_YR;
28 W_BY=0; //since X_BY value is zero
29 W_RB=0; //since X_RB value is zero
30 printf("\n Reactive power=%3.2 f VAR",W_YR+W_BY+
W_RB)

```

---

Scilab code Exa 12.9 Calculation of neutral current and power taken by each phase

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad

```



```

(a) For phase sequence RYB:

The current through the neutral wire,
-In= Magnitude      Angle(deg)
      20.94          16.41

Power taken by each load:
Pr=4840 W
Py=3865.4 W
Pb=2912.8 W

(b) For phase sequence RBY:

The current through the neutral wire,
In= Magnitude      Angle(deg)
     33.31          2.73

Power taken by each load:
Pr=4840 W
Py=3865.4 W
Pb=2912.8 W

-->

```

Figure 12.9: Calculation of neutral current and power taken by each phase

```

3 // Publisher : PHI Learning Private Limited
4 // Edition : Third ,2014
5
6 // Ex12_9.sce
7
8 clc;
9 clear;
10 z=10;
11 ang1=0;
12 ang2=37;
13 ang3=-53;
14 Zr=complex(z*cosd(ang1),z*sind(ang1));
15 Zy=complex(z*cosd(ang2),z*sind(ang2));
16 Zb=complex(z*cosd(ang3),z*sind(ang3));
17
18 printf("\n (a) For phase sequence RYB:\n")
19 V=220;
20 theta1=0;

```

```

21 theta2=-120;
22 theta3=120;
23 Vr=complex(V*cosd(theta1),V*sind(theta1));
24 Vy=complex(V*cosd(theta2),V*sind(theta2));
25 Vb=complex(V*cosd(theta3),V*sind(theta3));
26
27 Ir=Vr/Zr;
28 Iy=Vy/Zy;
29 Ib=Vb/Zb;
30 In=Ir+Iy+Ib;
31 In_mag=sqrt(real(In)^2+imag(In)^2);
32 In_angle=atand(imag(In)/real(In));
33 printf("\n The current through the neutral wire,\n
      -In=\tMagnitude\tAngle(deg) \n\t %2.2f \t %2.2f
      \n",In_mag,In_angle)
34
35 Ir_mag=sqrt(real(Ir)^2+imag(Ir)^2);
36 Iy_mag=sqrt(real(Iy)^2+imag(Iy)^2);
37 Ib_mag=sqrt(real(Ib)^2+imag(Ib)^2);
38 Pr=(Ir_mag)^2*real(Zr);
39 Py=(Iy_mag)^2*real(Zy);
40 Pb=(Ib_mag)^2*real(Zb);
41 printf("\n Power taken by each load:\n\t Pr=%d W \n
      \t Py=%4.1f W \n\t Pb=%4.1f W \n", Pr, Py, Pb)
42
43
44
45 printf("\n\n (b)For phase sequence RBY:\n")
46 V=220;
47 theta1=0;
48 theta2=120;
49 theta3=-120;
50 Vr=complex(V*cosd(theta1),V*sind(theta1));
51 Vy=complex(V*cosd(theta2),V*sind(theta2));
52 Vb=complex(V*cosd(theta3),V*sind(theta3));
53
54 Ir=Vr/Zr;
55 Iy=Vy/Zy;

```

```

56 Ib=Vb/Zb;
57 In=Ir+Iy+Ib;
58 In_mag=sqrt(real(In)^2+imag(In)^2);
59 In_angle=atand(imag(In)/real(In));
60 printf("\n The current through the neutral wire,\n
        In=\tMagnitude\tAngle(deg) \n\t %2.2f \t %2.2f
        \n",In_mag,In_angle)
61
62 Ir_mag=sqrt(real(Ir)^2+imag(Ir)^2);
63 Iy_mag=sqrt(real(Iy)^2+imag(Iy)^2);
64 Ib_mag=sqrt(real(Ib)^2+imag(Ib)^2);
65 Pr=(Ir_mag)^2*real(Zr);
66 Py=(Iy_mag)^2*real(Zy);
67 Pb=(Ib_mag)^2*real(Zb);
68 printf("\n Power taken by each load:\n\t Pr=%d W \n
        \t Py=%4.1f W \n\t Pb=%4.1f W \n", Pr, Py, Pb)

```

---

### Scilab code Exa 12.10 Determination of phase voltage and current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_10.sce
7
8 clc;
9 clear;
10 Z_R=complex(8,6);
11 Z_Y=complex(8,-6);
12 Z_B=complex(5,0);
13 Z_N=complex(0.5,1);
14 Y_R=1/Z_R;

```

```

Load phase voltages: Magnitude Angle(deg)
  For R phase      223.12 -0.193
  For Y phase      219.11 240.80
  For B phase      217.80 119.39

Load phase current: Magnitude Angle(deg)
  For R phase      22.31 -37.062
  For Y phase      21.91 277.67
  For B phase      43.56 119.39
  For Neutral      2.87 103.03
-->

```

Figure 12.10: Determination of phase voltage and current

```

15 Y_Y=1/Z_Y;
16 Y_B=1/Z_B;
17 Y_N=1/Z_N;
18 E_R=220;
19 E_Y=220;
20 E_B=220;
21 theta1=0;
22 theta2=-120;
23 theta3=120;
24 V_R=complex(E_R*cosd(theta1),E_R*sind(theta1));
25 V_Y=complex(E_Y*cosd(theta2),E_Y*sind(theta2));
26 V_B=complex(E_B*cosd(theta3),E_B*sind(theta3));
27 V_NN_dash=((V_R*Y_R)+(V_Y*Y_Y)+(V_B*Y_B))/(Y_R+Y_Y+
    Y_B+Y_N);
28
29 V_R_dash=V_R-V_NN_dash;
30 V_Y_dash=V_Y-V_NN_dash;
31 V_B_dash=V_B-V_NN_dash;

```

```

32 V_R_dash_mag=sqrt(real(V_R_dash)^2+imag(V_R_dash)^2)
    ;
33 V_Y_dash_mag=sqrt(real(V_Y_dash)^2+imag(V_Y_dash)^2)
    ;
34 V_B_dash_mag=sqrt(real(V_B_dash)^2+imag(V_B_dash)^2)
    ;
35 V_R_dash_angle=atand(imag(V_R_dash)/real(V_R_dash));
36 V_Y_dash_angle=atand(imag(V_Y_dash)/real(V_Y_dash))
    +180;
37 V_B_dash_angle=atand(imag(V_B_dash)/real(V_B_dash))
    +180;
38 printf("\n Load phase voltages: Magnitude\tAngle(deg
    )")
39 printf("\n      For R phase\t%3.2f\t%0.3f",
    V_R_dash_mag,V_R_dash_angle)
40 printf("\n      For Y phase\t%3.2f\t%3.2f",
    V_Y_dash_mag,V_Y_dash_angle)
41 printf("\n      For B phase\t%3.2f\t%3.2f",
    V_B_dash_mag,V_B_dash_angle)
42 //For V_NN_dash value , the answer given in the book
    is wrong.So load phase voltage vary from the
    book answer.
43 //Also V_R_dash angle is not 0.168. It is negative
    angle that is -0.193
44 I_R=V_R_dash*Y_R;
45 I_Y=V_Y_dash*Y_Y;
46 I_B=V_B_dash*Y_B;
47 I_N=V_NN_dash*Y_N;
48 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
49 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
50 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
51 I_N_mag=sqrt(real(I_N)^2+imag(I_N)^2);
52 I_R_angle=atand(imag(I_R)/real(I_R));
53 I_Y_angle=atand(imag(I_Y)/real(I_Y))+360;
54 I_B_angle=atand(imag(I_B)/real(I_B))+180;
55 I_N_angle=atand(imag(I_N)/real(I_N))+180;
56 printf("\n\n Load phase current: Magnitude\tAngle(
    deg)")

```

```

Phase voltages: Magnitude  Angle(deg)
For R phase      534.08    2.251
For Y phase      259.07   -43.71
For B phase       290     49.72
Phase current: Magnitude  Angle(deg)
For R phase      26.70   -27.749
For Y phase       6.48   -103.71
For B phase       29     139.72
-->|

```

Figure 12.11: Calculation of each branch voltage and current

```

57 printf("\n      For R phase\t%3.2 f\t%0.3 f", I_R_mag ,
      I_R_angle)
58 printf("\n      For Y phase\t%3.2 f\t%3.2 f", I_Y_mag ,
      I_Y_angle)
59 printf("\n      For B phase\t%3.2 f\t%3.2 f", I_B_mag ,
      I_B_angle)
60 printf("\n      For Neutral\t%3.2 f\t%3.2 f", I_N_mag ,
      I_N_angle)

```

---

### Scilab code Exa 12.11 Calculation of each branch voltage and current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited

```

```

4 //Edition:Third ,2014
5
6 //Ex12_11.sce
7
8 clc;
9 clear;
10 V1=400;
11 V=V1/sqrt(3);
12 Z_R=complex(20*cosd(30),20*sind(30));
13 Z_Y=complex(40*cosd(60),40*sind(60));
14 Z_B=complex(10*cosd(-90),10*sind(-90));
15 Y_R=1/Z_R;
16 Y_Y=1/Z_Y;
17 Y_B=1/Z_B;
18 theta1=0;
19 theta2=-120;
20 theta3=120;
21 V_R=complex(V*cosd(theta1),V*sind(theta1));
22 V_Y=complex(V*cosd(theta2),V*sind(theta2));
23 V_B=complex(V*cosd(theta3),V*sind(theta3));
24 V_NN_dash=((V_R*Y_R)+(V_Y*Y_Y)+(V_B*Y_B))/(Y_R+Y_Y+
    Y_B);
25 V_R_dash=V_R-V_NN_dash;
26 V_Y_dash=V_Y-V_NN_dash;
27 V_B_dash=V_B-V_NN_dash;
28 V_R_dash_mag=sqrt(real(V_R_dash)^2+imag(V_R_dash)^2)
    ;
29 V_Y_dash_mag=sqrt(real(V_Y_dash)^2+imag(V_Y_dash)^2)
    ;
30 V_B_dash_mag=sqrt(real(V_B_dash)^2+imag(V_B_dash)^2)
    ;
31 V_R_dash_angle=atand(imag(V_R_dash)/real(V_R_dash));
32 V_Y_dash_angle=atand(imag(V_Y_dash)/real(V_Y_dash));
33 V_B_dash_angle=atand(imag(V_B_dash)/real(V_B_dash));
34 printf("\n\n      Phase voltages: Magnitude\tAngle(
    deg)")
35 printf("\n      For R phase\t%3.2f\t%0.3f",
    V_R_dash_mag,V_R_dash_angle)

```

```

36 printf("\n      For Y phase\t%3.2f\t%3.2f",
      V_Y_dash_mag,V_Y_dash_angle)
37 printf("\n      For B phase\t%3.0f\t%3.2f",
      V_B_dash_mag,V_B_dash_angle)
38
39 I_R=V_R_dash*Y_R;
40 I_Y=V_Y_dash*Y_Y;
41 I_B=V_B_dash*Y_B;
42 I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
43 I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
44 I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
45 I_R_angle=atand(imag(I_R)/real(I_R));
46 I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
47 I_B_angle=atand(imag(I_B)/real(I_B))+180;
48 printf("\n      Phase current: Magnitude\tAngle(deg)"
      )
49 printf("\n      For R phase\t%2.2f\t%0.3f",I_R_mag,
      I_R_angle)
50 printf("\n      For Y phase\t%1.2f\t%3.2f",I_Y_mag,
      I_Y_angle)
51 printf("\n      For B phase\t%2.0f\t%3.2f",I_B_mag,
      I_B_angle)
52
53 //Answer vary due to roundoff error

```

---

**Scilab code Exa 12.12** Calculation of line current or star phase current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_12.sce

```



```

Scilab 5.5.2 Console

Line current I_R,I_Y,I_B values are,

    23.632696 - 12.433445i

- 1.5353578 - 6.2920134i

- 22.097338 + 18.725458i

-->|

```

Figure 12.12: Calculation of line current or star phase current

```

7
8 //The input data taken from Example:12.11
9 clc;
10 clear;
11 V1=400;
12 V=V1/sqrt(3);
13 Z_R=complex(20*cosd(30),20*sind(30));
14 Z_Y=complex(40*cosd(60),40*sind(60));
15 Z_B=complex(10*cosd(-90),10*sind(-90));
16 Z_YR=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_B;
17 Z_BY=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_R;
18 Z_RB=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_Y;
19 theta1=30;
20 theta2=-90;
21 theta3=150;
22 V_YR=complex(V1*cosd(theta1),V1*sind(theta1));
23 V_BY=complex(V1*cosd(theta2),V1*sind(theta2));
24 V_RB=complex(V1*cosd(theta3),V1*sind(theta3));
25 I_YR=V_YR/Z_YR;

```

```
Line current I_R , I_Y , I_B values are,  
  
23.632696 - 12.433445i  
  
- 1.5353578 - 6.2920134i  
  
- 22.097338 + 18.725458i  
  
-->
```

Figure 12.13: Calculation of line current

```
26 I_BY=V_BY/Z_BY;  
27 I_RB=V_RB/Z_RB;  
28 I_R=I_YR-I_RB;  
29 I_Y=I_BY-I_YR;  
30 I_B=I_RB-I_BY;  
31 printf("\n Line current I_R,I_Y,I_B values are,\n")  
32 disp(I_R)  
33 disp(I_Y)  
34 disp(I_B)
```

---

Scilab code Exa 12.13 Calculation of line current

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex12_13.sce
7
8 //The input data taken from Example:12.11
9 clc;
10 clear;
11 V1=400;
12 V=V1/sqrt(3);
13 Z_R=complex(20*cosd(30),20*sind(30));
14 Z_Y=complex(40*cosd(60),40*sind(60));
15 Z_B=complex(10*cosd(-90),10*sind(-90));
16 theta1=30;
17 theta2=-90;
18 theta3=150;
19 V_YR=complex(V1*cosd(theta1),V1*sind(theta1));
20 V_BY=complex(V1*cosd(theta2),V1*sind(theta2));
21 V_RB=complex(V1*cosd(theta3),V1*sind(theta3));
22
23 I_R=((V_YR*Z_B)-(V_RB*Z_Y))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
24 I_Y=((V_BY*Z_R)-(V_YR*Z_B))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
25 I_B=((V_RB*Z_Y)-(V_BY*Z_R))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
26 printf("\\n Line current I_R , I_Y , I_B values are,\\
    n")
27 disp(I_R)
28 disp(I_Y)
29 disp(I_B)

```

---

# Chapter 13

## Dynamic Response of Network

Scilab code Exa 13.1 Calculation of resistance

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex13_1.sce.
7
8 clc;
9 clear;
10 Vc=60;
11 V_not=120;
12 t=20;
13 C=10e-6;
14 R=-t/(C*log(Vc/V_not));
15 printf("\n The value of resistance=%1.3f mega_ohm",
        R*1e-6)
```

---

```
Scilab 5.5.2 Console

The value of resistance=2.885 mega_ohm
-->
```

Figure 13.1: Calculation of resistance

```
Scilab 5.5.2 Console

The current drawn from the source=271 mA

Time for draw the current of 300 mA from the source=3.244 ms

-->
```

Figure 13.2: Determination of current and time

**Scilab code Exa 13.2** Determination of current and time

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex13_2.sce
7
8 clc;
9 clear;
10 R1=60;
11 R2=80;
12 C=100e-6;
13 V=12;
14 t1=6e-3;
15 i_S=300e-3;
16 i_R=V/R1;
17 i_C=(V/R2)*exp(-t1/(R2*C));
18 i=i_R+i_C;
19 printf("\\n The current drawn from the source=%3.0f
    mA \\n",i*1e3)
20 I_C=i_S-i_R;
21 t2=(R2*C)*log(V/(R2*I_C));
22 printf("\\n Time for draw the current of 300 mA from
    the source=%1.3f ms \\n",t2*1e3)
```

---

**Scilab code Exa 13.5** Determination of time constant and damping ratio and current

```
1 //Book Name:Fundamentals of Electrical Engineering
```

Scilab 5.5.2 Console

```
Time constant=5 sec  
Damping ratio=0.2  
The value of current of after 8 seconds of switching=39.9 A  
-->
```

Figure 13.3: Determination of time constant and damping ratio and current

```
2 //Author:Rajendra Prasad  
3 //Publisher: PHI Learning Private Limited  
4 //Edition:Third ,2014  
5  
6 //Ex13_5.sce  
7  
8 clc;  
9 clear;  
10 V=100;  
11 R=2;  
12 L=10;  
13 t=8;  
14 T=L/R;  
15 printf("\n Time constant=%d sec \n",T)  
16 del=R/L;  
17 printf("\n Damping ratio=%1.1f \n",del)  
18 I=(V/R)*(1-exp(-t/T));  
19 printf("\n The value of current of after 8 seconds  
of switching=%2.1f A \n",I)
```

---

Scilab 5.5.2 Console

Steady state current=3.333 A

The value of current after 50 ms=0.45 A

-->|

Figure 13.4: Determination of current values

**Scilab code Exa 13.6** Determination of current values

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex13_6.sce
7
8 clc;
9 clear;
10 R=20;
```



```
Scilab 5.5.2 Console
Ratio of maximum value of current to steady state value of current=1.49
-->
```

Figure 13.5: Calculation of current ratio

```
11 L=0.5;
12 V=100;
13 R_S=10;
14 t1=0;
15 t2=50e-3;
16 Req=R+R_S;
17 T1=L/Req; //Time constant1
18 T2=L/R; //Time constant2
19 I=V/Req;
20 printf("\n Steady state current=%1.3 f A \n", I)
21 i=I*exp(-t2/T2);
22 printf("\n The value of current after 50 ms=%0.2 f A
    \n", i)
```

---

Scilab code Exa 13.7 Calculation of current ratio

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex13_7.sce
7
8 clc;
9 clear;
10 R=10;
11 L=0.1;
12 t1=0.01;
13 omega=100*%pi;
14 phi=omega*t1;
15 t=(asin(1)+atan((omega*L)/R))/omega;
16 Imax=((-omega*L*exp(-R*t/L))/(R^2+(omega*L)^2))-(sin
    ((100*%pi*t)-(atan(omega*L/R)))/sqrt(R^2+(omega*L
    )^2));
17 t=0;
18 Iss=((-omega*L*exp(-R*t/L))/(R^2+(omega*L)^2))-(sind
    ((100*%pi*t)-(atan(omega*L/R)))/sqrt(R^2+(omega*L
    )^2));
19 a=Imax/Iss;
20 printf("\\n Ratio of maximum value of current to
    steady state value of current=%1.2f \\n",a)
21 //Answer vary dueto round off error in 't'
    calculation
```

---

Scilab 5.5.2 Console

Current drawn from the load after 6 ms=271 mA

The time when current drawn from the source is 0.3 A=3.244 ms

-->

Figure 13.6: Determination of current

#### Scilab code Exa 13.14 Determination of current

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex13_14.sce
7
8 clc;
9 clear;
10 //From Ex_13.2
11 Id=300e-3;
12 t=6e-3;
13 V=12;
14 R=60;
15 Ir=V/R;
```

```
16 Ic1=0.15*exp(-125*t); // it Obtain, after the
    simplification of loop equation
17 I=Ir+Ic1;
18 printf("\n Current drawn from the load after 6 ms=%3
    .0 f mA \n",I*1e3)
19 Ic2=Id-Ir;
20 t=log(Ic2/0.15)/-125;
21 printf("\n The time when current drawn from the
    source is 0.3 A=%1.3 f ms \n",t*1e3)
```

---

# Chapter 14

## Electrical Power System

Scilab code Exa 14.1 Calculation of average load and energy consumption and load f

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex14_1.sce.
7
8 clc;
9 clear;
10 maximum_demand=1.5e3;
11 total_lamps=10;
12 lamps_on=7;
13 lamp_ontime=5;
14 lamp_power=100;
15 heater_on=2;
16 heater_ontime=3;
17 heater_power=1e3;
18 printf("\n (a)")
19 actual_energy_consumed=(lamps_on*lamp_power*
```

```
(a)
Average load=395.83 W

(b)
Monthly energy consumption=285 kW

(c)
Load factor=0.264

-->
```

Figure 14.1: Calculation of average load and energy consumption and load factor

```
        lamp_ontime)+(heater_on*heater_power*
        heater_ontime);
20 time_duration=24;
21 average_load=(actual_energy_consumed)/(time_duration
    );
22 printf("\n Average load=%3.2 f W \n",average_load)
23
24 printf("\n (b)")
25 monthly_energy_consump=actual_energy_consumed*30*1e
    -3;
26 printf("\n Monthly energy consumption=%3.0 f kW \n",
    monthly_energy_consump)
27
28 printf("\n (c)")
29 load_factor=average_load/maximum_demand;
30 printf("\n Load factor=%1.3 f \n",load_factor)
```

---

```
(a)
Diversity factor=1.5079

(b)
Load factor of consumer1 =0.20

Load factor of consumer2 =0.15

Load factor of consumer3 =0.25

Load factor of consumer4 =0.25

(c)
Combined average load =4.3 kW

Combined load factor =0.341

-->
```

Figure 14.2: Determination of diversity factor and load factor and combined average load

**Scilab code Exa 14.2** Determination of diversity factor and load factor and combined

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex14_2.sce.
7
8 clc;
```

```

9 clear;
10 //Loads are in kilowatt
11 avg_load1=1;
12 avg_load2=0.3;
13 avg_load3=0.5;
14 avg_load4=2.5;
15 max_load1=5;
16 max_load2=2;
17 max_load3=2;
18 max_load4=10;
19 max_demand1=5;
20 max_demand2=1.6;
21 max_demand3=1;
22 max_demand4=5;
23
24 printf("\n (a)")
25 sumof_individualmax_dem=max_load1+max_load2+
    max_load3+max_load4;
26 max_demandof_wholegroup=max_demand1+max_demand2+
    max_demand3+max_demand4;
27 diversity_factor=sumof_individualmax_dem/
    max_demandof_wholegroup;
28 printf("\n Diversity factor=%1.4f \n",
    diversity_factor)
29
30
31 printf("\n (b)")
32 LF_of_consumer1=avg_load1/max_load1;
33 printf("\n Load factor of consumer1 =%1.2f \n",
    LF_of_consumer1)
34 LF_of_consumer2=avg_load2/max_load2;
35 printf("\n Load factor of consumer2 =%1.2f \n",
    LF_of_consumer2)
36 LF_of_consumer3=avg_load3/max_load3;
37 printf("\n Load factor of consumer3 =%1.2f \n",
    LF_of_consumer3)
38 LF_of_consumer4=avg_load4/max_load4;
39 printf("\n Load factor of consumer4 =%1.2f \n",

```



```
Annual bill of the consumer=369562.5 rupees
```

```
-->
```

```
-->
```

Figure 14.3: Calculation of annual bill of the consumer

```
LF_of_consumer4)
40
41 printf("\n (c)")
42 combined_avg_load=(avg_load1+avg_load2+avg_load3+
  avg_load4);
43 printf("\n Combined average load =%1.1f kW \n",
  combined_avg_load)
44 combined_load_factor=combined_avg_load/
  max_demandof_wholegroup;
45 printf("\n Combined load factor =%1.3f \n",
  combined_load_factor)
```

---

Scilab code Exa 14.3 Calculation of annual bill of the consumer

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex14_3.sce.
7
8 clc;
9 clear;
10 average_demand=33.75; //in
    kilowatt
11 time_duration=24*365; // in hours
12 tariff=1.25; //in rupees
    per kilowatthour
13 annualenergy_consumption=average_demand*
    time_duration;
14 C=annualenergy_consumption*tariff;
15 printf("\n Annual bill of the consumer=%6.1f rupees
    \n",C)

```

---

#### Scilab code Exa 14.4 Calculation of overall cost per kWh

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex14_4.sce.
7
8 clc;
9 clear;
10 max_demand=75; //in kilowatt
11 time_duration=24*365; //in hour

```

```
Overall cost per kWh= 1.46 rupees
```

```
-->
```

Figure 14.4: Calculation of overall cost per kWh

```
12 load_factor=0.45;
13 tariff1=650;
14 tariff2=1.30;
15 annual_energy_consump=max_demand*time_duration*
    load_factor;
16 Ce=tariff2*annual_energy_consump;
17 Cf=tariff1*max_demand;
18 total_annualcharge=Ce+Cf;
19 overall_costperkwhr=total_annualcharge/
    annual_energy_consump;
20 printf("\n Overall cost per kWh= %1.2f rupees \n",
    overall_costperkwhr)
```

---

Scilab code Exa 14.5 Calculation of monthly bill of the consumer

Scilab 5.5.2 Console

```
Monthly Charge=5400 rupees.  
-->
```

Figure 14.5: Calculation of monthly bill of the consumer

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex14_5.sce
7
8 clc;
9 clear;
10 tariff1=3.50; //tariff in rupees per
    kilowatthour for first 500kilowatthour
11 tariff2=3.00; //tariff in rupees per
    kilowatthour for next 500kilowatthour
12 tariff3=2.50; //tariff in rupees per
    kilowatthour for usage exceeding 1000kilowatthour
13 days_in_a_month=31;
14 time_duration=24*days_in_a_month;
15 average_demand=2.5; //
    in kilowatt
16 monthly_consumption=time_duration*average_demand;
17 a1=500; //kWh for tariff1
18 a2=500; //kWh for tariff2
19 a3=monthly_consumption-a1-a2; //kWh for
    tariff3
20 monthly_charge=(a1*tariff1)+(a2*tariff2)+(a3*tariff3
    );
21 printf("\n Monthly Charge=%d rupees.",monthly_charge
    )

```

---

**Scilab code Exa 14.6** Calculation of annual bill of the consumer

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad

```

```
Annual bill of the consumer in rupees
```

```
2182846.2
```

```
-->|
```

Figure 14.6: Calculation of annual bill of the consumer

```
3 //Publisher: PHI Learning Private Limited
4 //Edition: Third ,2014
5
6 //Ex14_6.sce.
7
8 clc;
9 clear;
10 average_demand=450;
11 load_factor=0.65;
12 power_factor=0.8;
13 tariff1=75;           //in rupees per month per kVA
14 tariff2=1.30;        //in rupees per kilowatthour
15 working_time=8*300;
16 maximum_kw_demand=average_demand/load_factor;
17 maximum_kVA_demand=maximum_kw_demand/power_factor;
18 annual_energy_charge=tariff2*average_demand*
    working_time;
19 annual_max_demand_charge=tariff1*12*
```

```
    maximum_kVA_demand;  
20 annual_charge=annual_energy_charge+  
    annual_max_demand_charge;  
21 disp(annual_charge,'Annual bill of the consumer in  
    rupees ')  
22 //The answer vary dueto roundoff error.
```

---

# Chapter 15

## Domestic Lighting

Scilab code Exa 15.1 Calculation of lamp efficiency and luminous intensity and MSC

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex15_1.sce
7
8 clc;
9 clear;
10 W=100;
11 V=250;
12 light_flux=3000;
13 printf("\n(a)")
14 mew=light_flux/W;
15 printf("\n Lamp efficiency=%d Lumens/watt \n",mew)
16
17 printf("\n(b)")
18 total_solid_angle=(4*pi);
19 I=light_flux/total_solid_angle;
```



```

Scilab 5.5.2 Console

(a)
Lamp efficiency=30 Lumens/watt

(b)
Luminous intensity=238.73 cd

(c)
Mean Spherical Candle Power per watt=2.3873 cd/watt

-->|

```

Figure 15.1: Calculation of lamp efficiency and luminous intensity and MSCP

```

20 printf("\n Luminous intensity=%3.2 f cd \n",I)
21
22 printf("\n(c)")
23 M.S.C.P=I/W;
24 printf("\n Mean Spherical Candle Power per watt=%1.4
    f cd/watt \n",M.S.C.P)

```

---

**Scilab code Exa 15.2** Calculation of average luminance of the sphere

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex15_2.sce

```

```
Average luminance of the sphere=7957.7 lumens/m^2
-->|
```

Figure 15.2: Calculation of average luminance of the sphere

```
7
8 clc;
9 clear;
10 d=40e-2;
11 light_flux=5000;
12 absorption_factor=0.2;
13 transmission_factor=0.8;
14 F=light_flux*transmission_factor;
15 A=%pi*d^2;
16 L=F/A;
17 printf("\\n Average luminance of the sphere=%4.1f
    lumens/m^2 \\n",L)
18 //Answer vary due to roundoff error in surface area
    (A) calculation
```

---

```
Scilab 5.5.2 Console

Illumination=52.94 lux

-->
```

Figure 15.3: Determination of illumination

**Scilab code Exa 15.3** Determination of illumination

```
1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex15_3.sce
7
8 clc;
9 clear;
10 M.S.C.P=1000;
11 h=2.8;
12 x=2.5;
```

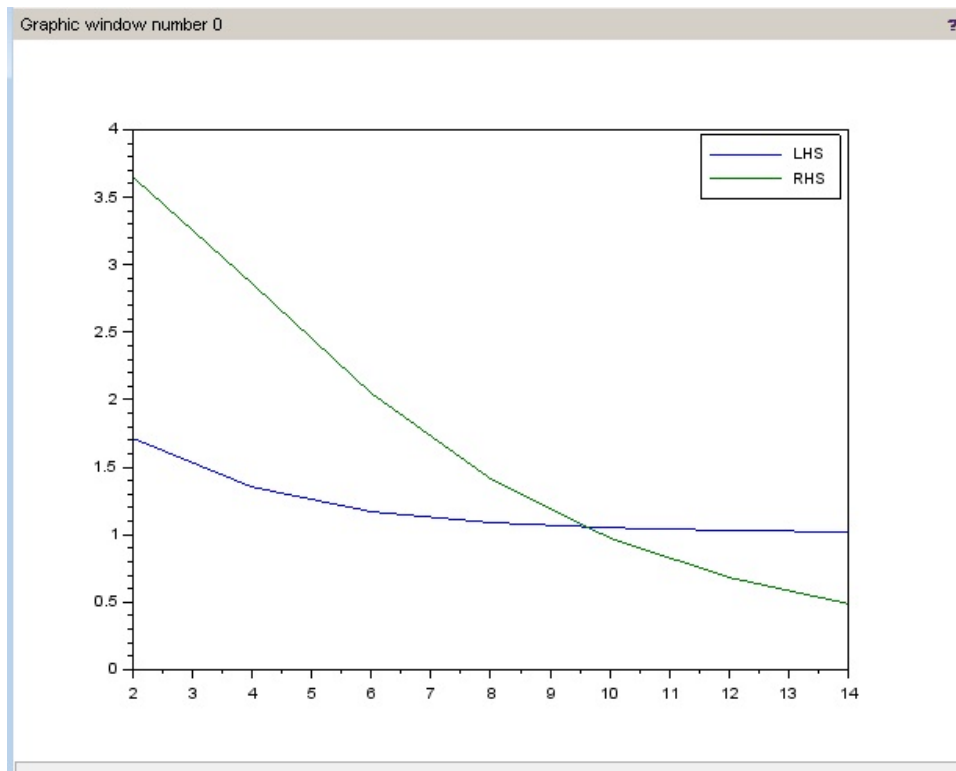


Figure 15.4: Calculation of distance between two lamps

```

13 E=(M.S.C.P*h)/(h^2+x^2)^(3/2);
14 printf("\n Illumination=%2.2f lux \n",E)

```

---

**Scilab code Exa 15.4** Calculation of distance between two lamps

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5

```

```

6 //Ex15_4.sce.
7
8 clc;
9 clear;
10 //There is a mistake in the question , given height
    is 5 instead of 4
11 h=4;
12 x=[2:2:14];
13 for i=1:length(x)
14
15 Ed(i)=(64/(4^2+x(i)^2)^(3/2))+1;
16 Eb(i)=(256/(4^2+(x(i)/2)^2)^(3/2));
17
18 end
19 xlabel("x-axis")
20 ylabel("y-axis")
21 title("Curves of L.H.S and R.H.S for different
    values of x")
22 plot(x,[Ed Eb])
23
24 legend('LHS','RHS')

```

---

#### Scilab code Exa 15.5 Determination of size of the conductor

```

1 //Book Name:Fundamentals of Electrical Engineering
2 //Author:Rajendra Prasad
3 //Publisher: PHI Learning Private Limited
4 //Edition:Third ,2014
5
6 //Ex15_5.sce
7
8 clc;
9 clear;

```

Scilab 5.5.2 Console

```
Voltage drop=4.845 V  
Size of the conductor=16 mm^2  
-->
```

Figure 15.5: Determination of size of the conductor

```
10 I=25;  
11 V=230;  
12 l=45;  
13 d=(0.02*V)+1; //Permissible voltage drop  
14 //Referring table 15.10,  
15 d1=(1/3.4)*(I/27); //voltage for selected values  
    from the table  
16 if (d<d1) then  
17     I_refer=43;  
18     l_refer=5.4;  
19     A=16;  
20     d2=(1/l_refer)*(I/I_refer);  
21 else  
22     d1=d2  
23 end  
24  
25 printf("\n Voltage drop=%1.3 f V \n", d2)
```

```
26 printf("\n Size of the conductor=%d mm^2 \n",A)
```

---