Scilab Textbook Companion for Utilization of Electrical Energy and Traction by J. B. Gupta, R. Manglik and R. Manglik[1]

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Book Description

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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

Chapter 1

Electric heating

Scilab code Exa 1.1 `power drawm`

```
//Example 1.1 power drawn
clc;
clear;
close;
format('v',6)
r1=100;//in ohms
r2=r1;// in ohms
V=250;// ac supply in volts
rp=((1)/((1/r1)+(1/r2)));// equivalent resistance in ohms
pp=((V^2)/rp);//power drawn in watts
disp("part (a) ")
disp(pp,"power drawn when elements are in parallel,(W)=")
rs=r1+r2;// equivalent resistance in ohms
ps=((V^2)/rs);//power drawn in watts
disp("part (b) ")
disp(ps,"power drawn when elements are in series ,(W)=")
```

Scilab code Exa 1.2 diameter and length of wire

```
//Example 1.2 // diameter and length
clc;
clear;
close;
format('v',6)
P=2.5;//power in kW
V=240;// in volts
K=1;//radiating efficiency
e=0.9;//emissivity
p=42.5*10^-6;// resistivity in ohm−cm
T1=1500;//in dgree celsius
T2=450;//in degree celsius
x=((%pi*V^2)/(4*(p*10^-2)*P*10^3));//
H=((5.72*K*e)*(((T1+273)/100)^4-((T2+273)/100)^4));
    //
z=((P*10^3)/(%pi*H))^2;//
l=(z*x)^(1/3);//length in meter
d=((sqrt(z))/l)*10^3;//diameter in mm
disp(l,"length in meter")
disp(d,"diameter in mm")
```

Scilab code Exa 1.3 design the heating element

```
//Example 1.3 // design heating element
clc;
clear;
close;
format('v',7)
V=440;// volts
P=20;//in kW
```

```
T1=1200;//in degree celsius
T2=700;// in degree celsius
K=0.6;//radiating efficiency
e=0.9;//emissivity
t=0.025;//thickness in mm
p=1.05*10^-6;//resisitivity in ohm - meter
Pp=(round(P*10^3))/3;//power per phase in watts
Pv= (V/sqrt(3));//phase voltage
R=Pv^2/Pp;//resistance of strip in ohms
x=((R*t*10^-3)/(p));//
H=((5.72*K*e)*(((T1+273)/100)^4-((T2+273)/100)^4));
    //in W/m^2
y=((Pp)/(H*2));//in m^2
w=sqrt(y/x)*10^3;//width in mm
l=x*w*10^-3;//length of strip in meter
disp(w,"width in mm")
disp(l,"length of strip in meter")
```

Scilab code Exa 1.4 `efficiency`

```
//Example 1.4 // loading in kW and efficiency of the
    tank
clc;
clear;
close;
format('v',5)
a=6;//area in m^2
l=a/6;//one side of tank in meter
V=l*l*l;//volume in m^2
e=90/100;//capacity
wh=6*e*1000;//water to be heated daily in kg
s=4200;//specific heat of water in J/Kg/degree
    celsius
t1=65;//in degree celsius
t2=20;//in degree celsius
```

```
hr=wh*s*(t1-t2)*10^-6;//heat required to raise the temperture of water
hr1=hr/3.6;//heat required in kWh
d=6.3;//difference in watts
l=((d*a*(t1-t2)*24)/1000);//losses from the surface of the tank in kWh
es=hr1+l;//energy supplied in kWh
lk=es/24;//loading in kW
ef=(hr1/es)*100;//efficiency of the tank in percentage
disp(lk,"loading in kW")
disp(ef,"efficiency of the tank in percentage")
```

Scilab code Exa 1.5 average kW and kVA and pf

```
//Example 1.5 // average kW ,KVA input ,arc voltage ,arc resistance and pf of the current drawn
clc;
clear;
close;
format('v',7)
sh=444;// specific heat of steel in J/Kg/ C
lh=37.25;//latent heat in kJ/kg
mp=1370;//melting point of steel  C
t1=19.1;//initial temperture in  C
e=0.5;//overall efficiency
ip=5700;//input current in amperes
rs=0.008;//resistance of transformer referred to secondary in ohms
rr=0.014;// recatance in ohms
m=4.3;// steel in tonnes
ers=((m*10^3*((sh*(mp-t1))+lh*10^3)));// energy required in joules
ersh=ers/(3.6*10^6);//energy required in kWh
ata=1;//time taken to melt steel in hours
```

```
ao=ersh/ata;//average output in kW
ai=ao/e;//average input in kW
vdr=ip*rs;//voltage drop due to resistance of
    furnace leads
vdr1=ip*rr;//voltage drop due to reactance of
    furnace leads
va=((ai*10^3)/(3*ip))-(vdr);//voltage resistive in
    nature
rac=va/ip;//arc resistance in
oppv=sqrt((va+vdr)^2+vdr1^2);//open circuit phase
    voltage in volts
kvas=3*ip*oppv*10^-3;//total kVA drawn
pf=((va+vdr)/oppv);//power factor
disp(ai,"average input in kW")
disp(va,"arc voltage in volts")
disp(rac,"arc resistance in  ")
disp(pf,"pf of the current drawn from the supply (
    lagging)")
disp(kvas,"total kVA drawn in kVA")
```

Scilab code Exa 1.6 average kW and kVA and pf

```
//Example 1.6 // average kW ,KVA input ,arc voltage
    ,arc resistance and pf of the current drawn
clc;
clear;
close;
format('v',7)
sh=0.12;// specific heat of steel in kcal/Kg/ C
lh=8.89;//latent heat in kcal/kg
mp=1370;//melting point of steel  C
t1=19.1;//initial temperture in  C
e=0.5;//overall efficiency
ip=5700;//input current in amperes
rs=0.008;//resistance of transformer referred to
```

```
secondary in ohms
rr=0.014;// recatance in ohms
m=4.3;// steel in tonnes
ers=((m*10^3*((sh*(mp-t1))+lh)));// energy required in joules
ersh=ers/(860);//energy required in kWh
ata=1;//time taken to melt steel in hours
ao=ersh/ata;//average output in kW
ai=ao/e;//average input in kW
vdr=ip*rs;//voltage drop due to resistance of furnace leads
vdr1=ip*rr;//voltage drop due to reactance of furnace leads
va=((ai*10^3)/(3*ip))-(vdr);//voltage resistive in nature
rac=va/ip;//arc resistance in
oppv=sqrt((va+vdr)^2+vdr1^2);//open circuit phase voltage in volts
kvas=3*ip*oppv*10^-3;//total kVA drawn
pf=((va+vdr)/oppv);//power factor
disp(ai,"average input in kW")
disp(va,"arc voltage in volts")
disp(rac,"arc resistance in  ")
disp(pf,"pf of the current drawn from the supply (lagging)")
disp(kvas,"total kVA drawn in kVA")
```

Scilab code Exa 1.7 rating

```
//Example 1.7 // rating of furnance
clc;
clear;
close;
format('v',6)
sh=0.1;// specific heat of steel in kcal/Kg/ C
```

```
lh=26.67;//latent heat in kcal/kg
mp=555;//melting point of steel  C
t1=35;//initial temperture in  C
e=0.8;//overall efficiency
ip=5700;//input current in amperes
rs=0.008;//resistance of transformer referred to secondary in ohms
rr=0.014;// recatance in ohms
m=2;// steel in tonnes
ers=((m*10^3*((sh*(mp-t1))+lh)));// energy required in joules
ersh=ers/(860);//energy required in kWh
ata=1;//time taken to melt steel in hours
ao=ersh/ata;//average output in kW
ai=ao/e;//average input in kW
vdr=ip*rs;//voltage drop due to resistance of furnace leads
vdr1=ip*rr;//voltage drop due to reactance of furnace leads
va=((ai*10^3)/(3*ip))-(vdr);//voltage resistive in nature
rac=va/ip;//arc resistance in
oppv=sqrt((va+vdr)^2+vdr1^2);//open circuit phase voltage in volts
kvas=3*ip*oppv*10^-3;//total kVA drawn
pf=((va+vdr)/oppv);//power factor
rf=ai/ata;// in kW
disp(rf,"rating of furnance  in kW")
```

Scilab code Exa 1.8 efficiency

```
//Example 1.8 // efficiency of furnance
clc;
clear;
close;
```

```
format('v',3)
sh=880;// specific heat of steel in J/Kg/ C
lh=32000;//latent heat in J/kg
mp=660;//melting point of steel  C
t1=15;//initial temperture in  C
ip=5700;//input current in amperes
rs=0.008;//resistance of transformer referred to secondary in ohms
rr=0.014;// recatance in ohms
m=1.8;// IN KG
ers=((m*((sh*(mp-t1))+lh)));// energy required in joules
ersh=ers/(3.6*10^6);//energy required in kWh
TM=10;//TIME TO MELT IN MINS
ip=5;//input of the furnance in kW
ei=(ip)*(TM/60);//energy input in kWh
n=(ersh/ei)*100;//efficiency of furnance in percentage
disp(n,"efficiency of furnance in percentage")
```

Scilab code Exa 1.9 power absorbed and power factor

```
//Example 1.9 // power absorbed and power factor
clc;
clear;
close;
format('v',8)
vs=10;//secondary voltage in volts
p=500;//power drawn in kW
pf=0.5;//
is=(p*10^3)/pf;//secondary current in amperes
zs=vs/is;//impedence of secondary circuit in ohms
rs=zs*pf;//resistance of secondary circuit in ohms
res=zs*(sqrt(1-pf^2));//rectancetance of secondary circuit in ohms
```

```
rs1=2*rs;// resistacne when hearth is full in
res1=res;// reactance when hearth is full in
zs1=(sqrt(rs1^2+res1^2));//impedance of secondary
   circuit in
pf1=rs1/zs1;//power factor
is1=vs/zs1;//secondary current in amperes
pd=is1^2*rs1*10^-4;//power drawn in kW
disp(pf1,"power factor is")
disp(pd,"power drawn in kW")
```

Scilab code Exa 1.10 height

```
//Example 1.10 // height
clc;
clear;
close;
format('v',8)
vs=10;//secondary voltage in volts
p=400;//power drawn in kW
pf=0.6;//
is=(p*10^3)/pf;//secondary current in amperes
zs=vs/is;//impedence of secondary circuit in ohms
rs=zs*pf;//resistance of secondary circuit in ohms
res=zs*(sqrt(1-pf^2));//rectancetance of secondary
   circuit in ohms
x=(rs)/res;//height
disp(x,"maximum heat will be obtained with the
   height of charge as 3/4 of height of hearth")
```

Scilab code Exa 1.11 frequency

```
//Example 1.11 // frequency
clc;
```

```
clear;
close;
format('v',5)
p=5*10^-7;//specific resistance in  −m
rp=1;//relative permeability
dp=0.0015;//depth of penetration in mter
f=((p*10^7)/((rp*(dp)^2)*4*(%pi)^2))*10^-3;// frequency in kHz
disp(f,"frequency in kHz")
```

Scilab code Exa 1.12 `power required`

```
//Example 1.12 // power required
clc;
clear;
close;
format('v',10)
l=0.5;//length in meter
b=0.25;//breadh in meter
h=0.02;//in meter
t1=25;// temperture  C
t2=125;// temperture  C
t=10;//time in minutes
f=30;//frequency in 30 MHz
w=600;//weight of the wood in kg/m^3
sh=1500;//specific heat in J/Kg/ C
e=50;//efficiency
vp=l*b*h;//volume in m^3
wp=vp*w;//weight of plywood in kg
hr=sh*wp*(t2-t1);//heat required in joules
hrt=(hr/(3600));//heat required to raise the temperture of plywood in Wh
pu=hrt/(1/6);//power utilized in watts
pi=(pu/e)*100;//power input required in percentage
disp(pi,"power input required ,(W)=")
```

Scilab code Exa 1.13 voltage and current

```
//Example 1.13 //voltage ,current and frequency
clc;
clear;
close;
format('v',5)
vl=600;//in volts
p=200;//power absorbed in watts
pf=0.05;//power factor
f=30*10^6;//frequency in Hz
ep=8.854*10^-12;//constant
er=5;//
a=150;// in cm^2
t=0.02;// in meter
c=((ep*er*a*10^-4)/t);//capacitance in farads
vr=(sqrt(p/(2*%pi*f*c*pf)));//voltage is required in
    volts
i=p/(vr*pf);//current in amperes
f2=((f*(vr/vl)^2))*10^-6;//frequency in Mhz
disp(ceil(vr),"voltage in volts")
disp(round(i),"current in amperes")
disp(f2,"frequency in MHz")
```

Scilab code Exa 1.14 voltage and current

```
//Example 1.14//voltage across electrodes and
   current
clc;
clear;
close;
```

```
format('v',6)
pf=0.04;//power factor
p=1000;//in watts
f=10*10^6;// in MHz
a1=.004;//area in m^2
a2=0.001;//area in m^2
t=0.02;//thickness in meter
t1=.01;//thicknes sin meter
t2=t-t1;//thickness in meter
ep=8.854*10^-12;//constant in F/m
er=5;//relative permittivity of plywood
er1=1;//relative permittivity in air
c=(ep*(((a1*er1)/t)+(a2/((t1/er)+(t2/er1)))));//
    capacitance in farads
vr=(sqrt(p/(2*%pi*f*c*pf)));//voltage is required in
     volts
disp("part (a)")
disp(round(vr),"voltage across the electrodes in
    volts")
i=p/(vr*pf);//current in amperes
disp("part (b)")
disp(i,"cureent in amperes is")
```

Chapter 3

Electrolytic processes

Scilab code Exa 3.1 ampere hours

```
//Example 3.1 // ampere hour required
clc;
clear;
close;
//given data :
r=5;//in cm
S=4*%pi*r^2;
t=0.005;//in mm
d=10.5;
m=S*t*d*10^-3;
Z=(0.001118*3600)/1000;
Amr=m/Z;
disp(Amr,"ampere hour required,(Ampere-hour)= ")
```

Scilab code Exa 3.2 amount of copper

```
//Example 3.2 // mass of copper deposited
clc;
```

```
clear;
close;
//given data :
m=20;//in gm
I=120;//in A
t=10*60;//in sec
t1=5*60;//in sec
I1=100;//in A
Cec=63.18/2;
Cen=58.6/2;
Z=m/(I*t);
Z1=(Z*(Cec/Cen))*10^-3;
m1=Z1*I1*t1;
disp("mass of copper depsoited is "+string(m1)+"kg
   or "+string(round(m1*10^3))+"gm")
```

Scilab code Exa 3.3 weight of copper

```
//Example 3.3 // mass of copper deposited
clc;
clear;
close;
//given data :
Z=1.044*10^-8;//in kg/C
I=40;//in A
t=1*60*60;//in seconds
m1=Z*I*t;
disp("mass of copper depsoited is "+string(m1)+"kg
   or "+string((m1*10^3))+"gm")
```

Scilab code Exa 3.4 thickness

```
//Example 3.4 // thickness of copper deposited
```

```
clc;
clear;
close;
//given data :
A=0.00025;//in m^2
D=8900;//in kg/m^3
Z=32.95*10^-8;//in kg/C
I=1;//in A
t=100*60;//in seconds
m=Z*I*t;//in kg
v=m/D;
T=(v/A)*10^3;
disp(T,"thickness of copper deposited,T(mm) = ")
```

Scilab code Exa 3.5 thickness

```
//Example 3.5 // thickness of copper deposited
clc;
clear;
close;
//given data :
A=0.00025;//in m^2
D=8900;//in kg/m^3
Z=32.95*10^-8;//in kg/C
I=1.5;//in A
t=60*60;//in seconds
m=Z*I*t;//in kg
v=m/D;
T=(v/A);
disp("Thickness of copper deposited is "+string(T)+"
   m or "+string(T*10^3)+"mm")
```

Scilab code Exa 3.6 current

```
//Example 3.6 // current
clc;
clear;
close;
//given data :
m=50;// in gm
t=2*60*60;// in sec
ECE_silver=111.8*10^-8;// in kg C^-1
atomic_weight1=108;// for silver
atomic_weight2=63.5;//for copper
valency=1;//for silver
Ces=atomic_weight1/valency;// chemical equivalent of
    silver
Cec=atomic_weight2/2;// chemical equivalent of
   copper
Z=ECE_silver*(Cec/Ces);
I=(m*10^-3)/(Z*t);
disp(I,"current,I(A) = ")
```

Scilab code Exa 3.7 energy consumption

```
//Example 3.7 // energy consumption
clc;
clear;
close;
//given data :
a=500;// electrolytic cells
I=6000;//in A
t=40;//in hour/week
Z=32.81*10^-8*3600;//in kg/A-h
V=0.25;// in volts
Ah=a*I*(t*52);// total number of ampere hour per
   annum
Ao=Z*Ah*10^-3;// annual output in tonnes
Ea=Ah*V*10^-3;// energy consumed per annum in kWh
```

```
Et=Ea/Ao;
disp(Et,"energy consumption,Et(kWh/tonne) = ")
```

Scilab code Exa 3.8 voltage

```
//Example 3.8 // voltage
clc;
clear;
close;
//given data :
Z=1.0384*10^-8;//in kg/C
VbyZ=14.212*10^7;// in joules
V=VbyZ*Z;
disp(V,"voltage,V(volts) = ")
```

Scilab code Exa 3.9 WEIGHT OF ALUMINIUM

```
//Example 3.9 // mass of aluminium
clc;
clear;
close;
//given data :
ECE_silver=111*10^-8;//in kg/C
Cew_silver=107.98;//chemical equivalent of silver
Cew_al=27/3;//chemical equivalent of aluminium
Z=(ECE_silver*Cew_al)/Cew_silver;
C_efficiency=0.92;
I=3000;//in A
t=24*60*60;//in seconds
m=Z*I*t*C_efficiency;
disp(m,"mass of aluminium,,m(kg) = ")
```

Scilab code Exa 3.10 quantity of electricity and ime taken

```
//Example 3.10 // quantity of electricity and time
   taken
clc;
clear;
close;
//given data :
d=0.1;//in m
l=.25;// in m
Tc=2;// thickness of coating in mm
D=8.9;//density of metal in gm/CC
C_density=160;//in A/sq
I_efficiency=0.9;
S=%pi*d*l;
m=S*Tc*10^-3*D*10^3;
Z=30.43*10^-8;// in kg/C
Q=(m/Z)/3600;// in A-h
Q_dash=Q/I_efficiency;
disp(Q_dash,"quantity of electricity,Q_dash(A-h) = "
   )
I=C_density*S;
t=Q_dash/I;
disp(t,"time required,t(hours) = ")
```

Chapter 4

Illumination

Scilab code Exa 4.1 MSCP

```
//Example 4.1 //MSCP
clc;
clear;
close;
format('v',3)
F=1000;//intensity in lumens
MSCP=F/(4*%pi);// MSCP of the lamps
disp(MSCP,"MSCP of the lamp is")
```

Scilab code Exa 4.2 lumens per watt and MSCP

```
//Example 4.2 //LUMES PER WATT AND MSCP
clc;
clear;
close;
format('v',4)
V=250;//in volts
I=0.8;//in amperes
```

```
F=3000;//intensity in lumens
wl=V*I;//wattage of lapms ins watts
lpw=F/wl;// lumens per watts is
MSCP=F/(4*%pi);// MSCP of the lamps
MW=MSCP/wl;//MSCP per watts
disp(lpw,"lumens per watt is")
disp(MW,"MSCP per watt of the lamp is")
```

Scilab code Exa 4.3 `average luminance`

```
//Example 4.3 //average luminane of the sphere
clc;
clear;
close;
format('v',6)
d=0.4;//diamter in meter
p=0.20;//in percentage absorption
F=4850;// lumens
Fe=(1-p)*F;// flux emitted by the globe in lumens
sa=4*%pi*(d/2)^2;//surface area in m^2
als=Fe/sa;//average lumninance of sphere in lumens/m
    ^2
disp(als,"average lumninance of sphere in lumens/m^2
    ")
```

Scilab code Exa 4.4 `Illumination`

```
//Example 4.4 //illumination
clc;
clear;
close;
format('v',7)
P=20;//filament power in watts
```

```
h=5;//height in meters
d=4;//diamter in meter
p=0.50;//in percentage absorption
ef=0.89;//efficiency in watts
cpl=P/ef;//candle power of lamp in CP
Lop=4*%pi*cpl;//lu,inous output in lumens
Fe=(1-p)*Lop;// flux emitted by the globe in lumens
sa=%pi*(d/2)^2;//surface area in m^2
als=Fe/sa;//average lumninance of sphere in lumens/m^2
disp(als,"average lumninance of sphere in lumens/m^2")
```

Scilab code Exa 4.5 `average intensity of Illumination`

```
//Example 4.5 //AVERAGE INTENSITY
clc;
clear;
close;
format('v',6)
cpl=100;//
h=5;//in meter
th=60;//in degree
F=1000;//intensity in lumens
MSCP=F/(4*%pi);// MSCP of the lamps
ai=((cpl/h^2)*cosd(90-th));//average intensity of illumination
disp(round(MSCP),"MSCP of a lamp is,=")
disp(ai,"average intensity of illumination is lux ")
```

Scilab code Exa 4.7 `Illumination and lamp efficiency`

```
//Example 4.7 //lamp efficiency and illumination
```

```
clc;
clear;
close;
format('v',7)
p=500;//lamp power in watts
mscp=1250;//
h=2.7;//in meters
ea=(mscp)/(h)^2;//illumination directly below lamp
    in lux
le=(4*%pi*mscp)/p;//lamp efficiency in lumens/watts
h1=3;//meters
eb=((mscp)/(h^2)*(2.7^3/(h1^2+h^2)^(3/2)));//
    illumnination at a point 3 meters away on the
    horizontal plane vertically below the lamp in lux
disp(ea,"illumination directly below lamp in lux")
disp(le,"lamp efficiency in lumens/W")
disp(eb,"illumnination at a point 3 meters away on
    the horizontal plane vertically below the lamp in
     lux")
```

Scilab code Exa 4.8 `height and Illumination`

```
//Example 4.8// height and illumination
clc;
clear;
close;
format('v',7)
l=100;//illumination at a point directly below the
    lamp in lumens/m^3
cp=256;//
h1=1.2;//in meters
h=sqrt(cp/l);//height in meters
x=sqrt(h^2+h1^2);//
x1=h/x;//
eb=((cp)/(h^2))*(x1)^3;//illumnination at a point
```

```
    1.2 meters away on the horizontal plane
    vertically below the lamp in lux
disp(h,"height in meters is")
disp(eb,"illumnination at a point 1.2 meters away on
    the horizontal plane vertically below the lamp
    in lux")
```

Scilab code Exa 4.9 candle power

```
//Example 4.9//candle power of lamp
clc;
clear;
close;
format('v',7)
L1=500;//candle power
h1=9;//in meters
d=2;//distance in meters
I2=20;//illumination in Lux
x=sqrt(h1^2+d^2);//from pythagoras theoram
Cpx=((I2-(L1/h1^2))*h1^2)/((h1/x)^3);//candle power
disp(Cpx,"candle power of lamp two in CP")
```

Scilab code Exa 4.10 distance

```
//Example 4.10//distance
clc;
clear;
close;
format('v',5)
h1=10;//in meters
eL=1;//ASSUME
Ea=1/(10)^2;//
X=(((10^3)*eL)/10^2)*10*(1/Ea);
```

```
x=(X)^(2/3);//
y=sqrt(x-100);//
disp(y,"distance in meters is")
```

Scilab code Exa 4.11 total light flux and average Illumination

```
//Example 4.11 //total flux and average luminane of
   the sphere
clc;
clear;
close;
format('v',6)
th=15;//in degree
l=400;//candela
d=8;// meter
p=0.80;//in percentage absorption
Fe=p*4*%pi*l;// flux emitted by the globe in lumens
dA=d*tand(th/2);//diameter in degree
sa=%pi*(dA)^2;//surface area in m^2
als=Fe/sa;//average lumninance of sphere in lux
disp(Fe,"total flux in lumens")
disp(als,"average lumninance of sphere in lux")
```

Scilab code Exa 4.12 maximum and minimum Illumination

```
//Example 4.12 //maximum and minimum illumination
clc;
clear;
close;
format('v',5 )
CP=1000;//
h=12;//in meter
d=24;//diamter in meter
```

```
mil=CP/(h)^2;//maximum illumination in lux
mal=mil*(12/sqrt(12^2+12^2))^3;//minimum
   illumination in lux
disp(mil,"maximum illumination in lux")
disp(mal,"minimum illumination in lux")
```

Scilab code Exa 4.13 Illumination

```
//Example 4.13//illumination
clc;
clear;
close;
format('v',5 )
p=60;//
CP=200;//
h=6;//in meter
d=10;//diamter in meter
mil=CP/(h)^2;//maximum illumination in lux
disp("part (a). ")
disp(mil," illumination at the centre of the area
   without reflector in lux")
mal=mil*(h/sqrt(h^2+(d/2)^2))^3;//minimum
   illumination in lux
tl=4*%pi*CP;//total lumens
ts=(p/100)*tl;//total lumens reaching the surface
A=%pi*(d/2)^2;//total surface area in m^2
alf=ts/A;//average illumination with reflector
x=sqrt(h^2+(d/2)^2);//
y=h/x;//
om=2*%pi*(1-y);// in steradians
tfr=CP*om;//total flux reaching the surface
alwr=tfr/A;//average illumination without reflector
disp("part (b). ")
disp(mal," illumination at the edge of the area
   without reflector in lux")
```

```
disp(alf,"average illumination with reflector in lux")
disp(alwr,"average illumination without reflelctor in lux")
//with the reflector the illumintaion at the edge and at the end will be the same since the reflection directs the light uniformity on the surface
```

Scilab code Exa 4.14 `Illumination`

```
//Example 4.14 //illumination under each lamp and midway between lamps
clc;
clear;
close;
format('v',5 )
CP=100;//
h=6;//in meter
d=16;// meter
x=sqrt(h^2+d^2);//
em=2*((CP/h^2)*(h/(d-h))^3);//illumination in the middle in lux
ee=((CP/h^2)*(1+(h/x)^3));//illumination iunder each lamp in lux
disp(ee,"illumination under each lamp in lux")
disp(em,"illumination in the middle in lux")
```

Scilab code Exa 4.15 `Illumination`

```
//Example 4.15 //illumination under each lamp and midway between lamps
clc;
```

```
clear;
close;
format('v',7 )
CP=800;//
h=10;//in meter
d=12;// meter
x=sqrt(h^2+d^2);//
x1=sqrt(h^2+(d/2)^2);//
em=((CP/h^2)*(1+(h/x)^3+(h/x)^3));//illumination
    iunder each lamp in lux
ee=2*((CP/h^2)*(h/x1)^3);//illumination at the
    centrelamp in lux
disp(em,"illumination under each lamp in lux")
disp(ee,"illumination in the middle in lux")
```

Scilab code Exa 4.16 Illumination

```
//Example 4.16 //illumination  midway between lamps
clc;
clear;
close;
format('v',5 )
CP=400;//
h=10;//in meter
d=20;// meter
x=sqrt(d^2-h^2);//
ee=4*((CP/h^2)*(h/x)^3);//illumination at the
    centrelamp in lux
disp(ee,"illumination in the middle in lux")
```

Scilab code Exa 4.17 spacing

```
//Example 4.17//distance
```

```
clc;
clear;
close;
format('v',5)
cp=500;//cp
h=4;//in meter
x=((2*cp*h^3)/h^2);//
y=((cp*h^3)/h^2);//
y1=cp/h^2;//
y2=y/2;//
y21=y1/2;//
d=sqrt((((x-y2)/y21)^(2/3))-h^2)*2.29;//
disp(d,"distance is,(m)=")
```

Scilab code Exa 4.18 wattage

```
//Example 4.18//wattage of lamp
clc;
clear;
close;
format('v',6)
d=6;//in meter
h=4;//in meter
ef=20;//lumens per watt
uc=0.5;//utilization coefficient
il=750;// in lux
a=(%pi/4)*(d)^2;//
F=a*il;//in lumens
tf=F/uc;//total flux emitted by the lamp
watt=tf/ef;//wattage of lamp
disp(watt,"wattage of lamp in watts")
```

Scilab code Exa 4.19 candle power

```
//Example 4.19//candle power
clc;
clear;
close;
vl=220;//voltage of lamp
wl=60;//wattage of lamp
wl1=75;//in watts
v2=440;// in volts
r1=((vl^2)/wl);// in ohms
r2=((vl^2)/wl1);// in ohms
i=(v2/(r1+r2));//in amperes
v1=i*r1;// volts
v12=i*r2;//in volts
cp6=(ceil(v1)/vl)^4 *(100);//candle power
cp7=(v12/vl)^4*(100);//candle power
disp(ceil(cp6),"potential drop across 60 watt lamps
    in volts")
disp(v12,"potential drop across 75 watt lamps in
    volts")
disp(round(cp6),"candle power of 60 watts lampe in
    percentage")
disp(cp7,"candle power of 75 watts lampe in
    percentage")
//answer is wrong in the book
```

Scilab code Exa 4.20 capacitance

```
//Example 4.20//capacitance
clc;
clear;
close;
w=84;//watts
pf=0.7;//power factor
v=240;//in volts
i=(w)/(v*pf);// in amperes
```

```
rva=v*i*sqrt(1-pf^2);//relative volt-amperes
cpf=1;//corrected power factor
rvas=v*i*sqrt(1-cpf^2);//
f=50;// in hertz
c=((rva)/(2*%pi*f*(v)^2));//in farads
disp(c*10^6,"capacitance in (micro-F) is")
```

Scilab code Exa 4.21 compare diameter and length

```
//Example 4.21//compare diameter and length
clc;
clear;
close;
format('v',6)
v1=110;//in volts
cp1=16;//in cp
cp2=25;//in cp
v2=220;//in volts
ri=((cp1/cp2)*(v2/v1));//ratio of curents
dr=(ri)^(2/3);//ratio of diameters
di=(cp1/cp2)*(1/dr);//ratio of lengths
disp(dr,"ratio of diameter is")
disp(di,"ratio of length is")
```

Scilab code Exa 4.22 constants and change of candle power per volt

```
//Example 4.22//constants and change of candle power
    per volt
clc;
clear;
close;
format('v',9)
c1=71.5;//candel power
```

```
v1=260;//in volts
c2=50;//candel power
v2=240;//in volts
b=log(c1/c2)/(log(v1/v2));//
a=c2/(v2)^(4.5);//
disp("part (a). ")
disp("constants are "+string(a)+" and "+string(b)+" ")
v=250;// in volts
p=4;//change in percentage
dvc=a*b*((v)^(b-1));//in candle per volts
dc=(1+(p/100))^b;//when voltage increase by 4%
pcp=((dc-1))*100;//percentage change in candle power
dc1=(1-(p/100))^b;//when voltage falls by 4%
pcp1=((dc1-1))*100;//percentage change in candle power
disp("part (b).")
disp(dvc,"change of candle power per volts")
//chage in candle power per volt is calculated wrong in the book
disp(pcp,"percentage change in candle power  when voltage increase by 4%")
disp(pcp1,"percentage change in candle power  when voltage falls by 4%")
```

Scilab code Exa 4.23 `average Illumination`

```
//Example 4.23//average illumination
clc;
clear;
close;
format('v',5)
dp=1.2;//depreciation factor
uf=0.6;//utiliazation factor
l=15;// in meters
```

```
b=6;// in meters
n=20;// no. of lamps
lw=250;// mscp in watts
a=l*b;//arean in m^2
tl=n*lw*4*%pi;///total lumens
lwp=((tl*uf)/dp);//lumens reaching on the working
    plane
e=lwp/a;//illumination on working plane in lux
disp(e,"illumination on working plane in lux")
```

Scilab code Exa 4.24 number location and wattage

```
//Example 4.24//number ,loaction and wattage
clc;
clear;
close;
format('v',5)
ef=40;//efficiency in lumens/watt
mil=80;// minimum illumination in lumens/m^2
dp=0.8;//depreciation factor
uf=0.4;//utiliazation factor
l=100;// in meters
b=10;// in meters
a=l*b;//arean in m^2
tl=a*mil;///total lumens
glr=tl/(uf*dp);//gross illumination required
twr=glr/ef;//total wattage required
disp(42,"number of lamps of 150watt rating in 2 rows
    ")
disp(twr,"total wattage in watts")
```

Scilab code Exa 4.25 number rating and dipsotion of lamps

```
//Example 4.25//number ,rating and disposition of
   lamps
clc;
clear;
close;
format('v',6)
h=4;//in meters
wp=75;//in lux
ef=14;//efficiency in lumens/watt
dp=0.2;//depreciation factor
uf=0.5;//utiliazation factor
l=72;// in meters
b=15;// in meters
a=l*b;//arean in m^2
mf=1-dp;//maintenance factor
glr=(a*wp)/(uf*mf);//gross illumination required
twr=glr/ef;//total wattage required
wec=twr/80;//wattage of each lamps
disp(80,"number of lamps of 150watt rating in 2 rows
   ")
disp(" wattage of each lamp "+string(wec)+" watts
   equivalent to 200  watts")
```

Scilab code Exa 4.26 number rating and dipsotion of lamps

```
//Example 4.26//number ,rating and disposition of
   lamps
clc;
clear;
close;
a=30*30;//
e=75;//
uf=0.5;//
df=1-0.2;//
le=15;//efficiency
```

```
ph=(a*e)/(uf*df);//
W=ph/le;//
ew=300;//W
N=W/ew;//
disp(N,"total number of lamps is ,= (say 42)")
disp(W,"wattage of lamps is ,(W)=")
```

Scilab code Exa 4.27 number and wattage

```
//Example 4.27//number  and wattage
clc;
clear;
close;
format('v',6)
h=5;// in meters
el=100;//in lux
ef=16;//efficiency in lumens/watt
dp=0.2;//depreciation factor
uf=0.4;//utiliazation factor
l=60;// in meters
b=15;// in meters
a=l*b;//arean in m^2
glr=(a*el)/(uf*(1-dp));//gross illumination required
n=12*3;//total no. of
twr=glr/ef;//total wattage required
wec=twr/n;//wattage of each lamp
disp(n,"number of lamps of 150watt rating in 2 rows"
    )
disp(" wattage of each lamp "+string(wec)+" watts
    equivalent to 500  watts")
```

Scilab code Exa 4.28 number spacing height and totl wattge

```
//Example 4.28//number ,spacing ,mounting height and
   total wattafe
clc;
clear;
close;
format('v',6)
h=5;// in meters
el=120;//in lux
ef=40;//efficiency in lumens/watt
tw=80;//in watts
df=1.4;//depreciation factor
uf=0.5;//utiliazation factor
l=30;// in meters
b=15;// in meters
a=l*b;//arean in m^2
glr=(a*el*df)/(uf);//gross lumens required
twr=glr/ef;//total wattage required
nt=twr/tw;//no. of tubes required
disp(twr,"total wattage required in watts")
disp(" number of tubes required is "+string(nt)+"
   equivalent to 48 tubes")
```

Scilab code Exa 4.29 space height ratio

```
//Example 4.29//number of lamps
clc;
clear;
close;
format('v',6)
el=50;//in lux
df=1.3;//depreciation factor
uf=0.5;//utiliazation factor
l=30;// in meters
b=12;// in meters
a=l*b;//arean in m^2
```

```
glr=(a*el*df)/(uf);//gross lumens required
watt=[100,200,300,500,1000];
lum=[1615,3650,4700,9950,21500];//
for i=1:5
    n(i)=glr/(lum(i));//
    disp("if "+string(watt(i))+" watt lamps are used
        then number of lamps required is "+string(
       round(n(i)))+" ")

end
```

Scilab code Exa 4.30 `Illumination`

```
//Example 4.30//illumination on surface
clc;
clear;
close;
format('v',6)
ef=17.4;//in mumens/watt
dp=1.2;//depreciation factor
wlf=1.3;//waste light factor
uf=0.4;//utiliazation factor
l=50;// in meters
b=16;// in meters
n=16;// no. of lamps
lw=1000;// mscp in watts
a=l*b;//arean in m^2
tl=n*lw*ef;///total lumens
lwp=((tl*uf)/(wlf*dp));//lumens reaching on the
   working plane
e=lwp/a;//illumination on the surface in lumens/m^2
disp(e,"illumination on the surface in lumens/m^2")
```

Scilab code Exa 4.31 number and size

```
//Example 4.31//size and number of projector
clc;
clear;
close;
format('v',6)
watt=[300,500,1000,1500];
lum=[5000,9000,18000,27000];//
el=50;// in lux
dp=0.8;//depreciation factor
wlf=0.5;//waste light factor
uf=1.2;//utiliazation factor
l=60;// in meters
b=15;// in meters
lw=1000;// mscp in watts
a=l*b;//arean in m^2
tl=a*el//total lumens
lwp=((tl*uf)/(wlf*dp));//lumens reaching on the
    working plane
n = lwp/lum(2);//number of projector required
ang=2*atand(4.5/8);//size
disp(ceil(n+1),"number of projectors are,=")
disp(watt(2),"wattage is,(W)=")
disp(ceil(ang+1),"beam angle is,(degree)=")
disp(""+string(round(n)+1)+ " projectors of "+string
    (watt(2))+" watts each with beam angle of "+
    string(round(ang+1))+" degree will be required")
```

Chapter 5

Refrigeration and Air conditioning

Scilab code Exa 5.1 power

```
//Example 5.1: Power
clc;
clear;
close;
//given data :
t1=20;// in degree C
t2=5;// in degree C
T=t1-t2;
A=3000;// volume of air to be conditioned in m^3
Ht=1220;// in J
H1=A*Ht*T;
m=1000; // per m^3
Hl=2450*10^3;// latent heat in J/kg
w=5;;// in kg
M=(w*A)/m;
H2=T*Hl;//in J
H=(H1+H2);
P=round(H/(3600*1000));
disp(P,"Power required ,(kW) = ")
```

Scilab code Exa 5.2 rating of heater

```
//Example 5.2: Rating of Heater
clc;
clear;
close;
//given data :
t1=25;// in degree C
t2=5;// in degree C
T=t1-t2;
A=6*5*4*(60/15);// volume of air to be conditioned
   in m^3/hour
Ht=1220;// in J
H1=A*Ht*T;
m=1000; // per m^3
Hl=836*10^3;// heat loss in J/C/h
H2=T*Hl;//in J/hour
H=(H1+H2);
Rh=round(H/(3600*1000));
disp(Rh,"Rating of heater,(kW) =")
```

Chapter 7

Train Movement and Energy Consumption

Scilab code Exa 7.1 distance average speed and scheduled speed

```
//Example 7.1.//distance,average speed and scheduled
    speed
clc;
clear;
close;
format('v',6)
a=5;//aceleration in kmphps
t1=30;//in seconds
vm=a*t1;//maximum speed in kmph
tfr=10;//time for free running in mins
b=5;//retardation in kmphps
ts=vm/b;//time for retardation in seconds
dta=((vm*t1)/(2*3600));//distance travelled during
   acceleration period
dtfr=((vm*tfr*60)/(3600));//distance travelled
   during retardation period
dtbp=dta;//distance travelled during breaking period
td=dta+dtfr+dtbp;//total distance between stations
disp("part (a) ")
```

```
disp(td,"total distance between station in km")
T=[0;t1;(t1+(tfr*60));(t1+(t1+(tfr*60)))];//
V=[0;vm;vm;0];//
plot2d(T,V)
xlabel("Time in seconds ")
ylabel("Spped in Km per Hour")
va=(td*3600)/(t1+(tfr*60)+ts);//average speed in kmph
disp("part (b) ")
disp(va,"average speed in kmph")
tst=5;//stop time in mins
vs=(td*3600)/(t1+(tfr*60)+ts+(tst*60));//sheduled speed in kmph
disp("part (c) ")
disp(vs,"sheduled speed in kmph")
```

Scilab code Exa 7.2 plot the curve

```
//Example 7.2 //draw the curve
clc;
clear;
close;
a=1.7;//aceleration in kmphps
b=3.3;//kmphps
s=1400;//m
va=42;//kmph
tr=((s*10^-3)/va)*3600;//secomds
k=((1/(2*a)))+((1/(2*b)));//
vm=((tr/(2*k))-sqrt(((tr^2)/(4*k^2))-((3600*s*10^-3)/k)));//in kmph
t1=vm/a;//seconds
t3=vm/b;//seconds
t2=tr-(t1+t3);//seconds
T=[0;(t1);(t1+t2);(t1+t2+t3)];
V=[0;vm;vm;0];
```

```
plot2d(T,V);
xlabel("Time in seconds ")
ylabel("Spped in Km per Hour")
```

Scilab code Exa 7.3 speed

```
//Example 7.3 //maximum speed
clc;
clear;
close;
format('v',4)
a=2.4;//aceleration in kmphps
b=3.2;//retardation in kmphps
s=1.5;//in km
vs=45;//shedule speed in kmph
ts=(s*3600)/vs;//shedule time in seconds
tst=20;//stop time
tr=ts-tst;//actual time for run in seconds
k=((1/(2*a))+(1/(2*b)));//constant
vm=((tr/(2*k))-sqrt(((tr^2)/(4*k^2))-((3600*s)/k)));
    //in kmph
disp(vm,"maximum speed in kmph")
```

Scilab code Exa 7.4 sceduled speed

```
//Example 7.4 //sheduled speed
clc;
clear;
close;
format('v',4)
s=1.5;//in Km
a=0.8;//aceleration in kmphps
tsr=26;//time for stop in seconds
```

```
rm=1.3;//ratio
b=3.2;//retardation in kmphps
k=((1/(2*a))+(1/(2*b)));//constant
T=1;//assume
va1=(3600*s)/T;//average spped
vm1=(va1*rm);//maximum speed
vm=sqrt((vm1-va1)/k);//maximum speed in kmph
va=vm/1.3;//actua speed in kmpj
ta=(3600*s)/va;//actual time in seconds
ts=ta+tsr;//shedule time
vs=(s*3600)/ts;//shedule speed in kmph
disp(vs,"schedule speed in kmph")
```

Scilab code Exa 7.5 acceleration

```
//Example 7.5: Acceleration
clc;
clear;
close;
//given data :
S=1;// in km
Vs=30;// in km/h
Ts=(S*3600)/Vs; // in sec
D=20;// duration of stop in sec
T=Ts-D;// in sec
Va=(S*3600)/T;// Average speed in km/h
Vm=1.25*Va;// Maximum speed in km/h
beta1=3;// braking retardation in km/h/sec
A=((Vm*T)-(S*3600))/Vm^2;
B=1/(2*beta1);
alfa=1/(2*(A-B));
disp(alfa,"The Acceleration,alfa(km/h/sec) = ")
```

Scilab code Exa 7.6 retardation

```
//Example 7.6: Retardation
clc;
clear;
close;
//given data :
format('v',6)
S=4;// in km
Vs=45;// in km/h
Ts=(S*3600)/Vs; // in sec
D=30;// duration of stop in sec
T=Ts-D;// in sec
Vm=70;// Maximum speed in km/h
alfa=1.5;// in km/h/sec
A=((Vm*T)-(S*3600))/Vm^2;
B=1/(2*alfa);
Beta=1/(2*(A-B));
disp(Beta,"Retardation(km/h/sec) = ")
```

Scilab code Exa 7.7 duration of acceleration coasting and braking periods

```
//Example 7.7: Acceleration, Coasting and Braking
    periods
clc;
clear;
close;
//given data :
S=1.6;// in km
Va=40;// in km/h
V1=64;// in km/h
alfa=2.0;//in km/p/sec
Beta_c=0.16;// in km/h/sec
Beta=3.2;// in km/h/sec
t1=V1/alfa;// in sec
```

```
disp(t1,"Duration of Acceleration ,t1(sec) = ")
T=(S*3600)/Va;// in sec
// Formula: T=(V1/alfa)+((V1−V2)/Beta_c)+(V2/Beta)
V2=(t1+(V1/Beta_c)-T)/((1/Beta_c)-(1/Beta));
t2=(V1-V2)/Beta_c;
disp(t2,"Duration of coasting ,t2(sec) = ")
t3=V2/Beta;
disp(t3,"Duration of braking ,t3(sec) = ")
```

Scilab code Exa 7.8 torque

```
//Example 7.8: Torque
clc;
clear;
close;
//given data :
W=200;// weight of train in tonnes
D=0.9;// diameter in m
G=(1/200)*100;//percentage gradient
r=50;// in N/tonne
gama=4;// gear ratio
eta=0.80;// gearing efficiency
We=1.10*W;// in tonne
Vm=48;// maximum speed in km/h
t1=30;// in sec
alfa=Vm/t1;// in km/h/sec
Ft=(277.8*We*alfa)+(98.1*W*G)+(W*r);// tractive
    effect required in N
T1=(Ft*D)/(eta*2*gama);// in N−m
T=round(T1/8);
disp(T,"Torque developed by each motor ,T(N−m) = ")
```

Scilab code Exa 7.9 time taken and current

```
//Example 7.9: Time taken and current
clc;
clear;
close;
//given data :
V=3000;// line voltage in volts
W=200;// weight of train in tonnes
D=0.9;// diameter in m
G=(30/1000)*100;//percentage gradient
r=50;// in N/tonne
gama=4;// gear ratio
Vm=50;//in km/h
eta=0.9;// gearing efficiency
We=1.10*W;// in tonne
T=4*6000;// in N-m
eta_m=85/100;// efficiency of motor
Ft=(eta*T*2*gama)/D;
A=(98.1*W*G)+(W*r);
B=Ft-A;
alfa=B/(277.8*We);// tractive effect required in N
t=Vm/alfa;
disp(t,"Time taken ,t(sec) = ")
Po=(Ft*Vm)/3600;// in kw
Pi=Po/eta_m;
It=(Pi*1000)/V;// in A
I=It/4
disp(I,"Current drawn per motor,I(A) = ")
```

Scilab code Exa 7.10 `time taken and current`

```
//Example 7.10: Current and time taken
clc;
clear;
close;
//given data :
```

```
V=36;// speed in km/h
W=120;// in tonne
G=2;// in per cent
r=2*9.81;// in N/tonne
Ft=(98.1*W*G)+(W*r);
e=88/100; // efficiency of motors and gear
VL=1500;//line voltage in volts
Po=(Ft*V)/3600;
Pi=Po/e;
I=(Pi*1000)/VL;
bc=((98.1*(2+(0.1*2)))/(277.8*1.1));//in kmphps
tt=V/bc;//in seconds
disp(I,"current required in amperes is")
disp(round(tt),"time taken to come to rest in
   seconds is")
```

Scilab code Exa 7.11 acceleration coasting retardation and scheduled speed

```
//Example 7.11.// acceleration ,coasting retardation
   and scheduled speed
clc;
clear;
close;
format('v',6)
//given data :
t1=24;//in sec
t2=69;// in sec
t3=11;// in sec
V1=48;// in km/h
alfa=V1/t1;
disp("part (a)")
disp(alfa,"Acceleration(km/h/sec) = ")
r=58;// in N/tonne
G=0;
Beta=r/(277.8*1.1);
```

```
disp("part (b)")
disp(Beta,"Retardation(kmphps) = ")
V2=V1-(Beta*t2);
S=round(((V1*t1)/7200)+(((V1+V2)*t2)/7200)+((V2*t3)
   /7200));
D=20;// duration of stop in sec
Ts=t1+t2+t3+D;
Vs=round((S*3600)/Ts);
disp("part (c)")
disp(Vs,"Schedule time,Vs(kmph) = ")
D1=15;//when the duration of stop in sec
Ts_dash=t1+t2+t3+D1;
Vs_dash=(S*3600)/Ts_dash;
disp(Vs_dash,"Schedule speed,VS_dash(kmph) = ")
```

Scilab code Exa 7.12 sceduled speed

```
//Example 7.12: Schedule speed
clc;
clear;
close;
//given data :
t1=30;//in sec
t2=50;// in sec
t3=20;// in sec
alpha=2;//kmphps
V1=alpha*(t1);// in km/h
r=40;// in N/tonne
G=1;
bc=((98.1+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t2);//km/hr
S=(((V1*t1)/7200)+(((V1+V2)*t2)/7200)+((V2*t3)/7200)
   );
D=30;// duration of stop in sec
Ts=t1+t2+t3+D;
```

```
Vs=((S*3600)/Ts);
disp(Vs,"Schedule time,Vs(kmph) = ")
```

Scilab code Exa 7.13 maximum power and distance travelled

```
//Example 7.13: maximum power and total distance
clc;
clear;
close;
format('v',5)
//given data :
w=250;//in tonnes
we=(1+(10/100))*w;//efective weight in tonnes
r=5*9.81;//in N/tonne
G=1;//
t1=30;//in sec
t2=70;// in sec
alpha=2;//kmphps
V1=alpha*(t1);// in km/h
ft=(277.8*we*alpha)+(98.1*G*w)+(w*r);//in newtons
po=((ft*V1)/3600);//maximum power output in kW
n=0.97;//efficiency
pi=po/n;//in kW
G=1;
bc=((98.1+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t2);//km/hr
beta1=3;//retardation
t3=V2/beta1;//in seconds
S=(((V1*t1)/7200)+(((V1+V2)*t2)/7200)+((V2*t3)/7200)
    );
disp(round(pi),"maximum power developed by traction
    motor is (kW)")
disp(S,"total distance travelled by train in km is")
```

Scilab code Exa 7.14 energy consumption

```
//Example 7.14: Energy consumption
clc;
clear;
close;
format('v',8)
//given data :
Vm=52;//max speed in kmph
t3=15.8;// duration of braking in sec
D=(1/2)*Vm*(t3/3600);
S=1400;// in m
S1=(S*10^-3)-D;
r=50;//in N/tonne
WeBY_W=1.1;
Ec=((0.01072*Vm^2*WeBY_W)/(S*10^-3))+(0.2778*r*(S1/(
    S*10^-3)));
disp(Ec,"energy consumption in Wh is")
```

Scilab code Exa 7.15 specific energy consumption

```
//Example 7.15: specific energy consumption
clc;
clear;
close;
format('v',9)
//given data :
w=1;//in tonnes
we=(1+(10/100))*w;//efective weight in tonnes
S=1525;//in meters
r=52.6/1000;//in N/kg
alpha=0.366;//m/s^2
```

```
V1=12.2;// in m/s
t1=V1/alpha;//in seconds
ft=we*alpha+r;//in newtons
ter=((1/2)*ft*V1*t1)/3600;//in watt-hours
seo=ter/(w*S);// in Wh/kg-m
n=0.65;//efficiency
sec1=seo/n//in Wh/kg-m
disp(sec1,"specific energy onsumption in Wh/kg-m")
```

Scilab code Exa 7.16 sceduled speed and specific energy consumption

```
//Example 7.16: Schedule speed and Specific energy
    consumption
clc;
clear;
close;
//given data :
t1=30;//in sec
t2=50;// in sec
t3=20;// in sec
alpha=2;//kmphps
V1=alpha*(t1);// in km/h
r=40;// in N/tonne
G=1;
bc=((98.1+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t2);//km/hr
S=(((V1*t1)/7200)+(((V1+V2)*t2)/7200)+((V2*t3)/7200)
    );
D=15;// duration of stop in sec
Ts=t1+t2+t3+D;
Vs=((S*3600)/Ts);
disp(Vs,"Schedule speed,Vs(kmph) = ")
S1=(V1*t1)/7200;//in meters
r=50;//in N/tonne
WeBY_W=1.1;
```

```
G=1;//
Ec=((0.01072*V1^2*WeBY_W)/(S))+(0.2778*(98.1*G+r)*((
    S1)/(S)));
N=0.75;//
Sec=Ec/0.75;//
disp(Sec,"Specific energy consumption in Wh/tonne-km
    is")
```

Scilab code Exa 7.17 sceduled speed and specific energy consumption

```
//Example 7.17: Schedule speed and specific energy
    consumption
clc;
clear;
close;
//given data :
t1=30;//in sec
t2=50;// in sec
t3=20;// in sec
alpha=2;//kmphps
V1=alpha*(t1);// in km/h
r=40;// in N/tonne
G=-1;
bc=((-98.1+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t2);//km/hr
S=(((V1*t1)/7200)+(((V1+V2)*t2)/7200)+((V2*t3)/7200)
    );
D=15;// duration of stop in sec
Ts=t1+t2+t3+D;
Vs=((S*3600)/Ts);
disp(Vs,"Schedule speed,Vs(kmph) = ")
S1=(V1*t1)/7200;//in meters
r=50;//in N/tonne
WeBY_W=1.1;
Ec=((0.01072*V1^2*WeBY_W)/(S))+(0.2778*(98.1*G+r)*((
```

```
   S1)/(S)));
N=0.75;//
Sec=Ec/0.75;//
disp(Sec,"Specific energy consumption in Wh/tonne−km
   is")
```

Scilab code Exa 7.18 maximum power total energy consumption and specific energy co

```
//Example 7.18.//maximum power,total energy
   consumption and specific energy consumption
clc;
clear;
close;
format('v',6)
//given data :
W=100;//in tonne
We=1.1*W;// in tonne
S=2.5;// distance in km
Va=50;//Average speed in kmph
Dr=(3600*S)/Va;
alfa=1;// in km/h/sec
Beta=2;// in km/h/sec
T=180;
r=40;//in N/tonne
G=1;
K=(1/(2*alfa))+(1/(2*Beta));
Vm=round((T/(2*K))-sqrt((T/(2*K))^2-((3600*S)/K)));
   // maximum speed
t1=Vm/alfa;// acceleration period
t3=Vm/Beta;// braking period
t2=T-(t1+t3);// in sec
Ft=(277.8*We*alfa)+(98.1*W*G)+(W*r);
P_max=round((Ft*Vm)/3600);
disp("part (a)")
disp(P_max,"Maximum power,(kWh) = ")
```

```
e=60/100;// efficiency
Ft=(277.8*We*alfa)+(98.1*W*G)+(W*r);
Ft_dash=(98.1*W*G)+(W*r);
P_max=round((Ft*Vm)/3600);
Et=((1/2)*Ft)*(Vm/3600)*(t1/3600)+((Ft_dash*Vm)/3600)*(t2/3600);
Ec=Et/e;
disp("part (b) ")
disp(Ec,"Total Energy Consumption,Ec(kWh) = ")
Sec=(Ec*1000)/(W*S);
disp("part (c) ")
disp(Sec,"Specific Energy Consumption,(Wh/tonne-km) = ")
```

Scilab code Exa 7.19 maximum power and energy taken

```
//Example 7.19. //maximum power and energy taken
clc;
clear;
close;
//given data :
format('v',7)
W=203;//in tonne
We=1.1*W;// in tonne
r=44;// N/tonne
G=(1/500)*100;// gradient
Vm=45;// maximum speed in kmph
t1=30;// in sec
alfa=Vm/t1;// in kmph
Ft=(277.8*We*alfa)+(98.1*W*G)+(W*r);// in N
Po=(Ft*Vm)/3600;
disp("part (a)")
disp(Po,"The maximum power output,(kW) = ")
e=60/100;// efficiency
Et=(1/2)*((Ft*Vm)/3600)*(t1/3600);
```

```
E=(Et/e);
disp(" part (b) ")
disp(E,"The energy taken(kWh) = ")
```

Scilab code Exa 7.20 maximum power and specific energy consumption

```
//Example 7.20.maximum power and specific energy
   consumption
clc;
clear;
close;
format('v',7)
//given data :
W=16;//in tonne
We=1.1*W;// in tonne
Vs=45;//in kmph
r=40;// in N/tonne
S=2.8;// in km
Ts=(S*3600)/Vs;
Td=30;// in sec
T=Ts-Td;
alfa=2;//in kmphps
Beta=3.2;// in kmphps
K=(1/(2*alfa))+(1/(2*Beta));
Vm=round((T/(2*K))-sqrt((T/(2*K))^2-((3600*S)/K)));
   // maximum speed
t1=Vm/alfa;// acceleration time
t3=Vm/Beta;// duration of braking
t2=T-(t1+t3);// time f free run in sec
Ft=(277.8*We*alfa)+(W*r);
P_max=(Ft*Vm)/3600;
disp("part (a)")
disp(P_max,"Maximum power output,(kW) = ")
// answer is wrong in book
Va=50;//Average speed in kmph
```

```
Dr=(3600*S)/Va;
T=180;
G=1;
e=80/100;//efficiency
Dt=(1/2)*((Vm*t3)/3600);// distance travelled during braking period in km
S1=S-Dt;// distance travelled with power in km
So=(((0.01072*Vm^2)/S)*(We/W))+((0.2778*r*S1)/S);
Sec=So/e;
disp("part (b)")
disp(Sec,"Specific energy consumption,(Wh/tonne-km) = ")
// answer is wrong in book
```

Scilab code Exa 7.21 Schedule speed specific energy consumption total energy consu

```
//Example 7.21: Schedule speed,specific energy consumption,total energy consumption and distance
clc;
clear;
close;
//given data :
format('v',6)
t1=30;//in sec
t2=40;// in sec
t3=30;// in sec
alpha=2;//kmphps
V1=alpha*(t1);// in km/h
r=40;// in N/tonne
G=1;
bc=((98.1+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t3);//km/hr
Beta=2.5;//retardation
t4=V2/Beta;//in seconds
S=(((V1*t1)/7200)+((V1*t2)/3600)+(((V1+V2)*t3)/7200)
```

```
    +((V2*t4)/7200));
D=15;// duration of stop in sec
Ts=t1+t2+t3+t4+D;
Vs=((S*3600)/Ts);
disp("part (a)")
disp(Vs,"Schedule time,Vs(kmph) = ")
disp("part (b)")
S1=((V1*t1)/7200)+((V1*t2)/3600);//in km
WeBY_W=1.1;
G=1;//
Ec=((0.01072*V1^2*WeBY_W)/(S))+(0.2778*(98.1*G+r)*((
    S1)/(S)));
N=0.75;//
Sec=Ec/0.75;//
disp(Sec,"Specific energy consumption in Wh/tonne-km
    is")
disp("part (c)")
W=200;//
tec=(Sec*W*S);//
disp(tec*10^-3,"total energy consumption in kWh")
disp("part (d)")
disp(S,"total distance travelled in Km is")
```

Scilab code Exa 7.22 specific energy consumption

```
//Example 7.22: specific energy consumption
clc;
clear;
close;
//given data :
W=500;//
t1=60;//in sec
t2=5*60;// in sec
t3=3*60;// in sec
alpha=2.5;//kmphps
```

```
V1=alpha*(t1);// in km/h
r=25;// in N/tonne
G=1;
bc=(((98.1*(8/1000)*100)+r))/(277.8*1.1);//in kmphps
V2=V1-(bc*t3);//km/hr
Beta=3;//retardation
t4=V2/Beta;//in seconds
S=(((V1*t1)/7200)+((V1*t2)/3600)+(((V1+V2)*t3)/7200)
   +((V2*t4)/7200));
D=15;// duration of stop in sec
Ts=t1+t2+t3+t4+D;
Vs=((S*3600)/Ts);
S1=((V1*t1)/7200)+((V1*t2)/3600);//in km
WeBY_W=1.1;
G=1;//
Ec=((0.01072*V1^2*WeBY_W)/(S))
   +(0.2778*((98.1*(8/1000)*100)+r)*((S1)/(S)));
N=0.80;//
Sec=Ec/N;//
disp(Sec,"Specific energy consumption in Wh/tonne-km
    is")
```

Scilab code Exa 7.23 weight and number of axles

```
//Example 7.23: weight of the locomotive abd number
   of axles
clc;
clear;
close;
//given data :
Wl=1;//
W1=400;//
G=2;//in percentage
mu=0.2;//
alpha=1;//
```

```
r=40;//
x=(277.8*1.1*alpha+98.1*G+r)/(9.81*1000);//
wlo=(x*W1)/(mu-x);//in tonnes
al=22;//allowable load in tonnes
na=wlo/al;//
disp(wlo,"weight of the locomotive in tonnes")
disp(round(na),"number of axles required")
```

Scilab code Exa 7.24 weight and number of axles

```
//Example 7.24: weight of the locomotive abd number
   of axles
clc;
clear;
close;
//given data :
W=12*30;//tonnes
we=1.04*360;//tonnes
r=5*9.81;//
G=1;//in percentage
mu=0.2;//
alpha=0.8;//
x=13.882;//
y=0.041;//
wlo=(x)/(mu-y);//in tonnes
al=20;//allowable load in tonnes
na=wlo/al;//
disp(wlo,"weight of the locomotive in tonnes")
disp(ceil(na),"number of axles required")
```

Scilab code Exa 7.25 trailing weight and maximum gradiant

```
//Example 7.25.// trailing weight and maximum gradiant
clc;
clear;
close;
format('v',6)
//given data :
w1=100;//tonnes
w=w1+500;//tonnes
we=1.1*w;//effective weight
alpha=1;//
G=1;//
r=45;//
ft=((277.8*we*alpha)+(98.1*w*G)+(w*r));//in newtons
ad=0.7;//adehsive percent
mu=(ft)/(100*10^3*9.81*ad);//
w2=130;//tonnes
ad2=w2*G;//
tadw=w1*ad+ad2;//tonnes
tted=mu*tadw*9.81*1000;//newtones
W=tted/(277.8*1.1*alpha+98.1*alpha+r);//in tonnes
trlw=W-(ad2+w1);//
disp("part (a)")
disp(round(trlw),"trailig weight in tonnes is")
w2=w1+500+ad2;//
G1=((tted/w2)-(277.8*1.1+r))*(1/98.1);//
disp("part (b)")
disp(G1,"maximum gradiant in percentage is")
```

Scilab code Exa 7.26 acceleration

```
//Example 7.26;acceleration
clc;
clear;
close;
```

```
//given data :
w1=100;//tonnes
w=w1+500;//tonnes
we=1.1*w;//effective weight
alpha=1;//
G=1;//
r=45;//
ft=((277.8*we*alpha)+(98.1*w*G)+(w*r));//in newtons
ad=0.7;//adehsive percent
mu=(ft)/(100*10^3*9.81*ad);//
w2=130;//tonnes
ad2=w2*G;//
tadw=w1*ad+ad2;//tonnes
tted=mu*tadw*9.81*1000;//newtones
W=tted/(277.8*1.1*alpha+98.1*alpha+r);//in tonnes
trlw=W-(ad2+w1);//
w2=w1+500+ad2;//
acc=((tted/w2)-(98.1+r))*(1/(277.8*1.1));//in kmphps
disp(acc,"acceleration in kmphps is")
```

Scilab code Exa 7.27 torque and weight

```
//Example 7.27: Torque and minimum weight
clc;
clear;
close;
//given data :
N=4;// number of motor
W=250;//in tonne
D=.95;// diameter in m
G=1;// percentage gradient
r=40;// in N/tonne
eta=95/100;// gear efficiency
gama=3;// gear ratio
We=1.1*W;
```

```
Vm=40;// kmph
t1=20;// in seconds
alfa=Vm/t1;
Ft=((277.8*We*alfa)+(98.1*W*G)+(W*r));
T=(Ft*D)/(eta*2*gama);
Td=round(T/N);
disp(Td,"Torque developed by each motor,Td(Nm) = ")
mu=0.25;// adhesive coefficient
WL=(Ft/(9.81*1000))/mu;
Dw=round(WL/.75);
disp(Dw,"Dead weight of locomotive,(tonnes) = ")
```

Chapter 8

Electric Traction Motors

Scilab code Exa 8.1 speed armature current characterstic

```
//Example 8.1: Motor speed
clc;
clear;
close;
v=230;//in volts
rm=0.3;//in ohms
Ia=[5;10;15;20;25;30;35;40];//in amperes
T=[20;50;100;155;215;290;360;430];//
for i=1:8
    eb(i)= v-(Ia(i))*rm;//
    N(i)=(9.55*eb(i)*Ia(i))/(T(i));//
    disp("speed in rpm is for current "+string(Ia(i)
       )+"  amperes "+string(round(N(i)))+" RPM")
end
plot2d(Ia,N)
xlabel("ARMATURE CURRENT ,Ia IN AMPS")
ylabel("SPEED ,N IN RPM")
xtitle("Spped-Armature current characteristic")
```

Scilab code Exa 8.2 speed torque curve

```
//Example 8.2: SPEED-TORQUE GRAPH
clc;
clear;
close;
v=600;//in volts
rm=0.8;//in ohms
N1=600;//
Ia=[20;40;60;80];//in amperes
EMF=[215;381;485;550]
for i=1:4
    eb(i)= v-(Ia(i))*rm;//
    N(i)=(N1/EMF(i))*eb(i);//
    T(i)=(9.55*eb(i)*Ia(i))/(N(i));//
    disp("speed in rpm is for current "+string(Ia(i)
       )+"  amperes "+string(round(N(i)))+" RPM and
       Torque in N-m is "+string(T(i))+"")
end
plot2d(T,N)
xlabel("TORQUE ,T IN Nm")
ylabel("SPEED ,N IN RPM")
xtitle("Speed-torque curve")
```

Scilab code Exa 8.3 motor speed and current

```
//Example 8.3: Motor speed and current drawn
clc;
clear;
close;
//given data :
N1=640;// in rpm
I1=15;// in A
I2=sqrt((2)*sqrt(2)*I1^2);
N2=round((2*I1*N1)/I2);
```

```
disp(I2,"Current drawn,I2(A) = ")
disp(N2,"Motor speed,N2(rpm) = ")
```

Scilab code Exa 8.4 speed and voltage

```
//Example 8.4: speed and voltage
clc;
clear;
close;
n1=700;//rpm
n2=750;//rpm
rm=0.3;//in ohms
v=500;//in volts
ib=50;//amperes
eb1=v-(ib*rm);//in volts
eb2=eb1;//
N=((v-(2*(ib*rm)))/((eb1/n1)+(eb2/n2)));//
pdv1=((eb1/n1)*N)+ib*rm;//in volts
pdv2=((eb1/n2)*N)+ib*rm;//in volts
disp(round(N),"speed in rpm is")
disp(round(pdv1),"PD across machine 1 in volts is")
disp(round(pdv2),"PD across machine 2 in volts is")
```

Scilab code Exa 8.5 current

```
//Example 8.5: Current drawn
clc;
clear;
close;
format('v',5)
//given data :
V=500;// in volts
Vm=40;// in kmph
```

```
Ft=1800;// in N
Rm=0.4;// in ohm
Lm=3200;// losses per motor in watt
Mo=(Ft*Vm*1000)/3600;
Cl=3200;// consatant losses in watt
// formuls: Mi=Po+Cl+C_losses
//C_losses=I^2*Rm
//Mi=V*I
//I1=(V+sqrt(V^2-(4*Rm*(Mo+Cl))))/(2*Rm);leaving as gives a very high value
I1=(V-sqrt(V^2-4*Rm*(Mo+Cl)))/(2*Rm);
disp(I1,"Current drawn by each motor,(A) =");
It=I1*2;
disp(It,"Total current drawn,(A) = ")
```

Scilab code Exa 8.6 power delivered

```
//Example 8.6.//power delivered
clc;
clear;
close;
//given data :
format('v',6)
Ft=35300;// in N
V=48;// in kmph
Po=((Ft*V*1000)/3600)*10^-3;
Ft1=55180;//in N
Pd=Po*sqrt(Ft1/Ft);
disp("part (a)")
disp(Pd,"power delivered(kW) = ")
Pd1=Po*(Ft1/Ft);
disp("part (b)")
disp(Pd1,"power delivered(kW) = ")
```

Scilab code Exa 8.7 new characterstics

```
//Example 8.7: speed and tractive effort
clc;
clear;
close;
Ia=[60;120;180;240;300;360];// in amperes
sp1=[80;50;45;42;38;35];//in kmph
tf1=[1.7;5;10;14;16;20];//innewtons
d1=0.85;//in meters
d2=0.9;//in meters
y1=71/21;//
y2=74/19;//
for i=1:6
    V(i)=((d2/d1)*(y1/y2))*sp1(i);//in kmph
    tf2(i)=((d1/d2)*(y2/y1))*(tf1(i));//in newtons
    disp("for armature current "+string(Ia(i))+"
       amperes  , speed is "+string(V(i))+" kmph and
        tractive effor in thousand newtons is "+
       string(tf2(i))+ "")
end
```

Scilab code Exa 8.8 motor speed

```
//Example 8.8: speed
clc;
clear;
close;
n1=500;//in rpm
d1=90;//in cm
d2=86;//in cm
v=600;//in volts
```

```
vd=0.1;//drop
eb1=v-(vd*v);//in volts
A=[90 -86;90 90];//
B=[240;54000];//
X=A\B;//
V1=X(1,1);//in volts
V2=X(2.1);//in volts
N1=n1*(V1-(vd*v))/(eb1);//
N2=N1*(d1/d2);//
disp(round(N1)," speed in rpm is")
disp(round(N2),"speed in rpm is")
//N2 is calculated wrong in the book
```

Scilab code Exa 8.9 power input and tractive efforts

```
//Example 8.9;power input and tractive efforts
clc;
clear;
close;
ia=350;//A
ib=305;//A
v=600;//V
pa=(v*ia)/1000;//kW
pb=(v*ib)/1000;//kW
disp("(i) When motors are connected in parallel and train speed is 40kmph")
disp(pa,"power input to motor A is,(kW)=")
disp(pb,"power input to motor B is,(kW)=")
fta=1625;//kg
ftb=1480;//kg
disp(fta,"tractive effor of motor A is,(kg)=")
disp(ftb,"tractive effor of motor B is,(kg)=")
disp("(ii) When motors are connected in series and current is 400A")
rm=0.08;//ohm
```

```
i=400;//A
eba=v-(i*rm);//V
abb=eba;//V
va=38.5;//V
vb=36.7;//V
vx=((v-2*(i*rm))*((va*vb)/(va+vb)))/eba;//
Va=((eba/va)*vx)+(i*rm);//V
Vb=((eba/vb)*vx)+(i*rm);//V
pa1=(Va*i)/1000;//kW
pb1=(Vb*i)/1000;//kW
disp(pa1,"power input to motor A is ,(kW)=")
disp(pb1,"power input to motor B is ,(kW)=")
fta1=1960;//kg
ftb1=2060;//kg
disp(fta1,"tractive effor of motor A is ,(kg)=")
disp(ftb1,"tractive effor of motor B is ,(kg)=")
```

Scilab code Exa 8.10 linear synchronous and vehicle speed

```
//Example 8.10;linear synchronous velocity
clc;
clear;
close;
f=50;//hz
t=0.5;//in meter
s=0.25;//
vs=2*f*t*(3600/1000);//kmph
vc=vs*(1-s);//kmph
disp(vs,"linear synchronous velocity in kmph is")
disp(vc,"vehicle speed in kmph is")
```

Chapter 9

Control of Traction Motors

Scilab code Exa 9.1 energy lost and total energy

```
//Example 9.1.//energy lost and total energy
clc;
clear;
close;
//given data :
format('v',7)
V=600;// in volts
I=350;//in A
Ts=20;// in sec
R=0.15;// in ohm
E_bse=(V/2)-(I*R);
E_bp=V-(I*R);
Tse=(E_bse/E_bp)*Ts;
Tp=Ts-Tse;
Vd=V-(2*I*R);
Ed1=(Vd/2)*I*(Tse/3600);
Ed2=((V/2)/2)*2*I*(Tp/3600);
El=(Ed1+Ed2)*10^-3;
disp("part (a)")
disp(El,"Energy lost in starting rhestat,El(kWh) = "
    )
```

```
El_1=(2*(I^2)*R*Ts)/(3600*1000);
disp("part (b)")
disp(El_1,"Energy lost in  motors,El(kWh) = ")
//answer is wrong in  part b in the textbook
Et=((V*I*Tse)+(2*V*I*Tp))/(3600*1000);
disp("part (c)")
disp(Et,"Total Energy,Et(kWh) = ")
```

Scilab code Exa 9.2 rheostatic losses and train speed

```
//Example 9.2.rheostatic losses and train speed
clc;
clear;
close;
//given data :
format('v',7)
V=600;// in volts
I=300;//in A
Ts=15;// in sec
R=0.1;// in ohm
E_bse=(V/2)-(I*R);
E_bp=V-(I*R);
Tse=(E_bse/E_bp)*Ts;
Tp=Ts-Tse;
Vd=V-(2*I*R);
Ed1=(round((Vd/2)*I*(Tse/3600))*10^-3);//
disp("part (i)")
disp(Ed1,"rheostatic in series,Ed1(kWh) = ")
Ed2=((V/2)/2)*2*I*(Tp/3600)*10^-3;
disp(Ed2,"rheostatic in parallel,Ed2(kWh) = ")
Vm=29;// in kmph
alfa=Vm/Ts;
S=alfa*Tse;
disp("part (ii)")
disp(S,"Speed at the end of series period,S(km/h) =
```

")

Scilab code Exa 9.3 efficiency and speed

```
//Example 9.3.efficiency and speed
clc;
clear;
close;
//given data :
format('v',5)
V=600;// in volts
I=200;//in A
Ts=20;// in sec
R=0.1;// in ohm
E_bse=(V/2)-(I*R);
E_bp=V-(I*R);
Tse=(E_bse/E_bp)*Ts;
Tp=Ts-Tse;
Vd=V-(2*I*R);
Mi=((V*I*Tse)/(2*3600))+((V*I*Tp)/3600);
Er=((Vd/4)*I*(Tse/3600))+(((V/2)/2)*I*(Tp/3600));
El=(I^2*R*Ts)/(3600);
Mo=Mi-Er-El;
eta=(Mo/Mi)*100;
disp("part (a)")
disp(eta,"Starting efficiency,(%) = ")
Vm=80;// in kmph
alfa=Vm/Ts;
S=alfa*Tse;
disp("part (b)")
disp(S,"speed,S(kmph) = ")
```

Scilab code Exa 9.4 time duration speed and rheostatic losses

```
//Example 9.4 time duration ,speed and rheostatic losses
clc
clear;
close;
//given data :
format('v',6)
W=150;// in tonne
We=1.1*W;// in tonnes
Vm=30;//kmph
V=600;// in volts
r=10;// N/tonne
I=300;//in A
R=0.1;// in ohm
Ft=4*15000;// in N
G=1;//gradient in %
alfa=(Ft-(W*r)-(98.1*W*G))/(277.8*We);
Ts=Vm/alfa;
E_bse=(V/2)-(I*R);
E_bp=V-(I*R);
Tse=(E_bse/E_bp)*Ts;
disp("part (a)")
disp(Ts,"Duration of starting period,Ts(seconds) = ")
disp(Tse,"Duration for Series running,Tse(seconds) = ")
sptr=alfa*Tse;//in kmph
disp("part (b)")
disp(sptr,"speed of train at transition in kmph is")
sptr=alfa*Tse;//in kmph
rls=((V-(2*I*R))/2)*(2*I)*(Tse/3600);//watts hours
rlp=((V/2)/2)*(4*I)*((Ts-Tse)/3600);//watts hours
tl=rls+rlp;//
disp("part (c)")
disp(rls,"rheostat losses during series operation in W-hours")
disp(rlp,"rheostat losses during parallel operation in W-hours")
```

```
disp(tl,"total losses in W-hours is")
```

Scilab code Exa 9.5 diverter resistance

```
//Example 9.5:diverter resistance
clc;
clear;
close;
format('v',6)
nf=1;//
n2=1.25*nf;//
of=1;//
of2=nf/n2;//
isef=1;//
ise2=0.66667;//
ia2=(1/ise2);//
idiv=ia2-ise2;//
rdiv=ise2/idiv;//
disp(rdiv*100,"diverter resistance required as
   percentage of the field resistance is")
//answer is wrong in the textbook
```

Scilab code Exa 9.6 speed and drawbar pull

```
//Example 9.6:draw chracterstics
clc;
clear;
close;
format('v',6)
Ia=[60;80;100;120;160;180];// in amperes
sp1=[47.4;40.3;35.8;33.9;29.8;28.5];//in kmph
dpk=[440;700;970;1245;1800;2360];//in kg
sp2=[58.1;50;45;40.3;35;32];//
```

```
for i=1:6
    dpk1(i)= ((dpk(i))*(sp1(i)))/(sp2(i));//
    disp("for current "+string(Ia(i))+" amperes ,
       speed in kmph is "+string(sp2(i))+" and
       drawbar pull in kg is "+string(dpk1(i))+" ")
end
```

Chapter 10

Braking Mechanical Consideration and Control Equipment

Scilab code Exa 10.1 `braking torque`

```
//Example 10.1:braking torque
clc;
clear;
close;
I=[50;100;150;200;250];//
sp=[73.6;48;41.1;37.3;35.2];
T=[150;525;930;1335;1750];
v=600;//in volts
rm=0.6;//
eb=v-(I(2)*rm);//in volts
rh=3;//in ohms
tr=rh+rm;//in ohms
i=eb/tr;//in amperes
tr=T(3);//
disp(tr,"braking torque is (N-m)")
```

Scilab code Exa 10.2 resistance

```
//Example 10.2:reistance
clc;
clear;
close;
I=[20;40;60;80];//
emf=[215;381;485;550];//in volts
emf2=[202;357;455;516];//
lt=40*9.81;// in N-m
N=600;//rpm
il=lt*(2*%pi*(N/60));//in W
ia=56;//in amperes from curve
va=440;//in volts from graph
tr=va/ia;// in ohms
tm=0.8;//in ohms
er=tr-tm;//in ohms
disp(er,"external resistance to be connected across
    the motor during break is in ohm")
```

Scilab code Exa 10.3 electrical energy and average power

```
//Example 10.3: Electrical energy and average power
clc;
clear;
close;
//given data :
format('v',6)
W=400;//in tonne
We=1.1*W;// in tonne
S=2;// distance in km
G=2;// gradient in %
```

```
eta=75/100;// efficiency
D=2;// distance in km
V1=40;// in km
V2=20;// in km
r=40;//N/tonne
Ea=(0.01072*We*(V1^2-V2^2))*10^-3;// in kWh
Ft=(W*r)-(98.1*W*G);
M=(-Ft*S*1000)/(1000*3600);
Et=Ea+M;// total energy available
Ee=eta*Et;
disp(Ee,"Electrical energy,Ee(kWh) = ")
As=(V1+V2)/2;// average speed
At=D/As;// Average time taken
P=round(Ee/At);
disp(P,"Average power,P(kW) = ")
```

Scilab code Exa 10.4 energy returned

```
//Example 10.4: Energy returned to the line
clc;
clear;
close;
//given data :
W=2340;//in tonne
We=1.1*W;// in tonne
G=100/80;// gradient in %
eta=70/100;// efficiency
V1=60;// in km
V2=36;// in km
r=5*9.81;//N/tonne
t=5*60;// in sec
Ea=(0.01072*We*(V1^2-V2^2))*10^-3;// in kWh
Ft=(W*r)-(98.1*W*G);//tractive effort in N
D=((V1+V2)/2)*(1000/3600)*t;// distance moved in m
M=(-Ft*D)/(1000*3600);
```

```
Et=Ea+M;
El=eta*Et;
disp(El,"Energy returned to the line,El(kWh) = ")
```

Scilab code Exa 10.5 power

```
//Example 10.5: Energy returned to the line
clc;
clear;
close;
//given data :
W=500;//in tonne
G=(20*100)/1000;// gradient in %
eta=75/100;// efficiency
V=40;// in kmph
r=40;//N/tonne
Ft=(W*r)-(98.1*W*G);//tractive effort in N
P=(-Ft*V)/3600;// Power available in kW
Pf=round(P*eta);
disp(Pf,"power fed into the line,Pf(kW) = ")
```

Scilab code Exa 10.6 power

```
//Example 10.6: Power generated
clc;
clear;
close;
//given data :
OD=640;// voltage represent by phasor OD
R=0.5;// reactor in ohm
Ia=OD/R;
V=400;// in volts
alfa=38.66;//Phase angle in degree
```

```
P=(V*Ia*cosd(alfa))*10^-3;
disp(P,"Power generated ,P(kW) = ")
```

Chapter 11

Power supply for electric traction

Scilab code Exa 11.1 `total length`

```
//Example 11.1: Total Length
clc;
clear;
close;
//given data :
l=20;// in m
w=0.5;// weight per meter in kg
T=500;// Tension applied in kg
del=(w*l^2)/(2*T);
two_S=2*(l+(2/3)*(del^2/l));
disp(two_S,"Total Length(m) = ")
```

Scilab code Exa 11.2 `sag`

```
//Example 11.2: Sag
clc;
```

```
clear;
close;
//given data :
format('v',5)
l=30;// in meter
w=0.72;// weight per meter in kg
E=640;// in kg/cm^2
d=1;// diameter in cm
T=E*(%pi/4)*d^2;
del=((w*l^2)/(2*T))*100;
disp(del,"sag(cm) = ")
```

Scilab code Exa 11.3 sag

```
//Example 11.3: Sag
clc;
clear;
close;
//given data :
l=30;// in meter
w1=0.9;// average weight of catenary wire in kg/m
w2=1.2//average weight of trolley wire in kg/m
w3=(20/100)*w2//average weight of dropper and
   fittings in kg/m
w=w1+w2+w3;
T=1000;// in kg
del=((w*l^2)/(2*T));
disp(del,"sag(m) = ")
```

Scilab code Exa 11.4 current

```
//Example 11.4: Current
clc;
```

```
clear;
close;
//given data :
I=300;// in A
R=0.08;// in ohm
Vd=6;// voltage drop in volts
I_dash=((R*(I/2))-Vd)/R;
disp(I_dash,"Current(A) = ")
```

Scilab code Exa 11.5 `potential`

```
//Example 11.5: Current
clc;
clear;
close;
//given data :
a=7;//far end voltage in volts
i=125;// in A
r=0.02;// in ohm
l=3;// in km
p=(i*r*l^2)/2;
I=((p-a)/(r*l));//
disp(p,"potential of the track at tha far end of the
    section in volts is")
disp(I,"Current carried by -ve feeder,I(A) = ")
```

Scilab code Exa 11.6 `current`

```
//Example 11.6: Current
clc;
clear;
close;
//given data :
```

```
format('v',8)
ix=200;//amperes
r=0.02;//in ohms
x=poly(0,"x");
p=-19+12*x+0*x^2;//
y=roots(p);//km
ipx=ix*(3-y);//in amperes
inx=2*ix;//in amperes
it=ipx+inx;//in amperes
disp(it,"current through negetive booster in amperes
    is")
```

Scilab code Exa 11.7 `voltage and kW`

```
//Example 11.7: potential drop and capacity if
   booster
clc;
clear;
close;
//given data :
format('v',8)
ix=250;//amperes
vb=2;//in volts
r=0.02;//in ohms
x=poly(0,"x");
p=-27.6+16*x+0*x^2;//
y=roots(p);//km
pc=vb+(ix*r*(1.6)^2)/2;//in volts
pd=((ix*r*(y^2))/2);//in volts
tcurr= (1.6*ix)+((ix*(3.2-y)));//in amperes
vnf=r*tcurr;//in volts
bnb=vnf-vb;//in volts
cb=((bnb*tcurr)/1000);//in kw
disp(pc,"maximum potential drop on any two points on
    the rails in volts is")
```

```
disp(cb,"capacity of booster in kW is")
```

Scilab code Exa 11.8 `rating of the booster`

```
//Example 11.8: rating of booster
clc;
clear;
close;
//given data :
format('v',8)
i=200;// A/km
r=0.01;//in ohms/km
x=poly(0,"x")
p=-20+8*x+0*x^2;//
y=roots(p);//km
i1=400;//in amperes
i2=(4-y)*i//in amperes
tc=i1+i2;//in amperes
vcn=r*tc;//in volts
nb=vcn-4;//in volts
rb=(tc*10)/1000;//
disp(rb,"rating of the booster in kW is")
```

Scilab code Exa 11.9 `voltage`

```
//Example 11.9 //voltage
clc;
clear;
close;
format('v',5)
vw=60;//in volts
vt=12;//in volts
tv=vw+vt;//in volts
```

```
vs=600;//in volts
va=vs-tv;//in volts
vr=578;//volts
vn=10;//in volts
vtn=tv-vn;//in volts
vad=vs-vr;//
vp=vtn-vad;//in volts
disp("part (a)")
disp(va,"voltage available to trolley when it is at
   the far end without using boosters in volts is")
disp("part (b)")
disp("positive booster should provide boost of "+
   string(vp)+" volts")
```