APPENDIX C

(7) Following MATLAB program computes MLE and log-likelihood for exponential, EE, Weibull and gamma distribution based on third Bus-motor failure data.

```
function F=contexp3(x)
y=[0 20 40 60 80 100];
z=[20 40 60 80 100 1000];
n=[27 16 18 13 11 16];
F=-sum(n.*log(expcdf(z,1/x(1))-expcdf(y,1/x(1))));

[x,fval]=fminsearch(@contexp3,[.5])

function F=conteexp3(x)
y=[0 20 40 60 80 100];
z=[20 40 60 80 100 1000];
n=[27 16 18 13 11 16];
F=-sum(n.*log((expcdf(z,x(2))).^x(1)-(expcdf(y,x(2))).^x(1)));

[x,fval]=fminsearch(@conteexp3,[5,25],optimset('maxfunevals',600
0,'maxiter',4000))

function F=contweib3(x)
y=[0 20 40 60 80 100];
z=[20 40 60 80 100 1000];
n=[27 16 18 13 11 16];
F=-sum(n.*log((weibcdf(z,x(1),x(2)))-(weibcdf(y,x(1),x(2)))));

[x,fval]=fminsearch(@contweib3,[.0005,2])

function F=contgam3(x)
y=[0 20 40 60 80 100];
z=[20 40 60 80 100 1000];
n=[27 16 18 13 11 16];
F=-sum(n.*log((gamcdf(z,x(1),1/x(2)))-(gamcdf(y,x(1),1/x(2)))));

[x,fval]=fminsearch(@contgam3,[10,15])
```

(8) Following MATLAB program computes MLE and beta expectation TI for EE distribution based on third Bus-motor failure data.

```
function F=busmotor3ee(ml)
y=[0 20 40 60 80 100];
z=[20 40 60 80 100 1000];
global x;
F=-sum(x.*(log((expcdf(z,1/ml(2))).^ml(1)-
((expcdf(y,1/ml(2))).^ml(1)))));

    [m,fval,exitflag]=fminsearch(@busmotor3ee,[1,.1]);

    beta=.90
    btol=-(1/m(2))*log(1-beta^(1/m(1)))
    beta=.95
    btol=-(1/m(2))*log(1-beta^(1/m(1)))

    beta=.975
    btol=-(1/m(2))*log(1-beta^(1/m(1)))

    beta=.99
    btol=-(1/m(2))*log(1-beta^(1/m(1)))
```

(9) Following MATLAB program computes MLE, asymptotic variance and beta content gamma level TI for EE Distribution based on third Bus-motor failure data.

```
n=101;k=6;
global x m;

for bs=1:5000
  for i=1:n
    b(i)=0;
  end
  global x u u1;
  u=rand(1,n);
  u1=u.^(1/1.1971);
  b=expinv(u1,1/0.0189);
  for i=1:6
    x(i)=0;
  end
```

```
for j=1:n
        if ((b(j)>0)&(b(j)<20))
          x(1)= x(1)+1;
        end
        if ((b(j)>20)&(b(j)<40))
          x(2)= x(2)+1;
        end
        if ((b(j)>40)&(b(j)<60))
          x(3)= x(3)+1;
        end
        if ((b(j)>60)&(b(j)<80))
          x(4)= x(4)+1;
        end
        if ((b(j)>80)&(b(j)<100))
          x(5)= x(5)+1;
        end
        if (b(j)>100)
          x(6)= x(6)+1;
        end

  end
  global x;
  m(1)=0;m(2)=0;
  [m,fval,exitflag]=fminsearch(@busmotor3ee,[1,.1]);
  a(bs)=m(1);
  l(bs)=m(2);
end
c=cov(a,l)

ml(1)=1.1971;ml(2)=0.0189;
disp('Result for beta=.90& gamma=.90');
beta=.90;zgamma=-1.2816;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.90& gamma=.95');
beta=.90;zgamma=-1.64;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
```

```
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.95& gamma=.90');
beta=.95;zgamma=-1.2816;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.95& gamma=.95');
beta=.95;zgamma=-1.64;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.975& gamma=.90');
beta=.975;zgamma=-1.2816;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.975& gamma=.95');
beta=.975;zgamma=-1.64;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)

disp('Result for beta=.99& gamma=.90');
beta=.99;zgamma=-1.2816;
s(2)=(1/ml(2)^2)*log(1-beta^(1/ml(1)));
s(1)=-(1/(ml(2)*ml(1)^2))*(beta^(1/ml(1))*log(beta))/(1-beta^(1/ml(1)));
sigma=sqrt(s*c*s')
dhat=(1-(zgamma*sigma*ml(2))/(n*log(1-beta^(1/ml(1)))))
btol=-dhat*log(1-beta^(1/ml(1)))/ml(2)
```

Cramer's regularity conditions : Let $\{f(x,\theta), \theta \in \Omega \subset R_m\}$ be a family of p.d.f.'s indexed $\theta = (\theta_1 ... \theta_m)'$. This will be a Cramer family if the following regularity conditions hold in an open interval $N_\rho(\theta_0)$ where θ_0 is true value of the parameter.

1) The support $S_\theta = \{x / f(x,\theta) > 0\}$ does not depend on θ.

   i.e. $S_\theta = S \quad \forall \theta \in \Omega \subset R_m$.

2) The parameter space $\theta \in \Omega$ is an open set of R_m.

3) The identity $\int_S f(x,\theta) = 1 \quad \forall \theta \in \Omega \subset R_m$ can be differentiated under integral sign twice w.r.t. components of θ.

4) Partial derivatives of $\log f(x,\theta)$ w.r.t. components of θ exit upto third order for almost all values of $x \in S$ for every $\theta \in N_\rho(\theta_0)$.

5) For any $(\theta_r, \theta_s, \theta_t)$, r=1,2,...,m, s=1,2,...,m, t=1,2,...,m and $\left|\frac{\partial^3 \log f}{\partial\theta_r \partial\theta_s \partial\theta_t}\right| \le M_{rst}(x)$ for any $\theta \in N_\rho(\theta_0)$ where $E_\theta(M_{rst}(x)) < \infty$.