1. (a) \( E(T) = \int_0^\infty \Gamma \left( 1 + \frac{1}{\beta} \right) = 17.55 \Gamma \left( 1 + \frac{1}{1.39} \right) = 16.01372 \)

(b) \( F_T(\phi_{0.5}) = 1 - e^{-\left(\phi_{0.5} / 17.55\right)^{1.39}} = 0.5 \)

\( \phi_{0.5} = 13.48227 \)

Half of the dialysis patients' survival time is below 13.5 months.

(c) \( S_T(t) = 1 - F_T(t) = e^{-\left(t / 17.55\right)^{1.39}} \) \( \text{See graph} \)

\( S_T(24) = e^{-\left(24 / 17.55\right)^{1.39}} = 0.2132967 \)

The probability that a dialysis patient will survive beyond 24 months is 0.21.

(d) \( F_T(\phi_{0.95}) = 1 - e^{-\left(\phi_{0.95} / 17.55\right)^{1.39}} = 0.95 \)

\( \phi_{0.95} = 38.64426 \)

95% of the patients will die before 38.64 months.

(e) \( \beta = 1.39 > 1 \) \( \Rightarrow h_T(t) \) is increasing.

The population of dialysis patients with chronic kidney disease gets weaker over time.
2. (a) See R-code.
\[ \hat{\beta} = 3.873157 \]
\[ \hat{\gamma} = 6.920191 \]

(b) \[ P(T < 5.0) = F_T(5.0) = 0.2472299 \]
24.7% of the turbochargers will fail before 5,000 hours.

(c) \[ F_T(\phi_{0.9}) = 1 - e^{-(\phi_{0.9} / 6.920191)^{3.873157}} = 0.9 \]
\[ \phi_{0.9} = 8.58297 \text{ (1005 of hours)} \]
90% of the turbochargers will fail before 8582.97 hours.

(d) See graph.
Hazard function is increasing. The population of turbochargers gets weaker over time.

(e) See graph.
No, Weibull model doesn't seem reasonable for these data. The QQ plot have curvature in it.
Since Weibull model is no longer a reasonable model for these data, the answers to parts (b) (c) and (d) are not accurate.
1. (a)

```
> t = seq(0.70, 0.01)
> plot(t, dweibull(t, 1.39, 17.55), type="l", lty=1, xlab="t", ylab="PDF")
> abline(h=0)
> 17.55*gamma(1+1/1.39)
[1] 16.01372
```

(b)

```
> qweibull(0.5, 1.39, 17.55)
[1] 13.48227
```

(c)

```
> survivor = 1-pweibull(t, 1.39, 17.55)
> plot(t, survivor, type="l", xlab="t", ylab="SURVIVOR", ylim=c(0,1), cex.lab=1.25)
```
2. (a)

```r
> turbodata=c(1.6, 2.0, 2.6, 3.0, 3.5, 3.9, 4.5, 4.6, 4.8, 5.0,
+           5.1, 5.3, 5.4, 5.6, 5.8, 6.0, 6.0, 6.1, 6.3, 6.5,
+           6.5, 6.7, 7.0, 7.1, 7.3, 7.3, 7.3, 7.7, 7.7, 7.8,
+           7.9, 8.0, 8.1, 8.3, 8.4, 8.4, 8.5, 8.7, 8.8, 9.0)
> fitdist(turbodata,"weibull")
Fitting of the distribution 'weibull' by maximum likelihood
Parameters:
  estimate Std. Error
shape  3.873157  0.5176799
scale  6.920191  0.2946851
```

(b)

```r
> pweibull(5,3.873157,6.920191)
[1] 0.2472299
```

(c)

```r
> qweibull(0.9,3.873157,6.920191)
[1] 8.58297
```

(d)

```r
> t=seq(0,15,0.01)
> pdf = dweibull(t,3.873157,6.920191)
```
> survivor = 1-pweibull(t,3.873157,6.920191)
> hazard = pdf/survivor
> plot(t,hazard,type="l",xlab="t",ylab="HAZARD",cex.lab=1.25)
> abline(h=0)

(e)

> library(car)
> qqPlot(turbo$data,distribution="weibull",shape=beta.hat,scale=eta.hat,xlab="Weibull quantiles",ylab="Turbochargers data",pch=16)