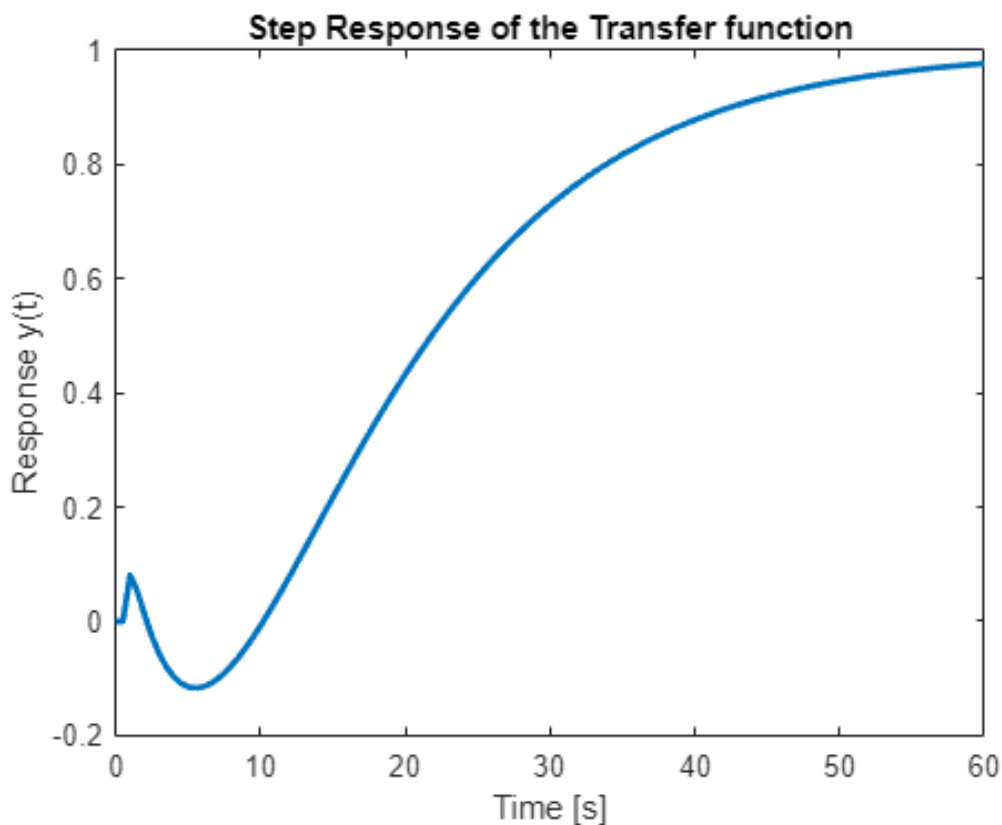


```

% defining variables
syms s
G = ((1-5*s)*(1-2*s)*exp(-0.5*s))/((12*s+1)*(6*s+1)*(0.3*s+1)); % the transfer function
U = 1/s; % step input
y=ilaplace(G*U); % response of step input
dy=diff(y);
t=0:0.5:60;
t=t'; % for easier copying
y=subs(y);
doubley= double(y); % made for copying
plot(t,y,'linewidth',2)
title("Step Response of the Transfer function")
ylabel("Response y(t)")
xlabel("Time [s]")

```

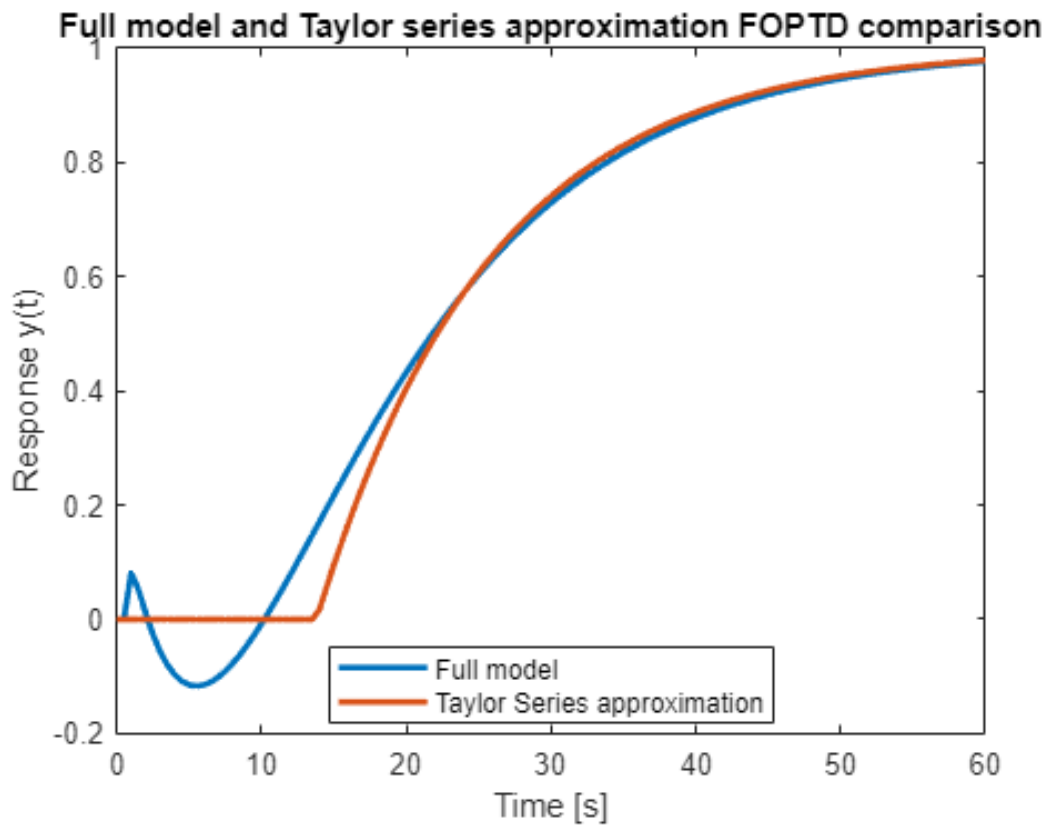


```

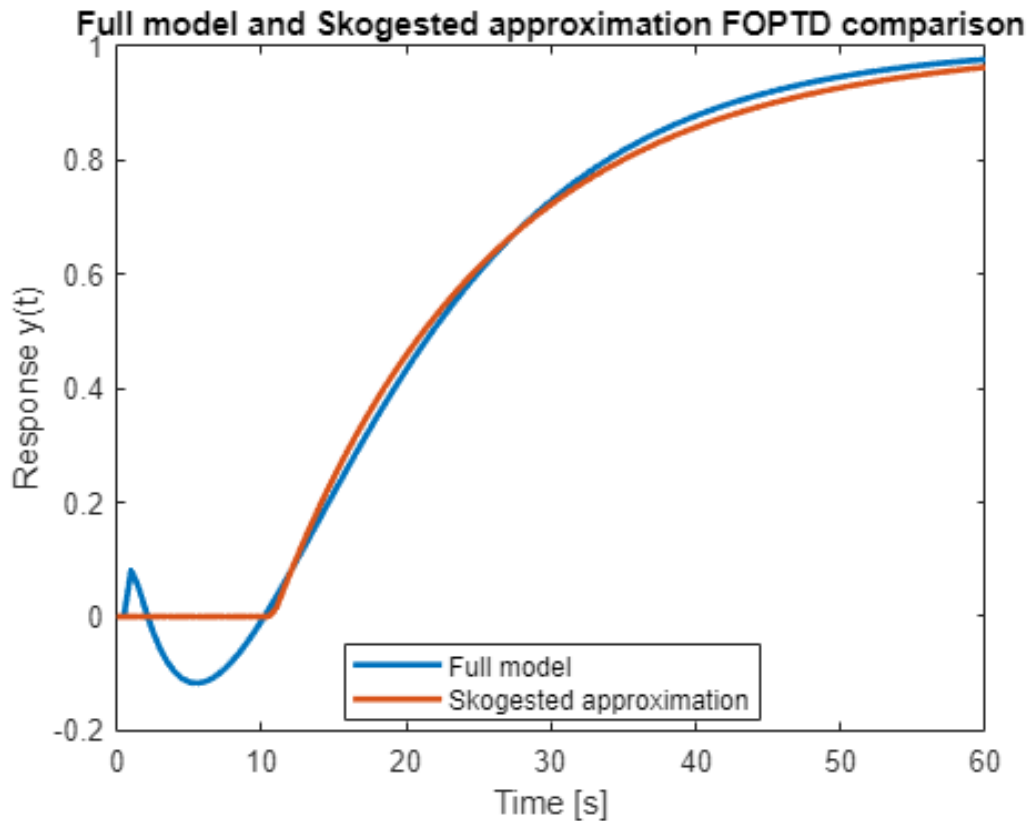
%b
G_b = exp(-13.8*s)/(12*s+1); % obtained by solving on paper
y_b=ilaplace(G_b*U);
y_b=subs(y_b);
plot(t,y,'linewidth',2)
hold on
plot(t,y_b,'linewidth',2)
hold off
ylabel("Response y(t)")
xlabel("Time [s]")
title("Full model and Taylor series approximation FOPTD comparison")

```

```
legend("Full model","Taylor Series approximation", Location="best")
```



```
%c
G_c = exp(-10.8*s)/(15*s+1); % obtained by solving on paper
y_c=ilaplace(G_c*U);
y_c=subs(y_c);
plot(t,y,'linewidth',2)
hold on
plot(t,y_c,'linewidth',2)
hold off
ylabel("Response y(t)")
xlabel("Time [s]")
title("Full model and Skogested approximation FOPTD comparison")
legend("Full model","Skogested approximation", Location="best")
```



```
%d
t_d=14;
m = subs(dy,t_d);
```

m =

$$\frac{595 e^{-\frac{9}{8}}}{2106} - \frac{220 e^{-\frac{9}{4}}}{513} + \frac{12190 e^{-45}}{20007}$$

```
p=double(y(find(t==t_d)))
```

p = 0.1705

```
theta = (t_d*m-p)/m
```

theta =

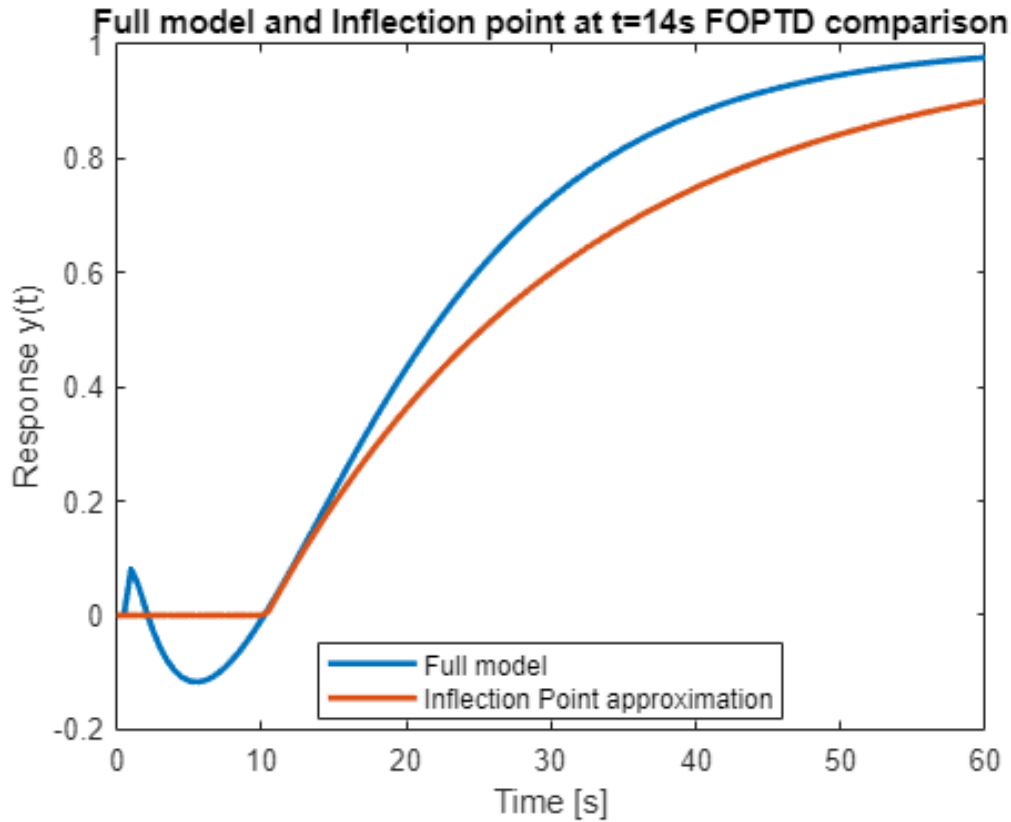
$$-\frac{\frac{3080 e^{-\frac{9}{4}}}{513} - \frac{4165 e^{-\frac{9}{8}}}{1053} - \frac{170660 e^{-45}}{20007} + \frac{6143957457824883}{36028797018963968}}{\frac{595 e^{-\frac{9}{8}}}{2106} - \frac{220 e^{-\frac{9}{4}}}{513} + \frac{12190 e^{-45}}{20007}}$$

```
tau_d=1/m;
G_d = exp(-theta*s)/(tau_d*s+1);
y_d=ilaplace(G_d*U);
y_d=subs(y_d);
plot(t,y,'linewidth',2)
```

```

hold on
plot(t,y_d,'linewidth',2)
hold off
ylabel("Response y(t)")
xlabel("Time [s]")
title("Full model and Inflection point at t=14s FOPTD comparison")
legend("Full model","Inflection Point approximation", Location="best")

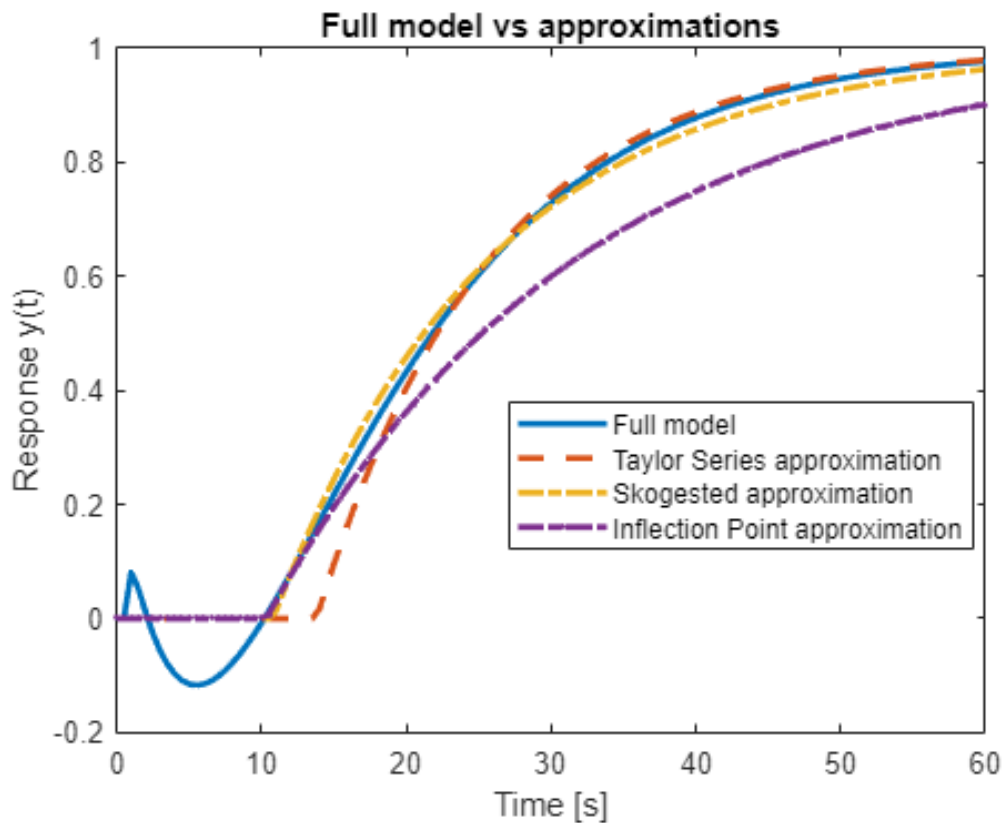
```



```

plot(t,y,'linewidth',2)
hold on
plot(t,y_b,'--','linewidth',2)
plot(t,y_c,'-.','linewidth',2)
plot(t,y_d,'-..','linewidth',2)
hold off
title("Full model vs approximations")
ylabel("Response y(t)")
xlabel("Time [s]")
legend("Full model","Taylor Series approximation","Skogested approximation","Inflection Point a

```



%e in excel

% f

```
G_2t = ((1-5*s)*exp(-2.8*s))/((12*s+1)*(6*s+1));
```

```
G_2s = ((1-5*s)*exp(-2.65*s))/((12*s+1)*(6.15*s+1));
```

```
y_2t=ilaplace(G_2t*U);
```

```
y_2t=subs(y_2t);
```

```
y_2s=ilaplace(G_2s*U);
```

```
y_2s=subs(y_2s);
```

```
y2s=double(y_2s);
```

```
plot(t,y,'linewidth',2)
```

```
hold on
```

```
plot(t,y_2t,'--','linewidth',2)
```

```
plot(t,y_2s,'-.','linewidth',2)
```

```
hold off
```

```
title("Full model vs approximations SOPTD")
```

```
ylabel("Response y(t)")
```

```
xlabel("Time [s]")
```

```
legend("Full model","Taylor Series approximation","Skogested approximation", Location="best")
```

