1. Look to the formula for the closed-loop system. The coefficient of $s$ is $\frac{\tau}{1+K_C K_F}$, so the new tau value is

```
tau = 25;
kc = 12;
kf = 3;
tau/(1+kc*kf)
```

```
ans = 0.6757
```

2. In the system with a proportional controller, the steady-state output is 0.5. With the PID controller, the final output is 1.

3. This is a Type 1 system ($s^1$ in the denominator), so the SSE for a step input will be 0 and the SSE for a parabolic input will be ∞. The SSE for the ramp input is

```
syms s
g = (s+2)/(s*(s+3)*(s+4));
kv = limit(s*g,s,0)
```

kv =
$\frac{1}{6}$

```
error=1/kv
```

error = $6$

4. This is a unity feedback system with a disturbance, so use appropriate equation. Input and dist are given in the time domain, so need to convert those to s notation before calcuating the SSE

```
syms s
r = 3/s;
d = -1/s;
c = 5;
g = 7/(s+2);
sse = limit(s*r/(1+c*g),s,0)-limit(s*g*d/(1+c*g),s,0)
```

sse =
$\frac{13}{37}$

5. Have to solve this one "backwards". You know the SSE and that all s go to 0, so solve for K. Pay attention to input, which is 10, not unit.

```
syms s k
r = 10/s^2;
g = k*(s^2+3*s+30)/(s*(s+5));
k = solve(1/6000 == limit(s*r*(1/(1+g)),s,0),k)
```

k = 10000

6. First find T(s) then find location of poles

```
syms s
g = 240/((s+1)*(s+2)*(s+3)*(s+4));
t = simplify(g/(1+g))
```

t =

$$\frac{240}{s^4 + 10\,s^3 + 35\,s^2 + 50\,s + 264}$$

```
roots([1 10 35 50 264])
```

```
ans = 4×1 complex
  -5.3948 + 2.6702i
  -5.3948 - 2.6702i
   0.3948 + 2.6702i
   0.3948 - 2.6702i
```

Two of the poles are in the RHP, so the system is unstable

```
%sysCGH=zpk([],[-1 -2 -3 -4],240);
%rlocus(sysCGH)
%[KP,CL_roots]=rlocfind(sysCGH)
```

7.

```
sysCGH = zpk([],[-2 -4 -6],1);
Kp=0.1;
[Gm, Pm, Wgm, Wpm] = margin(Kp*sysCGH)
```

```
Gm = 4.8000e+03
Pm = Inf
Wgm = 6.6333
Wpm = NaN
```

```
Kp=1;
[Gm, Pm, Wgm, Wpm] = margin(Kp*sysCGH)
```

```
Gm = 480.0003
Pm = Inf
Wgm = 6.6333
Wpm = NaN
```

```
Kp=100;
[Gm, Pm, Wgm, Wpm] = margin(Kp*sysCGH)
```

```
Gm = 4.8000
Pm = 72.7213
Wgm = 6.6333
Wpm = 2.5446
```

Final gain margins are 4800, 480 and 4.8 for (a), (b), and (c).