# TM Homework 4

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Link back to GitHub

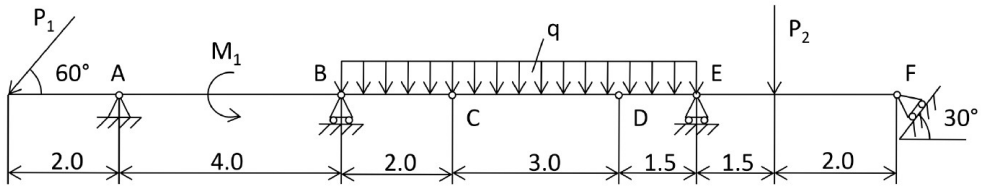
## 1 Task 1

### 1.1 Task description

Determine the reaction forces and the forces in the interim pins of the composite stud. The studs and acting forces are shown.

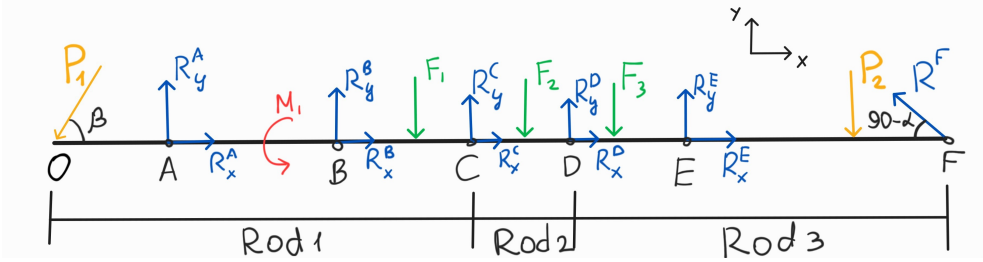
Needed variables:

$P_1 = 6, P_2 = 10, M_1 = 30, q = 1.5$.




### 1.2 Solution

Using our minds we got such a picture:




So, the research objects are rods OC, CD and DF.

**Force analysis:**

We are already given with some variables, and we can find some more:

$F_1 = 2q = 3$ $F_2 = 3q = 4.5$ $F_3 = 1.5q = 2.25$

And here are the unknown parameters we need to find: $R_x^A$, $R_y^A$, $\vec{R}^B$, $\vec{R}^E$, $\vec{R}^F$, $R_x^C$, $R_y^C$, $R_x^D$, $R_y^D$

$$\text{Rod 1:} \quad \begin{cases} x_{\text{rod1}} &= -P_1\cos(\beta) + R_x^A + r_x^C \\ y_{\text{rod1}} &= -P_1\sin(\beta) + R_y^A + R^B - F_1 + R_y^C \\ M_A &= OA * P_1\sin(\beta) + M_1 + AB * R^B - (AB + \frac{BC}{2})F_1 + (AB + BC) * R_y^C \end{cases}$$

$$\text{Rod 2:} \quad \begin{cases} x_{\text{rod2}} &= -R_x^C + R_x^D \\ y_{\text{rod2}} &= -R_y^C + R_y^D - F_2 \\ M_C &= -\frac{CD}{2}F_2 + CD * R_y^D \end{cases}$$

$$\text{Rod 3:} \quad \begin{cases} x_{\text{rod3}} &= -R_x^D - R^F\cos(\alpha) \\ y_{\text{rod3}} &= -R_y^D - F_3 + R^E - P_2 + R^F\sin(\alpha) \\ M_D &= -\frac{DE}{2}F_3 + DE * R^E - (DE + EP_2) * P_2 + (DE + EF) * R^F\sin(\alpha) \end{cases}$$

Then we solve it using paper and pen or like smart guys - using python. Then we code it and get the answer. You may see the code in the folder HW4.

Here is what we get as a result:

```
[{r_ax: 4.63926237144912, r_ay: 13.4192286340600, r_b: -2.97307621135332,
r_cx: -1.63926237144912, r_cy: -2.25000000000000, r_dx: -1.63926237144912,
r_dy: 2.25000000000000, r_e: 11.6607142857143, r_f: 3.27852474289824}]
```

So, we got the answer.

### 1.3 Answers

HIGHLIGHTED ANSWERS ARE HERE

$$R_x^A = 4.64$$
$$R_y^A = 13.42$$
$$R^B = -2.97$$
$$R_x^C = -1.64$$
$$R_y^C = -2.25$$
$$R_x^D = -1.64$$
$$R_y^D = 2.25$$
$$R^E = 11.66$$
$$R^F = 3.28$$

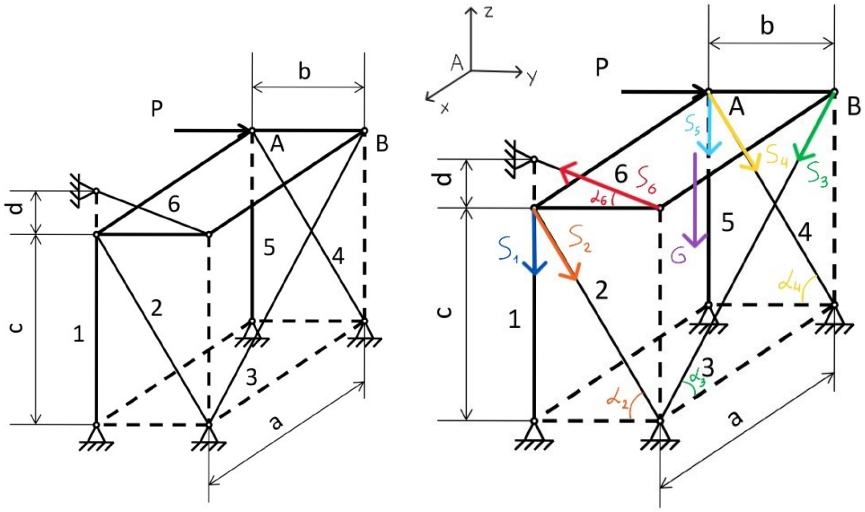
# 2 Task 2

## 2.1 Task description

Determine the reaction forces in rods supporting a thin horizontal rectangular plate of weight G under action of force P applied along the side AB. The constructions and the acting forces are shown.

Needed variables:

$G = 10, P = 20, a = 8.5, b = 2.5, c = 3.5, d = 2$




## 2.2 Solution

We have 5 fixed pin supports for 6 rods (1 - 6). So, we have 6 research objects = 6 rods.

**Force analysis:**

From the task we have $\vec{G}$, $\vec{P}$, and $\vec{S}_1$, $\vec{S}_2$, $\vec{S}_3$, $\vec{S}_4$, $\vec{S}_5$, $\vec{S}_6$ - parameters we have to find.

Then we create a system of equations:

$$\begin{cases} X - axis : S_3 \cos(\alpha_3) \\ Y - axis : S_2 \cos(\alpha_2) + S_4 \cos(\alpha_4) - S_6 \cos(\alpha_6) + P \\ Z - axis : -S_1 - S_2 \sin(\alpha_2) - S_3 \sin(\alpha_3) - S_4 \sin(\alpha_4) - S_5 + S_6 \sin(\alpha_6) - G \\ M_x^A : -G\frac{b}{2} - S_3 \sin(\alpha_3)b + S_6 \sin(\alpha_6)b \\ M_y^A : S_1 a + S_2 \sin(\beta)a - S_6 \sin(\gamma)a + G\frac{a}{2} \\ M_z^A : S_2 \cos(\beta)a - S_3 \cos(\alpha)b - S_6 \cos(\gamma)a \end{cases}$$

Then we code the function to solve the system (see the .ipynb file in HW4 folder).

After running several times we get the correct solution:

```
[{s1: −8.75000000000000, s2: 10.7529065838033, s3: 0.0,
s4: −34.4093010681705, s5: 23.0000000000000, s6: 8.00390529679106}]
```

So, we got the answer.

### 2.3 Answers

HIGHLIGHTED ANSWERS ARE HERE

$$S_1 = -8.75$$
$$S_2 = 10.75$$
$$S_3 = 0$$
$$S_4 = -34.41$$
$$S_5 = 23$$
$$S_6 = 8$$

## 3 MEME

No comments...