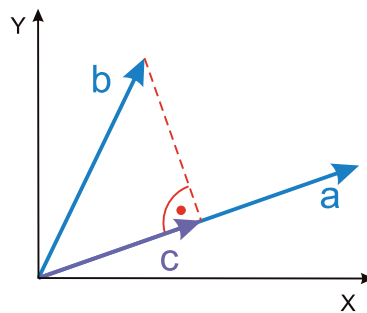


Name: .....

Date: .....

**Mathematics**

1) For the given vectors  $\mathbf{a} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$  and  $\mathbf{b} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$ , calculate the vector  $\mathbf{c}$  which is the projection of the vector  $\mathbf{b}$  onto the direction of the vector  $\mathbf{a}$ .



2) Calculate the eigenvalues of the matrix  $\mathbf{A} = \begin{pmatrix} 5 & 0 & 0 \\ 0 & 4 & -4 \\ 0 & -2 & 5 \end{pmatrix}$ .

3) Calculate the inverse of the matrix  $\mathbf{A} = \begin{pmatrix} 4 & 3 & 0 \\ 3 & -1 & 0 \\ 0 & 0 & -5 \end{pmatrix}$ .

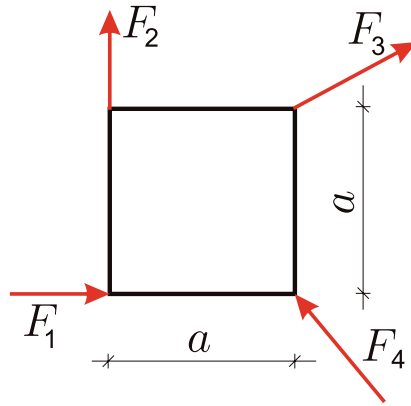
4) Calculate the first derivative of the function  $y = \frac{x}{x^2 - 2}$ .

5) Calculate the integrals  $\int_0^{\frac{\pi}{4}} \sin x \cos x dx$  and  $\int_0^{\infty} \frac{1}{x^3} dx$ .

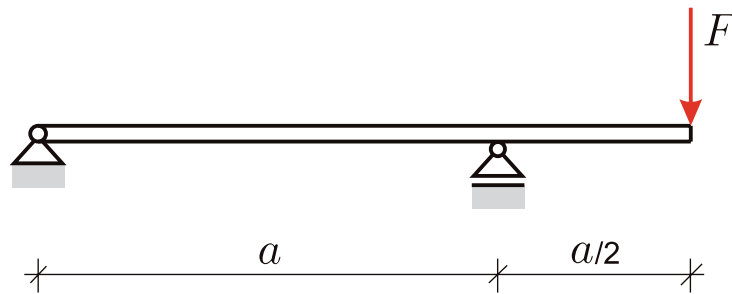
6) Solve the differential equation  $y' = ay$  for the initial condition  $y(1) = b$ . Here  $a$  and  $b$  are given constants.

## Mechanics

7) A square plate is loaded by forces:  $\mathbf{F}_1$  to  $\mathbf{F}_4$ . Three of these forces are known and they amount to:  $\mathbf{F}_1 = \begin{pmatrix} 3 \\ 0 \end{pmatrix}$  kN,  $\mathbf{F}_2 = \begin{pmatrix} 0 \\ 3 \end{pmatrix}$  kN,  $\mathbf{F}_3 = \begin{pmatrix} -1 \\ 5 \end{pmatrix}$  kN. Calculate the unknown force  $\mathbf{F}_4$  so that the system is in equilibrium. The length  $a$  amounts to 2m.



8) For the given system determine the section-forces (normal-force, shear-force and bending-moment) and draw their diagrams.



## Programming

9) Write on paper a computer program to compute the sum of all numbers between 0 and 500 which are multiples of 3. Use a programming language of your choice.

10) The central concepts in object-oriented programming are inheritance, polymorphism, and encapsulation. Explain briefly in your own words.