University of Miskolc, Institute of Mathematics

Name:

Neptun code:

Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

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(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2, 1), (3, 3), (5, 2), (6, 4), (8, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u = 4$!

(1) Let determine the normal vector at the given point!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

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(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

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(1) Let calculate the normal vector at the endpoints of the curve!

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Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

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Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

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(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

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(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2, -1), (3, 3), (5, 2), (6, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

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Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

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(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

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(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Neptun code:

Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

Name:

Neptun code:

Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

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Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

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(1) What is the Hermite arc?

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Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

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Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2, 1), (3, 3), (5, 2), (6, 4), (8, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

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Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

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(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

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(1) What are the ruled surfaces?

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Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

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(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

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Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

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(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

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Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

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Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2, -1), (3, 3), (-5, 2), (6, 4), (8, 4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

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(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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(1) What are the advantages of using the splines?

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(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

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(1) Let calculate the point of the curve at the parameter $u=4$!

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(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

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Grayscale mapping *(2 points)*

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Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

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Neptun code:

Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2, -1), (3, 3), (5, 2), (6, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1), (3,3), (5,2), (6,4), (8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

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Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

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(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

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Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

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Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

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(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

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(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

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(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

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(1) Let define the Bernstein polynomial (of degree n)!

(1) Let describe the parametric form of the Bézier curve by using Bernstein polynomials!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2, -1), (3, 3), (5, 2), (6, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2, 1), (3, 3), (5, 2), (6, 4), (8, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

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(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

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Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

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(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

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Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

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Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

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Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

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(1) What is the Hermite arc?

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(1) Let define the Hermite polynomials of degree 3!

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(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

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(2) Let illustrate the methods by figures!

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(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

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(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u = 4$!

(1) Let determine the normal vector at the given point!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

University of Miskolc, Institute of Mathematics

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Splines *(4 points)*

(1) What are the advantages of using the splines?

(1) How can we construct splines by using Hermite arcs?

(1) What are the Bessel parabolas?

(1) How can we use the Bessel parabolas in the case of splines?

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2, -1), (3, 3), (5, 2), (6, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

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(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

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(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Linear convolution *(2 points)*

(2) Let describe the linear convolutional filter by using a two dimensional kernel matrix!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u = 4$!

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Task 2 Splines *(4 points)*

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(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u = 4$!

(1) Let determine the normal vector at the given point!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Interpolation *(4 points)*

(1) Let introduce the problem of the interpolation!

(2) Show the solution of the interpolation by using Lagrange interpolation (polynomials)!

(1) Mention some benefits and drawbacks of using this method!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

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Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

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Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

(1) Let calculate the point of the curve at the parameter $u=4$!

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Exam
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Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

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(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

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GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

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Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

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(1) What are the advantages of using the splines?

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Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Image formats *(2 points)*

(1) Let overview the main image formats and their commonly used classification!

(1) List the most frequently used file formats and describe them (with mentioning the abbreviations)!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2, -1), (3, 3), (-5, 2), (6, 4), (8, 4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Histogram calculation *(2 points)*

(2) Describe (by using mathematical formulas and/or pseudo code) the calculation of image histogram!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u=4$!

(1) Let determine the normal vector at the given point!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

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(1) Let create figures!

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Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

(1) Let plot the spline (and the Bessel parabolas)!

(1) Let determine the tangent vectors at the parameter values!

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(1) Let draw figures for the mentioned concepts!

Task 2 Overhauser spline *(4 points)*

(1) What is the Overhauser spline?

(2) How can we calculate it (in parametric form)?

(1) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

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(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

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(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (Overhauser) *(6 points)*

Let given the points $(2,-1),(3,3),(-5,2),(6,4)$ on the plane, and the corresponding parameter values $1,3,5,6$.

(3) Let calculate the Overhauser spline!

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(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (Bézier) *(6 points)*

Let given the points $(2,-1),(3,3),(5,2),(6,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the Bernstein polynomials!

(1) Let plot the Bézier curve!

(1) Let plot the used Bernstein polynomials!

(1) Let calculate the normal vector at the endpoints of the curve!

(2) Elevate the degree of the curve! Let draw a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Splines *(4 points)*

(1) How can we obtain the tangent vectors in the case of splines, only using the neightbour points?

(1) What is the Catmull-Rom spline? How can we calculate it?

(2) Let draw a figure as part of the answer!

Task 3 Bézier curve *(4 points)*

(1) How can we split the Bézier curve at the parameter $c \in \mathbb{R}$!

(1) How can we elevate the degree of a Bézier curve?

(2) Let illustrate the methods by figures!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Median filter *(2 points)*

(1) Let define the method of median filtering!

(1) Describe the main characteristics of the median filtering!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2, 1), (3, 3), (5, 2), (6, 4), (8, -4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

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(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

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Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Swept surfaces *(4 points)*

(1) How can we obtain swepts surfaces?

(1) Let write its parametric form!

(1) Let draw figure!

(1) Mention some surfaces which can be created by using this method!

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let name the frequently used point-wise properties of the spatial curves!

(1) What is the curve length and how can we calculate it?

(1) Let define the curvature!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) Let introduce the de Casteljau algorithm!

(1) Illustrate the algorithm on a figure!

(2) Let describe (at least 4 of) the main properties of the Bézier curves!

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Curve parametrization *(4 points)*

(4) What are the commonly used parametrization methods in the case of spline interpolation?

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5

Grayscale mapping *(2 points)*

(2) Let define at least 3 calculation methods, which are able to map an RGB color to a grayscale color!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve description methods *(4 points)*

(1) Let introduce the description methods of the planar and spatial curves!

(1) Let define the tangent vector and the binormal vector!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Gaussian filter *(2 points)*

(1) What is the Gaussian filter?

(1) Show an example as an approximation by using discrete linear convolution!

Task 6 Numerical exercise (de Casteljau) *(6 points)*

Let given the points $(2,1),(3,3),(5,2),(6,4),(8,-4)$ on the plane!

(1) Let calculate the point of the Bézier curve at the parameter $t = 0.4$ by using the de Casteljau algorithm!

(1) Let mention the steps of the calculations and plot the resulted curve!

(1) Let determine the equation of the tangent line at the given point!

(1) Let calculate the normal vector at the given point!

(2) Let split the curve at the given parameter! Write the control points of the resulted curves and illustrate the splitting process with a figure!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Frennet-Serret Frame *(4 points)*

(1) Let define the Frennet-Serret Frame for the spatial curves $\mathbf{r}(t), t \in [a, b]$.

(1) Let name its vectors and

(1) planes.

(1) Let visualize it on a figure!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Parametric surfaces *(4 points)*

(1) How can we describe the surfaces (from mathematical standpoints)?

(1) What is the differential geometric definition of the surface?

(2) What are the commonly used point-wise properties of the surfaces?

Task 5 Noise types *(2 points)*

(2) List at least 4 types of noises and their reasons!

Task 6 Numerical exercise (Lagrange) *(6 points)*

Let given the points $(2, -1), (3, 3), (-5, 2), (6, 4)$ on the plane, and the corresponding parameter values $1, 3, 5, 6$.

(2) Let calculate the Lagrange interpolation curve!

(1) Let plot the curve!

(1) Let calculate and draw the tangent vectors at the interpolation points!

(1) Let calculate the point of the curve at the parameter $u = 4$!

(1) Let determine the normal vector at the given point!

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Exam
GEOMETRIC MODELING AND ITS APPLICATIONS (GEAGT232-M)

Task 1 Curve properties *(4 points)*

(1) Let define the tangent line!

(1) Let define the curvature!

(1) Let define the osculating circle!

(1) Let draw figures for the mentioned concepts!

Task 2 Hermite arcs *(4 points)*

(1) What is the Hermite arc?

(1) Let introduce the constrainst and illustrate with a figure!

(1) How can we solve it (by using matrix form)?

(1) Let define the Hermite polynomials of degree 3!

Task 3 Bézier curve *(4 points)*

(1) What are the connections between the de Casteljau algorithm and the Bernstein polynomial form of the Bézier cuve?

(1) How can we calculate the derivative of the Bézier curve?

(1) Let define the hodograph!

(1) What does the variation diminishing property means?

Task 4 Ruled surfaces *(4 points)*

(1) What are the ruled surfaces?

(2) Let mention the two, frequently used ways how can we obtain them!

(1) Let create figures!

Task 5 Histogram operations *(2 points)*

(1) Let describe the histogram stretching and histogram equalization methods!

(1) Let illustrate it by drawing a figure!

Task 6 Numerical exercise (Catmull-Rom) *(6 points)*

Let given the point $(2,-1),(3,3),(-5,2),(6,4),(8,4)$ on the plane.

(2) Let calculate the tangent vectors of the Catmull-Rom spline ($\tau = 0.5$)!

(1) Let plot the curve and the tangent vectors!

(3) Let determine the uniform, the cord length proportional, the centripetal parametrization!

*Mark: 0-11 (**1**), 12-15 (**2**), 16-18 (**3**), 19-21 (**4**), 22-24 (**5**)*