COURSE SPECIFICATION FORM,
approved by the Academic Council 17.06.2015 (#39)

SECTION A: DEFINITIVE

Items in this section may be reviewed and developed within Schools as part of the Annual Program Monitoring Process and in line with the Guidelines to Modifications to Programs and Courses.

1.	**General course information**		
1.1	School: School of Science and Technology	1.6	Credits (ECTS): 8 ECTS
1.2	Course Title: Linear Algebra with Applications	1.7	Course Code: MATH 273
1.3	Pre-requisites: MATH 161 Calculus I (C and above)	1.8	Effective from: 2019 *(year)*
1.4	Co-requisites: MATH 162 Calculus II		
1.5	Programs: *(in which the course is offered)* _____BSc in Mathematics_____ ☒ Core ☐ Elective		

2. Course description (max.150 words)

This course is a one-semester course intended for mathematics, engineering and science students. It introduces students to the fundamental concepts of linear algebra. The course primarily deals with two mathematical objects: matrix and vector, and covers topics such as solutions of systems of linear equations, properties of invertible matrices, linear transformation, determinant, eigenvalues and eigenvectors, vector spaces and subspaces, linear independence, basis, coordinates, inner product, norm, orthogonal basis, similarity, and quadratic forms.

3.	**Summative assessment methods** (tick if applicable)**:**				
3.1	Examination	☒	3.5	Presentation	☐
3.2	Term paper	☐	3.6	Peer-assessment	☐
3.3	Project	☐	3.7	Essay	☐
3.4	Laboratory Practicum	☐	3.8	Other *(specify)* Quiz and Homework Assignments, Course Participation	

4. Course aims

1) Introduction of fundamental concepts in linear algebra
2) Applications of linear algebra
3) Solving linear algebra problems

5. Course learning outcomes (CLOs)

5.1 By the end of the course the student will be expected to be able to:

1) understand types of solutions of systems of linear equations;
2) understand row echelon forms;
3) be able to perform the row reduction algorithm;
4) be able to solve vector equations;
5) be able to solve matrix equations;
6) understand how to present solutions of systems of linear equations in different forms;
7) know how to determine linearly dependent or independent sets of vectors;
8) understand linear transformations;
9) be able to construct the standard matrix of a linear transformation;

10) be able to do matrix operations: summation, multiplication, transposition, inversion;
11) know properties of (non)invertible matrices and properties related to (non)invertible matrices;
12) know how to work with partitioned matrices;
13) understand subspaces of $\mathbb{R}^n$;
14) know how to determine the dimension of a subspace and the rank of a matrix;
15) know the properties of determinants and be able to compute the determinant;
16) understand (abstract) vector spaces;
17) know how to work with null spaces and column spaces of matrices;
18) be able to determine whether vectors form a linearly independent set or a basis of some subspace;
19) know how to work with isomorphisms;
20) know how to determine the dimension of a vector space;
21) know the properties of the rank of a matrix;
22) know how to change a basis;
23) know how to find eigenvalues and corresponding eigenvectors;
24) be able to perform the diagonalization of a matrix;
25) know the connection between eigenvectors and linear transformations;
26) be able to work with complex eigenvalues (optional);
27) know applications of eigenvalues and eigenvectors;
28) be able to calculate the inner (dot) product of two vectors and the length of a vector;
29) be able to determine whether a set of vectors is orthogonal;
30) be able to calculate orthogonal projections;
31) be able to compute the orthogonal bases of a vector space via the modified Gram-Schmidt process;
32) be able to find least-squares solutions of matrix equations;
33) know applications of least-squares solutions;
34) know quadratic forms.

5.2

CLO ref #	Program Learning Outcome(s) to which CLO is linked	Graduate Attribute(s) to which CLO is linked
1	1, 3	1, 2, 3
2	1	
3	1	
4	1	
5	1	
6	1	
7	1, 3	1, 2, 3
8	1, 2	1, 2
9	1	
10	1	
11	1	
12	1, 2	1, 2
13	1	

14	1, 5	5, 6
15	1, 2	1, 2
16	1, 2	1, 2
17	1, 2	1, 2
18	1, 2	1, 2
19	1, 2, 3	1, 2, 3
20	1, 2	1, 2
21	1, 2	1, 2
22	1, 2	1, 2
23	1, 2	1, 2
24	1, 2	1, 2
25	1, 2, 3	1, 2, 3
26	1, 2	1, 2
27	1	
28	1, 2	1, 2
29	1, 2	1, 2
30	1	
31	1	
32	1, 3	1, 2, 3
33	1	
34	1, 2	1, 2

SECTION B: NON-DEFINITIVE
Course Syllabus

Details of teaching, learning and assessment

Items in this Section should be considered annually (or each time a course is delivered) and amended as appropriate, in conjunction with the Annual Program Monitoring Process. The template can be adapted by Schools to meet the necessary accreditation requirements.

6.	**Detailed course information**		
6.1	Academic Year: 2019/2020	6.3	Schedule (class days, time):
6.2	Semester: Fall 2019	6.4	Location (building, room):

7.	**Course leader and teaching staff**			
Position	**Name**	**Office #**	**Contact information**	**Office hours/or by appointment**
Course Leader				
Course Instructor(s)	**Manat Mustafa**	**7.220**	manat.mustafa@nu.edu.kz	MTTh 16.30 – 17.30, or by appointment
Teaching Assistant(s)				

8. Course Outline

Session	**Date** (tentative)	**Topics and Assignments**	**Course Aims** (ref. # only, see item 4)	**CLOs**
Week 1	August 12-16	introduction, system of linear equations, row reduction and echelon forms		1, 2, 3
Week 2	August 19-23	vector equations, Ax=b, solutions sets of linear systems		3, 4, 5, 6
Week 3	August 26- 30	application of linear systems, linear independence, linear transformation, the standard matrix of linear transformations		3, 6, 7, 8, 9
Week 4	September 2-6	matrix operations, the inverse of a matrix, characterizations of invertible matrices		10, 11
Week 5	September 9-13	review session in preparation for the first midterm exam, partitioned matrices, matrix factorizations, subspaces of R^n		1–11, 10, 12, 13
	Sep 12, Thursday	**Midterm Exam 1**		1–11
Week 6	September 16-20	dimension and rank, determinants, properties of determinants		14, 15
Week 7	September 23-27	vector spaces, subspaces, null spaces, column spaces, linear transformations		16, 17, 7, 8
Week 8	Septembe	**Fall Break**		

	r 30 - October 4			
Week 9	October 7-11	linearly independent sets, bases, coordinate systems, dimension of vector spaces		19, 21, 22, 23
Week 10	October 14-18	change of basis, rank, eigenvectors, eigenvalues		23, 24, 25, 26
Week 11	October 21-25	the characteristic equation and diagonalization, eigenvalues and linear transformations		1–26, 23, 27, 28
Week 12	**October 28- Novembe r 1**	review session in preparation for the second midterm exam, discrete dynamical systems, inner product, length, and orthogonality		1–26
	October 31, Thursday	**Midterm exam 2**		
Week 13	November 4-8	orthogonal sets, orthogonal projections, the Gram-Schmidt process		29, 30, 31
Week 14	November 11-15	least-squares problems, applications to linear models , diagonalization of symmetric matrices		32, 33, 23
Week 15	November 18-22	quadratic forms, review session		34, 1–34

9.	**Learning and Teaching Methods** (briefly describe the approaches to teaching and learning to be employed in the course)
1	Presentation and discussion of linear algebra objects
2	Application of methods of linear algebra to the solution of problems

10.	**Summative Assessments**			
#	**Activity**	**Date** (tentative)	**Weighting (%)**	**CLOs**
1	Course participation	all lectures	5%	all
2	Quizzes	all lectures	10%	all
3	Homework on WeBWorK	Every week	10%	all
4	Midterm exam 1	Sep 12	20%	1–11
5	Midterm exam 2	Oct 31	20%	1–26
6	Final exam	TBA	35%	all

11.	**Grading**	
Letter Grade	**Percent range**	**Grade description** (where applicable)
A	**95–100**	
A–	**90–94.9**	
B+	**85–89.9**	
B	**80–84.9**	
B–	**75–79.9**	
C+	**70–74.9**	
C	**65–69.9**	**lowest passing grade**

C–	**60–64.9**	
D+	**55–59.9**	
D	**50–54.9**	
F	**<50**	

12.	**Learning resources** (use a full citation and where the texts/materials can be accessed)
E-resources, including, but not limited to: databases, animations, simulations, professional blogs, websites, other e-reference materials (e.g. video, audio, digests)	Moodle, WeBWorK
E-textbooks	
Laboratory physical resources	
Special software programs	
Journals (inc. e-journals)	
Text books	David C. Lay: Linear Algebra and Its Applications $4^{th}/5^{th}$ edition, Addison-Wesley 2012 alternative textbooks: H. Anton, C. Rorres, Elementary Linear Algebra

13.	**Course expectations**
Students have to attend all classes. Missing more than five classes (without valid excuse) will result in a zero score for class participation. Students are expected to actively and positively participate in the class beyond the questions asked to assess a score for class participation. They are encouraged to pay attention in every lecture, take proper notes, ask for clarification, and to engage in discussions. The homework assignments will be done using WeBWorK. The late submission of a homework (WeBWorK) will result in a zero score. The deadline is mentioned on the homework sheet. Not submitting a homework will also results in a zero score. Missing a quiz (without valid excuse) results in a zero score. There is no makeup for quizzes.	

14.	**Academic Integrity Statement**
Students have to follow the University's Academic Integrity Policies, e.g., the Student Code of Conduct. Non integer behavior, such as cheating, forgery, plagiarism, or copying of other student's work, will have the consequences laid out in the Disciplinary Procedures (approved by the Academic Council on 05 February 2014). These consequences include but are not limited to a 0 grade for the test, exam, or the course and a hearing before the Disciplinary Council to determine further sanctions.	

15.	**E-Learning**

16.	**Approval and review**	
Date of Approval:	**Minutes #:**	**Committee:**
Date(s) of Approved Change:	**Minutes #:**	**Committee:**