The University of Jordan

Accreditation & Quality Assurance Center

COURSE Syllabus: Linear Algebra II
### Course Title
Linear Algebra II

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<table>
<thead>
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<tbody>
<tr>
<td>1</td>
<td>Course title</td>
<td>Linear Algebra II</td>
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<tr>
<td>2</td>
<td>Course number</td>
<td>(0301441)</td>
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<tr>
<td>3</td>
<td>Credit hours (theory, practical)</td>
<td>3</td>
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<tr>
<td>4</td>
<td>Prerequisites/corequisites</td>
<td>(0301241)</td>
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<tr>
<td>5</td>
<td>Program title</td>
<td>B.Sc.</td>
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<td>6</td>
<td>Program code</td>
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<td>7</td>
<td>Awarding institution</td>
<td>The University of Jordan</td>
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<tr>
<td>8</td>
<td>Faculty</td>
<td>Science</td>
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<tr>
<td>9</td>
<td>Department</td>
<td>Mathematics</td>
</tr>
<tr>
<td>10</td>
<td>Level of course</td>
<td>Obligatory Specialization requirement</td>
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<tr>
<td>11</td>
<td>Year of study and semester(s)</td>
<td>4th year, 1st and 2nd semesters</td>
</tr>
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<td>12</td>
<td>Final Qualification</td>
<td>B.Sc. in Mathematics</td>
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<tr>
<td>13</td>
<td>Other department(s) involved in teaching the course</td>
<td>None</td>
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<tr>
<td>14</td>
<td>Language of Instruction</td>
<td>English</td>
</tr>
<tr>
<td>15</td>
<td>Date of production/revision</td>
<td>13/11/2017</td>
</tr>
</tbody>
</table>

### Office Coordinator:

Office numbers, office hours, phone numbers, and email addresses should be listed.

Dr. Hassan AlNajjar, Math Dept, office: 311, phone: 06-5355000 Ex. 22081, email: h.najjar@ju.edu.jo

### Other Instructors:

Office numbers, office hours, phone numbers, and email addresses should be listed.

*Dr. Fuad Kittanh*
*Dr. Emad Abu Osba*

### Course Description:

Vector spaces; subspaces; quotient spaces; linear independence and bases; dual spaces; inner product spaces; orthonormal bases; linear transformations; eigenvalues, eigenvectors and determinants of linear transformations; matrix representation; change of basis and similarity; invariant subspaces; canonical forms of linear transformations; diagonal form; triangular form; nilpotent transformations; Jordan form; companion matrices; commutators; the trace functional and Jacobson’s lemma; normal transformations and the spectral theorem.
19. Course aims and outcomes:

A- Aims:

1- Engage students in sound mathematical thinking and reasoning. This should include students finding patterns, generalizing, and asking/answering relevant questions.
2- Provide a setting that prepares students to read and learn mathematics on their own.
3- Explore multiple representations of topics including graphical, symbolic, numerical, oral, and written. Encourage students to make connections among the various representations to gain a richer, more flexible understanding of each concept.
4- Analyze the structure of real-world problems and plan solution strategies. Solve the problems using appropriate tools.
5- Develop a mathematical vocabulary by expressing mathematical ideas orally and in writing.
6- Enhance and reinforce the student’s understanding of concepts through the use of technology when appropriate.

B- Intended Learning Outcomes (ILOs):

Successful completion of the course should lead to the following outcomes:

A. Knowledge and Understanding Skills: Student is expected to

A1. Explore multiple representations of topics including graphical, symbolic, numerical, oral, and written.
A2. Make connections among the various representations to gain a richer, more flexible understanding of each concept.

B. Intellectual Analytical and Cognitive Skills: Student is expected to

B1. Make mathematical thinking and reasoning, find patterns, generalize, and ask/answer relevant questions.
B2. Read and learn mathematics on his own.
B3. Analyze the structure of real-world problems and plan solution strategies. Solve the problems using appropriate tools.

C. Subject- Specific Skills: Student is expected to

C1. Write and read proofs in linear algebra.
C2. Find basis and dimension for vector spaces.
C3. Find the kernel and range of a linear transform.
C4. Find Jordan form for given matrices.

D. Creativity /Transferable Key Skills/Evaluation: Student is expected to

D1. Develop a mathematical vocabulary by expressing mathematical ideas orally and in writing.
D2. Enhance and reinforce the student’s understanding of concepts through the use of technology when appropriate.
20. Topic Outline and Schedule:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topic</th>
<th>Week</th>
<th>Instructor</th>
<th>Achieved ILOs</th>
<th>Evaluation Methods</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Vector spaces</strong>&lt;br&gt;Definition and properties of vector spaces, Subspaces, Sums, Direct Sums, Quotient spaces.&lt;br&gt;<strong>Exercises</strong>: 3, 5, 8, 9, 10, 11, 13, 14, 15.</td>
<td>1-2</td>
<td>A1, A2, D1, D2</td>
<td></td>
<td>Exam</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Finite Dimensional Vector spaces</strong>&lt;br&gt;Span, Linear independence, Bases, Dimension.&lt;br&gt;<strong>Exercise</strong>: 1, 2, 3, 8 – 14.</td>
<td>3-4</td>
<td>C2</td>
<td></td>
<td>Exam</td>
<td></td>
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<td>3</td>
<td><strong>Linear Transformations</strong>&lt;br&gt;Definitions of Linear transformation, Null space, Range, Matrix of linear transformation, Invertibility, Change of bases, Similarity.&lt;br&gt;<strong>Exercises</strong>: 5, 6, 7, 9, 10, 12, 13, 15, 19, 22, 23, 24.</td>
<td>5-6</td>
<td>B3, C3</td>
<td></td>
<td>Exam</td>
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<td>4</td>
<td><strong>Eigenvalues and Eigenvectors</strong>&lt;br&gt;Invariant subspace, Triangular and Diagonal Matrices.&lt;br&gt;<strong>Exercises</strong>: 1 - 5, 10, 11, 14, 18, 19, 21.</td>
<td>7-8</td>
<td>B1, B2</td>
<td></td>
<td>Exam</td>
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<td>5</td>
<td><strong>Inner Product Spaces</strong>&lt;br&gt;Inner Product, Norm, Orthonormal bases, Orthogonal Projection, Adjoint Operators.&lt;br&gt;<strong>Exercises</strong>: 2, 4, 5, 6, 7, 10, 11, 13, 15, 17, 18, 27, 28, 29, 30, 31.</td>
<td>9-10</td>
<td>B1, B2</td>
<td></td>
<td>Exam</td>
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<td>6</td>
<td><strong>Operators on Inner Product Spaces</strong>&lt;br&gt;Self Adjoint Operators, Normal Operators, Spectral Theorem.&lt;br&gt;<strong>Exercises</strong>: 1, 2, 3, 4, 6.</td>
<td>11-12</td>
<td>B1, B2</td>
<td></td>
<td>Exam</td>
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<td>7</td>
<td><strong>Operators on Complex Vector Spaces</strong>&lt;br&gt;Generalized Eigenvector, Characteristic polynomial, Minimal polynomial, Nilpotent transformation, Jordan form.&lt;br&gt;<strong>Exercises</strong>: 1, 2, 5, 6, 21, 22.</td>
<td>12-13</td>
<td>C4</td>
<td></td>
<td>Exam</td>
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<td>8</td>
<td><strong>Trace and Determinant</strong>:&lt;br&gt;Trace of Linear Transformation, Determinants of Linear transformation.&lt;br&gt;<strong>Exercises</strong>: 1, 4, 7, 10, 12, 16, 18, 21, 24.</td>
<td>14-15</td>
<td></td>
<td></td>
<td>Exam</td>
<td></td>
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</tbody>
</table>

21. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:
In order to succeed in this course, each student needs to be an active participant in learning – both in class and out of class.
- The instructor will spend most of the class time on presenting the new material as well as on discussing homework problems.
- Group work in this class is encouraged.
- To actively participate in class, you need to prepare by reading the textbook and to do all assigned problems before class.
- You should be prepared to discuss your homework at each class meeting.
- You are encouraged to work together with other students and to ask questions and seek help from your professor, both in and out of class.

22. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:
<table>
<thead>
<tr>
<th>ILO/s</th>
<th>Learning Methods</th>
<th>Evaluation Methods</th>
<th>Related ILO/s to the program</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lectures</td>
<td>Exam</td>
<td>A1, B1, C1, D2</td>
</tr>
</tbody>
</table>

23. Course Policies:

1. Attendance is absolutely essential to succeed in this course. You are expected to attend every class; please notify your instructor if you know you are going to be absent. All exams must be taken at the scheduled time. Exceptions will be made only in extreme circumstances, by prior arrangement with the instructor.
2. If a student is absent for more than 10% of lectures without an excuse of sickness or due to other insurmountable difficulty, then he/she shall be barred from the final examination also he/she will get a failing grade in this course.
3. Medical certificates shall be given to the University Physician to be authorized by him. They should be presented to the Dean of the Faculty within two weeks of the student’s ceasing to attend classes.
4. Test papers shall be returned to students after correction. His/her mark is considered final after a lapse of one week following their return.
5. Cheating is prohibited. The University of Jordan regulations on cheating will be applied to any student who cheats in exams or on home works.

24. Required equipment:

Data Shows

25. References:

A- Required book(s), assigned reading and audio-visuals:


B- Recommended books, materials, and media:

1) P. Halmos, Finite Dimensional vector spaces.
2) N. Herstein, Topics in Algebra.
3) G. Strang, Linear Algebra and Application.

26. Additional information:
Name of Course Coordinator: Dr. Hassan AlNajjar  Signature: -------------- Date: 13/11/2017

Head of curriculum committee/Department: Dr. Emad Abu Osba  Signature: ---------------------

Head of Department: __________________ Signature: -----------------------------

Head of curriculum committee/Faculty: __________________ Signature: -----------------------------

Dean: __________________ Signature: -----------------------------

Copy to:
Head of Department
Assistant Dean for Quality Assurance
Course File