The University of Jordan

Accreditation & Quality Assurance Center

Course Syllabus

Course Name: Modern Algebra II
<table>
<thead>
<tr>
<th></th>
<th>Course title</th>
<th>Modern Algebra II</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>Course number</td>
<td>(0331442)</td>
</tr>
<tr>
<td>3</td>
<td>Credit hours (theory, practical)</td>
<td>3</td>
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<td></td>
<td>Contact hours (theory, practical)</td>
<td>3</td>
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<tr>
<td>4</td>
<td>Prerequisites/corequisites</td>
<td>(0331341)</td>
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<tr>
<td>5</td>
<td>Program title</td>
<td>B.Sc.</td>
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<tr>
<td>6</td>
<td>Program code</td>
<td></td>
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<tr>
<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>
</tr>
<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>
</tr>
<tr>
<td>11</td>
<td>Year of study and semester(s)</td>
<td>4th year, 1st or 2nd semesters</td>
</tr>
<tr>
<td>12</td>
<td>Final Qualification</td>
<td>B.Sc. in Mathematics</td>
</tr>
<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>
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<tr>
<td>15</td>
<td>Date of production/revision</td>
<td>8/11/2017</td>
</tr>
</tbody>
</table>

**16. Course Coordinator:**

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

Omar AbuGhneim, Math. Building Office 329, phone: 06-5355000 Ex. 22103, o.abughneim@ju.edu.jo
Office hours Sun 8-9, Tus and Ths 10-11, Mon and Wed 11-12.

**17. Other instructors:**

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

Hasan Al-Ezeh
Emad Abuosba
Osama Alkam,
Manal Ghanem
Hasan Alnajjar

**18. Course Description:**

As stated in the approved study plan.

Rings, subrings, integral domains, factor rings and ideals. Ring homomorphisms; polynomial rings; factorization of polynomials; reducibility and irreducibility tests; divisibility in integral domains; principal ideal domains and unique factorization domains.
19. Course aims and outcomes:

A- Aims:
1. In abstract algebra I, students learn about groups and many of their properties. A group is a set with one operation and this operation satisfies certain conditions. In many important groups, there is another operation that we do not talk about in group theory. For instance, numbers (Integers, rational numbers, …), polynomials, functions, and matrices are structures with two operations, namely addition and multiplication. When considering these sets as groups, we simply used addition and ignored multiplication. In many cases, however, one wants to account both addition and multiplication. The concept of rings does this, where a ring is a set endowed with two binary operations (addition and multiplication) and these two operations satisfy certain conditions. Students study rings and their properties and look at various examples of rings.
2. Commutative rings with unity where cancellation law holds are an abstraction of the Integers. These rings are called integral domains. Students will learn about integral domains and their properties. Also, students examine several examples of integral domains.
3. The concept of ideals and factor rings is introduced. Ideals are used to construct and study sophisticated factor rings. Maximal and prime ideals are introduced and used to construct fields and integral domains.
4. Homomorphisms are functions between rings that preserve the ring operations. One way to find out information about a ring is to study its interaction with other rings by way of homomorphisms. Students learn a formal method for determining whether two rings are really the same through ring isomorphism.
5. Students are most familiar and most comfortable with polynomials. They have seen polynomials with real coefficients (or integer coefficients) in college algebra and calculus classes and they worked on them as functions. As an abstraction, one can define polynomials with coefficients from commutative rings. These abstract structures are rings and are called polynomial rings. Students examine polynomial rings and study their properties.
6. In college algebra and calculus, students spend some time in finding zeros of polynomials and in factoring polynomials. In many cases, it is not easy to decide if a certain polynomial can be factored. Students learn some tests that enable them to decide the irreducibility of certain polynomials in more abstract setting. Also, students will see how these irreducible polynomials can be used to construct finite fields.
7. Students are expected to spend two to three hours, after each class, reading the material given in class. They should be able to redo the proofs of the theorems. A collection of exercises is assigned at the end of each chapter. Students are expected to work on these problems by themselves. They can discuss their ideas and solutions of these problems with their peers. In case, students were unable to solve a certain problem they can ask about it in class. I will ask students to present their work on some of these problems in class.

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. Learn and apply the elementary theorems and proof techniques of rings.
   A2. Define, interpret and analyze fundamental principles and theory concerning subrings, ideals, principal ideals, prime ideals, maximal ideals, quotient rings, Boolean rings and direct sum of rings.
   A3. Determine, use and apply homomorphisms and isomorphisms between rings.

B. Intellectual Analytical and Cognitive Skills: Student is expected to
   B1. Define, interpret and analyze fundamental principles and theory concerning the basic algebraic structures of rings, integral domains, and fields.
   B2. Demonstrate the ability to do direct proofs, proofs by contradiction, proof by contrapositive and proof by induction concerning properties of rings.

C. Subject-Specific Skills: Student is expected to
   C1. Exhibit knowledge of reducibility tests, their usefulness, and apply the tests to determine the reducibility or irreducibility of a polynomial.
   C2. Do factorization in an integral domains with a special emphasis on Unique Factorization Domains, Principal Ideal Domains and Euclidian Domains.
   C3. Deal and examine polynomial rings. Demonstrate the division algorithm for polynomial over fields and its Applications.

D. Creativity/Transferable Key Skills/Evaluation: Student is expected to
   D1. Read write and criticize proofs.
   D2. Perform logical thinking.
20. Topic Outline and Schedule:

<table>
<thead>
<tr>
<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) Introduction to Rings: Definition and Examples, Properties of Rings, Subrings. Suggested problems: 1, 2, 4, 6, 8, 13, 17-19, 23, 25, 26, 28, 29, 31, 38, 39, 42, 43, 45, 46, 49, 50, 51.</td>
<td>1</td>
<td></td>
<td>A1, A2, D1, D2, D3</td>
<td>Exams</td>
<td></td>
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<tr>
<td>2) Integral Domains: Definition and Examples, Fields, Characteristic of a Ring. Suggested problems: 4-16, 20, 22, 26, 28, 30-32, 38, 40, 42, 45a, 48, 53-56.</td>
<td>2-3</td>
<td></td>
<td>A2, B1, B2, D1, D2, D3</td>
<td>Exams</td>
<td></td>
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<tr>
<td>3) Ideals and Factor Rings: Ideals, Factor Rings, Prime Ideals and Maximal Ideals. Suggested problems: 6-8, 11, 13, 14, 16, 18, 22, 24, 26-28, 32-37, 39, 45-47, 51, 56, 59, 60.</td>
<td>4-6</td>
<td></td>
<td>A2, B2, D1, D2, D3</td>
<td>Exams</td>
<td></td>
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<tr>
<td>4) Ring Homomorphisms: Definition and Examples, Properties of Ring Homomorphisms, The Field of Quotients. Suggested problems: 5, 6, 8, 10, 13, 15, 16, 18, 20, 18, 20, 23-28, 31-36, 44-46, 49-51, 60, 65.</td>
<td>6-7</td>
<td></td>
<td>A3, B2, D1, D2, D3</td>
<td>Exams</td>
<td></td>
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<tr>
<td>5) Polynomial Rings: Notation and Terminology, The Division Algorithm and Consequences. Suggested problems: 2, 3, 6, 9-17 odd, 21-23, 25, 26, 29-31, 38, 39, 42, 43, 47.</td>
<td>8-9</td>
<td></td>
<td>B2, C3, D1, D2, D3</td>
<td>Exams</td>
<td></td>
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<tr>
<td>6) Factorization of Polynomials: Reducibility Tests, Irreducibility Tests, Unique Factorization in Z[x]. Suggested problems: 2-11, 13, 21, 22, 24-26, 31, 32.</td>
<td>10</td>
<td></td>
<td>B2, C1, D1, D2, D3</td>
<td>Exams</td>
<td></td>
</tr>
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</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.

- Class time will be spent on lecture as well as discussion of homework problems and some group work.
- To actively participate in class, you need to prepare by reading the textbook and doing all assigned homework before class (homework will be assigned each class period, to be discussed the following period).
- You should be prepared to discuss your homework (including presenting your solutions to the class) at each class meeting - your class participation grade will be determined by your participation in this.
- You are encouraged to work together with other students and to ask questions and seek help from the professor, both in and out of class. But you have to write your homework by yourself (You are not allowed to seek help in writing your homework and you are not allowed to copy from others)
- You are encouraged to visit the webpage: [http://www.d.umn.edu/~jgallian/](http://www.d.umn.edu/~jgallian/) for more practicing, and problem solving.
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lectures</td>
<td>Exams</td>
<td>A3, A6, B1, C1, C2, D1, D2</td>
</tr>
</tbody>
</table>

23. Course Policies:

According to university regulations, attendance is mandatory. If a student is unable to attend a class, then he/she should contact the instructor. If a student misses more than 10% of the classes without excuse, then he/she will be assigned a failing grade in class.

In cases of extreme emergency or serious illness, the student will be allowed to make up the missed exams. Times and dates for makeup exams will be assigned latter.

There are severe sanction for cheating, plagiarizing and any other form of dishonesty. The university regulations on cheating will be applied to any student who cheats in exams or on any homework.

24. Required equipment:

Data Shows

25. References:

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

Contemporary Abstract Algebra, by J. Gallian. (Seventh Edition)

B- Recommended books, materials, and media:

1. A First Course in Abstract Algebra by J. Fraleigh.
2. Topics in Algebra by I. Herstein.

26. Additional information:
Name of Course Coordinator: Dr. Omar AbuGhneim Signature: -------------------------- Date: 8/11/2017
Head of curriculum committee/Department: Dr. Emad Abu Osba Signature: -------------------------------
Head of Department: Dr. Baha Alzalg Signature: -------------------------------
Head of curriculum committee/Faculty: Dr. Amal Al-Aboudi Signature: -------------------------------
Dean: Dr. Sami Mahmoud Signature: -------------------------------

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