**National Commission for Academic Accreditation & Assessment**

**Course Specification**

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| Institution : Majmaah University |
| College/Department :Zulfi, College of Science |
| Time the Course offered: Each term |

**A Course Identification and General Information**

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| 1. Course title and code: **Group theory MATH 242** |
| 2. Credit hours : 3h+1h |
| 3. Program(s) in which the course is offered. Bachelor degree of Mathematics |
| 4. Name of faculty member responsible for the course : Rabah Kellil |
| 5. Level/year at which this course is offered : 6th level |
| 6. Pre-requisites for this course : MATH 231 Mathematics Basis  **Prerequisites by Topic**  1- Sets and their properties-Relations and their properties for the first part of the course  2- Equivalence relation for the quotient set and then for the factor group and Lagrange’s theorem.  3- Functions and their properties to define a permutation as a bijection between a finite sets and itself. |
| 7. Co-requisites for this course (if any) |
| 8. Location if not on main campus |

**B Objectives**

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| 1. Summary of the main learning outcomes for students enrolled in the course.   1. A rigorous introduction to Group Theory. Group Axioms and examples of groups. The symmetric group. Subgroups and Lagrange's Theorem. Cyclic and Abelian groups. Conjugacy and the class equation. Normal subgroups, quotient groups, homomorphisms, isomorphisms, the First Isomorphism theorem, the correspondence theorem. Cayley's Theorem. p-groups, Cauchy’s Theorem, Sylow’s Theorems. Direct products. Groups of automorphism of a finite and infinite groups. Burnside’s theorem, Dihedral groups, Quaternion's groups, |
| 2. Briefly describe any plans for developing and improving the course that are being implemented. (eg increased use of IT or web based reference material, changes in content as a result of new research in the field).  The course is self contained and doesn’t need to be changed. However the part (Burnside’s theorem, Dihedral groups, Quaternion's groups) can be deleted as it can be developed in a specialised course in Master’s degree studies. |

**A full academic year is equivalent to 36 Credit hour, which each semester is to be 18 Credit hour. Each course is credited with a number of credit hour (>=2) according to the student's workload (contact hours, laboratory work, examination etc) and accumulation of credits hour is accomplished after successful completion of the course. In this case, one Credit hour is equal 25 – 30 student's workload hour.**

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| **C.Course Description**(Note: General description in the form to be used for the Bulletin or Handbook should be attached)  **Contents:**  Definitions and examples of groups , subgroups, Lagrange’s theorem, normal subgroups, Simple groups, quotient (or factor) groups, cyclic groups, homomorphism, Isomorphism’s theorems, Auto orphism, Cayley ‘s theorem and its generalization, Symmetric groups , Group action on a set, Classes equation. p-groups, Cauchy’s theorem, Solow's theorems, External and internal product of groups, Burnside’s theorem, Dihedral groups, Quaternion's groups, Groups of automorphisms of a finite and infinite groups.  (The credit point is equal 25-30 hours ) | | | | | | | | | |
| **Topic** | **Contact hours** | | | **Total of contact hours** | **Self- Study** | | | | **Total hours** |
| **Lecture** | **tutorials** | **Lab** | **Internet** | **Library** | **Homework** | **Discussions** |
| Definitions and examples of groups , subgroups, Lagrange’s theorem. | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| Normal subgroups, quotient (or factor) groups, cyclic groups, | 3 | 1 |  | 4 |  |  | 07 |  | 11 |
| Mid-term 1 | 50mn |  |  |  |  |  |  |  |  |
| homomorphism, Isomorphism’s theorems, Automorphism, Cayley ‘s theorem and its generalization | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| Simple groups Symmetric groups Sn  and properties, Group action on a set, Classes equation. | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| Mid-term 2 | 50mn |  |  |  |  |  |  |  |  |
| p-groups, Cauchy’s theorem, Solow's theorems | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| External and internal product of groups, | 3 | 1 |  | 4 |  |  | 07 |  | 11 |
| Burnside’s theorem, Dihedral groups, Quaternion's groups, | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| Groups of automorphisms of a finite and infinite groups. | 6 | 2 |  | 8 |  |  | 14 |  | 22 |
| Final Exam | 2H |  |  |  |  |  |  |  |  |
| Total | 45h  40  mn | 14 |  | 56 |  |  | 98 |  | 157h  40 mn |

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| 4. Development of Learning Outcomes in Domains of Learning  For each of the domains of learning shown below indicate:  On successful completion of the module, students should be able to: |
| **a. Knowledge** |
| 1. Description of the knowledge to be acquired  * State the axioms defining a group. * Deduce simple statements from these axioms. * Provide examples of groups. * Determine the image and the kernel of a group homomorphism. * State, prove and apply some of the classical theorems of elementary Group Theory. * State, prove and apply some of the classical theorems of symmetric groups and be able to deduce the table of any symmetric group and to decompose a permutation as a product of cycles of disjoint support and then to determine the order and the inverse of the given permutation. * Classify finitely generated Abelian groups. |
| 1. Teaching strategies to be used to develop that knowledge   We first introduce new notions, give examples from the simple ones (numbers sets) to those related to matrices, functional sets, we establish the attached properties, we give and prove different theorems related to those notions. Finally we construct new examples and concepts. To well fix the principal facts, homework is proposed. |
| 1. Methods of assessment of knowledge acquired   For the midterm and the final exams (20/100, 20/100, 20/100); in general the methods of assessment are as:   * + MCQ on principal theorems   + Proving additional notions that can been elaborated from the general study   + In general we introduce a short question to control the ability of the student to make the relationship between all the parts studied.   For the homework which represents 20/100 is as stated above. |
| **b. Cognitive Skills** |
| (i) Description of cognitive skills to be developed   * The ability to recognize a group structure. * The ability to design new groups, to define their subgroups and to distinguish the normal ones. * The ability to make calculus with any permutation and to extract its principal properties. * To compare two group structures using the isomorphism theorems. * To discover that a group can be seen as a geometrical object (the action of a group on a set and representation). * To understand that a finite group can be seen as a subgroup of the well known symmetric group Sn for a certain n. |
| (ii) Teaching strategies to be used to develop these cognitive skills   * **Explanations and examples given in lectures.** * **Guidance and supervision of the work developed in tutorial classes.** * **Allow the students to have brainstorm for any important issues discussed in the class**   **Site visits** |
| * (iii) Methods of assessment of students cognitive skills   + Short questions and discussion during the tutorial class+ short quizes. |
| **c. Interpersonal Skills and Responsibility** |
| (i) Description of the interpersonal skills and capacity to carry responsibility to be developed |
| (ii) Teaching strategies to be used to develop these skills and abilities |
| (iii) Methods of assessment of students interpersonal skills and capacity to carry responsibility |
| **d. Communication, Information Technology and Numerical Skills** |
| 1. Description of the skills to be developed in this domain.    * **The ability to use MAPLE to solve some question relative to subgroups of finite group**    * **The ability to write a mathematical text in word.** |
| 1. Teaching strategies to be used to develop these skills    * We show that MAPLE can solve many mathematical problems and show how MAPLE works.    * We explore the different sub-packages of the software. |
| (iii) Methods of assessment of students numerical and communication skills  By easy exercises to solve using computer. |
| **e. Psychomotor Skills (if applicable)**  **The ability to work on a computer** |
| (i) Description of the psychomotor skills to be developed and the level of performance required  **- The ability to work on a computer**  **- The ability to write a document in some text editor as word.** |
| (ii) Teaching strategies to be used to develop these skills |
| (iii) Methods of assessment of students psychomotor skills  **To control the document produced by the student, the results obtained for the exercises proposed.** |

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| **Course Competency** |
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| **Course Prerequisite Competency** |
| 1. |
| 2. |
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**D- CourseEvaluation methods :**

**[ \*notes: Mid-term1, Mid-term2 and Final Exams are written exam]**

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| **Mark** | **Mid-Exam1**\* | **Mid-Exam2\*** | **Lab.** | **presentation** | **Homework** | **project** | **Tutorials** | **Quizzes** | **Peer**  **project** | **Final Exam\*** | **Total** |
| **At. Mo. Physics** | 20 | 20 |  |  | 20 |  |  |  |  | 40 | 100 |

Based on your course syllabus, indicate how your course is *assessed*. If an item is given but not assessed, simply leave the last 4 columns blank.

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| **Assessment**  **Method** | **Number/Type** | | | | **Instructor**  **Assessed** | **TA/Grader**  **Assessed** | **Peer/Self**  **Assessed** |
| Homework | 6  To construct and apply the theorems developed in the course  to create new examples from those studied in the course  To well fix any new notion important to understand the course | | | |  |  |  |
| Mid Terms/Final Exams | 2 Mid Terms exam and a Final Exams | | | |  |  |  |
| Quizzes |  | | | |  |  |  |
| Individual Projects |  |  |  |  |  |  |  |
| Team Projects |  |  |  |  |  |  |  |
| Lab Assignments |  | | | |  |  |  |
| Computer Assignments |  | | | |  |  |  |
| Computer Tools Used | We use the MAPLE package to construct some subgroups of a given symmetric group | | | |  |  |  |
| Oral Presentations |  | | | |  |  |  |
| Written Reports |  | | | |  |  |  |
| Other |  | | | |  |  |  |

**E.Student Support**

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| 1. Arrangements for availability of teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week)  **Every member of the teaching staff reserves usually 2 hours a day for individual student consultations and academic advising (in the office of the teacher). However the ACADEMIC ADVISING UNIT created recently can be associated to the advising process.** |

##### F. Learning Resources

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| 1. Required Text(s) |
| 1. Essential References    * Group theory, W.R. Scott, Dover, 2010, ISBN 0486653773, 13: 9780486653778.    * Introduction to Group Theory, Oleg Bogopolski, TU Dortmund, Germany, 2008, ISBN 978-3-03719-041-8 |
| 3- Recommended Books and Reference Material (Journals, Reports, etc) (Attach List)  Here are a few of my favorite references.   1. For general group theory, my favorite reference is Rotman's book. 2. For arithmetic groups (here there is some overlap with answer 3), I like Dave Witte Morris's book on the subject (it's not in print yet, but it is available on his webpage). 3. For some particular view of groups as a geometric object , the favorite references are Bourbaki's volume on the subject and Mike Davis's "The Geometry and Topology of Coxeter Groups". 4. For geometric group theory, in addition to the wonderful book of Bridson and Haefliger that Henry mentioned, I like Pierre de la Harpe's book on the subject (mostly for the amazing bibliography). 5. For the symmetric group, I really like G. D. James's "The Representation Theory of the Symmetric Groups". |
| 4-.Electronic Materials, Web Sites etc Use the GAP system that can be download at <http://www.gap-system.org/Releases/index.html> |
| 5- Other learning material such as computer-based programs/CD, professional standards/regulations  Some package of self learning on basic mathematics and editing software as Latex, Scientific work, Lyx |

**G. Facilities Required**

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| Indicate requirements for the course including size of classrooms and laboratories |
| 1. Accommodation (Lecture rooms, laboratories, etc.)   * + There are 20 seats in classrooms and   + 20 seats in the computer lab. |
| 1. Computing resources    * 20 seats in the computer lab equipped with MAPLE software |
| 3. Other resources (specify --eg. If specific laboratory equipment is required, list requirements or attach list)  MATLAB and MATHEMATICA packages are required to equip the mathematics laboratory. |

**H. Course Evaluation and Improvement Processes**

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| 1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching   * **Students questioner once during semester** * **Students department meeting (once during each semester)** * **Faculty-students periodical meeting (during office hours)** |
| 1. Other Strategies for Evaluation of Teaching by the Instructor or by the Department    1. **Faculty annual evaluation including teaching by the department and the university** |
| 3 Processes for Improvement of Teaching   * **Attendance of Faculty to workshops offered by Teaching and Learning Development Department** * **Periodical revision of the method of teaching and the course outcomes** * **Review of annual course assessment** |
| 4. Processes for Verifying Standards of Student Achievement (eg. Check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution)  **Periodical check by the unit of measurement** |
| 5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.  **Department curriculum committee meets in regular basis and recommends revision for improvement. However, we review each semester; in view of the unit of measurement, the methods used in teaching.** |

**Please fill in this table based on the following criteria:**

1. Based on your course syllabus, provide 3 - 5 *major course objectives* in column 1 along with 2 - 3

*outcomes for each objective* in column 2.

2. In column 3, indicate how the objectives and outcomes in column 1 and 2 map into ME Program Learning Outcomes (PLO)

3. In column 3, indicate how the objectives and outcomes in columns 1 and 2 *map* into the NCAAA Outcomes

4. In column 4, indicate how the objectives and outcomes in columns 1 and 2 *map* into the Asiin criteria

5- Learning outcomes in step 2, 3, 4 are listed in (Program Guidance)

| **Course Objectives:** | **Course Outcomes:** | **PLO** | **NCAAA** | **Asiin** |
| --- | --- | --- | --- | --- |
| 1- Definitions and examples of groups, subgroups, Lagrange’s theorem, | 1- The student should be able to define, identify a group structure. He also is able to identify its subgroups and produce subgroups of any group. | a | knowledge | a,b |
| 2-Rewirte the principal theorems related to groups and subgroup. Be able to apply Lagrange’s theorem to have an idea on possible subgroups of a finite group. | c;d | Cognitive | f,j |
| 3-Discover the principal subgroup of classical groups (number groups, matrices groups) and make the difference between the abelian and non abelain ones. | e,f | Cognitive |  |
| 2- Normal subgroups, quotient (or factor) groups, cyclic groups, | 1- Recall the order of an element, the order of a subgroup, construct subgroup generated by an element, and recall the notion of cyclic group. | a,c | Knowledge  +Cognitive | a,b,f,j |
| 2- Be able to prove that a subgroup is normal and then construct the corresponding factor group. apply Lagrange’s theorem to have an idea on possible subgroups of a finite group and of the factor group | a, f | Knowledge  +Cognitive | a,b,f,j;e |
| 3-Determine the nature of a subgroup of a cyclic group. Deduce the second form of Lagrange’s theorem. | a,c | Knowledge  +Cognitive | a,b,f,j |
| 3- homomorphism, Isomorphism’s theorems, Automorphism, Symmetric groups Sn  and properties, Cayley ‘s theorem and its generalization | 1-The student should be able to recall and to use the principal isomorphisms theorems to compare two structures. To use those theorems to construct the subgroups of a factor group. | a,c | Knowledge  +Cognitive | a,b,f,j,e |
| 2-the student should be able to perform with any permutation and can decompose it as a product of cycles and extract the properties of such permutation. | a,c | Knowledge  +Cognitive | a,b,f,j,e |
| 3- the student should recognize the importance of Cayley’s theorem to think that a finite group is subgroup of a certain group Sn and then can be easy to study. | a,c | Knowledge  +Cognitive | a,b,f,j,e |
| 4- Simple groups  Group action on a set, Classes equation. | 1-The student should be able to determine the principal facts related to the action of a group on a set. | c,d | Cognitive | f,j,e,h |
| 2-The student should be able to determine the different orbits of an action, to study the particular action of the group on itself and on the set of its subgroups. | c,d | Cognitive | f,j,e,h |
| 3-The student should be able to use the classes equation and its applications to study particular cases. | c,d | Cognitive | f,j,e,h |
| 5-p-groups, Cauchy’s theorem, Solow's theorems | 1-The student should be able to apply the classes equation to study that a group of order p2 is necessary abelain. | c,d | Cognitive | f,j,e,h |
| 2- The student should be able to apply the Cauchy’s theorem and Sylow’s theorem to classify finite groups. | c,d | Cognitive | f,j,e,h |

**Prepared by :Dr Rabah Kellil**

**Date of Preparation: 12-04-2014**

**Revised:**

**Head of Department:**