Far Western University
Faculty of Education
B. Ed. In Mathematics Education

Course Title: Abstract Algebra **Nature of Course: Theoretical**
Course No: Math.Ed.476 **Credit hrs. : 3**
Semester: 7th **Teaching Hours: 48**
Level: Undergraduate

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1. **Course Description**

This course is designed to build a strong conceptual understanding and problem-solving ability in undergraduate students on the topic of algebraic structures. The course explores fundamental structures like groups, rings, and fields. The beauty of the course lies in learning the axiomatic approach to defining these structures, understanding isomorphisms, and developing proofs for various theorems. Simple ideas from the number system, basic knowledge of logic and proof techniques, and an understanding of functions are the prerequisites for this course.

2. General Objectives

At the end of the course, the students will be able :

- To develop a clear conceptual understanding of fundamental algebraic structures, including groups, rings, and fields.
- To strengthen theorem-proving skills and problem-solving ability specific to abstract algebra.
- To apply the axiomatic method for defining structures and to appreciate the importance of mathematical rigours.
- To understand and identify isomorphisms and homomorphisms between algebraic structures.
- To lay a solid theoretical foundation for advanced mathematical studies and applications in related fields.

3. Contents in Detail with Specific Objectives

Specific objectives	**Contents**
Unit–I: Binary Operations and Groups) (8 hours)	
• To apply basic set operations for different algebraic structures and to test whether a given operation defined on a set is binary or not. • To verify closure, commutativity and associativity of operations. • To construct Cayley tables for finite sets for given operations and identify identity and inverse elements using Cayley tables. • To define a group, verify whether a given algebraic system is a group or not and distinguish between Abelian and non-Abelian groups. • To construct examples of groups such as $\mathbb{Z}$, $\mathbb{Z}_n$ and symmetry groups. • To interpret clock arithmetic as a group model. • To explain the symmetries of a square as a group. , Rubik's cube moves as a group structure & Demonstrate Human Group Circle as a real-life group model.	**1.1 Review of Sets:** Operations and Set Relations **1.2 Binary Operations:** Definition, examples (addition, multiplication, composition), and testing for binary properties **1.3 Cayley Tables:** Construction and identification of identity and inverse elements **1.4 Group Foundations:** Definition, axioms, and examples including $\mathbb{Z}$, $\mathbb{Z}_n$, and symmetries **1.5 Real-Life Models:** Clock arithmetic, Rubik's cube, and introduction to Cryptography (RSA basics) as a group application

<table>
<tr><th colspan="2">Unit II: Subgroups and Cyclic Structures (12 Hours)</th></tr>
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To describe properties of subgroups, verify whether a given subset is a subgroup or not. and apply one-step and two-step subgroup tests.
To state and apply fundamental properties of subgroups.
To compute integral powers of an element of a group & categories as positive, negative and zero powers of elements.
To construct cyclic groups and their generators,
To find the order of an element and the order of a cyclic group and construct cyclic groups with suitable examples.
To describe properties of permutation groups and permutations, distinguish between even and odd permutations.
To find the symmetric group S_n & express permutations in cycle notation.
To define left and right cosets of a subgroup, find cosets of a given subgroup.
To state and apply Lagrange’s Theorem, verify examples and visual methods.
To define the product (multiplication) of subgroups, determine when the product of subgroups is a subgroup.
To define normal subgroups, test whether a given subgroup is normal or not.
To define quotient (factor) groups, construct quotient groups of a group modulo a normal subgroup.
To fined normalizer and centralizer of a group, define the center of a group. Prove theorems related properties of normalizer and centralizer.

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2.1 Subgroup Fundamentals: One-step and two-step subgroup tests.
2.2 Integral Powers: Computing positive, negative, and zero powers of elements.
2.3 Cyclic Groups: Definitions, generators, and finding the order of elements.
2.4 Permutation Groups: Even/odd permutations, symmetric group Sn and cycle notation.
2.5 Cosets: Defining and finding left/right cosets of a subgroup.
2.6. Lagrange’s Theorem: Statement, application, and visual verification.
2.7 Group Products: Determining when the Multiplication of subgroups remains a subgroup.
2.8 Advanced Structures: Normal subgroups, quotient group, normaliser, centraliser, centra
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<tr><th colspan="2">Unit–III: Group Homomorphisms and Isomorphisms (8 hours)</th></tr>
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To define group homomorphisms with suitable examples, verify whether a given mapping is a homomorphism or not.
To apply basic properties of homomorphisms.
To describe isomorphisms and explain their intuitive meaning and distinguish between homomorphism and isomorphism.
To define kernel and image of a homomorphism, compute kernel and image for given homomorphisms.
To test whether a homomorphism is injective or surjective using the kernel and image.
To state & prove the First Isomorphism Theorem, Second Isomorphism Theorem and Third Isomorphism Theorem.

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3.1 Homomorphisms: Definitions, examples, and basic properties
3.2 Isomorphisms: Intuitive meaning and distinguishing from homomorphisms
3.3 Kernel and Image: Computing and testing for injectivity/surjectivity
3.4 Isomorphism Theorems: State and prove the First, Second, and Third Isomorphism Theorems
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Unit–IV: Rings (12hours)	
• To identify properties of a set to be a ring with suitable examples such as $\mathbb{Z}$, $\mathbb{Z}_n$ and polynomial rings, verify whether a given algebraic system is a ring or not. • To describe subrings with examples, and test whether a given subset is a subring or not. • To state and apply basic properties of rings and subrings. • To identify additional properties of a sub-ring to be an ideals of a ring. • To distinguish between proper, prime and maximal ideals. • To construct quotient rings using ideals. • To describe properties of integral domain and division ring. • To prove theorem related ring isomorphism.	**4.1 Ring Theory:** Definitions and examples ($\mathbb{Z}$, $\mathbb{Z}_n$, polynomial rings). **4.2 Subrings and Ideals:** Properties of Ring & Sub Rings Proper, prime, and maximal ideals, Quotient Rings. **4.3 Polynomial Rings: The Division Algorithm for polynomials** and its relationship to integers. **4.4 Quotient Rings:** Constructing rings using ideals. **4.5 Special Rings:** Integral domains, division rings, **4.**6 Ring homomorphism and isomorphism. **4.7 Some Theorems of Rings:** First, Second, and Third Isomorphism Theorems of Rings
Unit–V Fields: (8 hours)	
• To describe properties of a set to be a field and identify standard examples like $\mathbb{Q}$, $\mathbb{R}$, $\mathbb{C}$, and $\mathbb{Z}_p$. • To explain the relationship between integral domains and fields, including the construction of fields of fractions. • To define an extension field and classify extensions as finite or algebraic. • To prove that if $F \subseteq E \subseteq K$ are fields, then $[K:F] = [K:E][E:F]$. • To define irreducible polynomials and apply the Eisenstein Criterion to test for irreducibility.	**5.1 Field Foundations:** Definitions and examples $(\mathbb{Q}, \mathbb{R}, \mathbb{C}, \mathbb{Z}_p)$. . **5.2 Integral Domains vs. Fields:** Relationship and construction of fields of fractions, Integral Domains & Fields. **5.3 Extension Fields:** Classification of finite and algebraic extensions. **5.4 Transitivity:** Proving [K: F] = [K: E] [E: F] for fields F **⊆ E ⊆F**. **5.5 Irreducibility:** Eisenstein Criterion and testing for irreducible polynomials.

4. Methodology and Techniques

The following methods and techniques are to be used in class teaching activities.

- **Lecture with Visual Aids:** Use diagrams, symmetry models, and digital tools (GeoGebra, Group Explorer).
- **Interactive Demonstrations:** Hands-on activities with symmetry blocks, modular clocks, and polynomial tiles.
- **Problem-Based Learning:** Real-world and pedagogical problems instead of abstract proof exercises.
- **Technology Integration:** Short videos, online simulators, and interactive apps.

5. Evaluation Scheme

5.1 **Internal Evaluation (40%)**

Internal Evaluation will be conducted by course teacher based on following activities.

a) **Attendance and Participation in class activities**: **5+5= 10 marks**

b) **Assignment I: Theorem Proving** **5+5= 10 marks**

(Students will be asked to prove one theorem from each chapter and present any one)

c) **Assignment II**: **Problem Solving and Presentation** **5+5=10 marks**

(Assign one problem from each unit and ask them to solve individually and present in the classroom)

d) **Mid-term exam:** **10 marks**

5.2 External Evaluation (60%)

External Examinations: It is also a written examination and the questions will be asked covering all the topics in the session of the course. It carries 60 marks.

End Semester Examination Model

Nature of question	Total questions to be asked	Total questions to be answered	Total marks
Group A: Multiple choice	10 questions	10	10×1 = 10
Group B: Short answer type question	6 with 2 'or' questions	6	6×5 = 30
Group C: Long answer type question/case studies	2 with 1 'or' question	2	2×10 =20
Total			**60**

6. Recommended Textbooks

Bahattarai, B. N. (2004). *Modern Algebra*. Cambridge Publication

Dumit, D. S. & Foote, R. M. (2004). *Abstract algebra*. Wiley

Gallian, J. A. (2021). *Contemporary Abstract Algebra* (10th ed.). A John Wiley & Sons INC.

Refrences

Bhattarcharya. P. B., Jain, S. R., & Nagpal, S. R. (1995). *Basic abstract algebra*. Cambridge University Press

Far Western University
Faculty of Education
Mathematics Education

Course Title: Discrete Mathematics
Course No.: Math.Ed.477
Semester: Seventh
Level: Undergraduate

Nature of the Course: Theoretical
Credit hours: 3
Teaching hours: 48

1. Course Introduction

The course deals with several dimensions of discrete mathematics. The purpose of the course is to make students familiar with the multiple topics under discrete mathematics that may help to make solid foundations for related higher-level mathematical courses. The prerequisites of the course is knowledge and skills of logic and basic algebra. It develops mathematical reasoning and knowledge and skills in various fields. It covers set, relations, and functions, combinatorics, counting, and Markov chains.

2. Course Objectives

At the end of the course the students are expected to achieve the following objectives:

a) To demonstrate understanding and skills on sets, relations, and functions.
b) To apply the concepts of permutations and combinations in solving counting problems.
c) To use advanced enumeration technique through different approaches.
d) To realize the importance of recurrence relations and solve recurrence relations.
e) To solve problems associated with Markov Chains.
f) To be confident on the learning of skills, concepts, and theorems of discrete mathematics.
g) To be engaged in constructing meanings of concepts and principles of discrete mathematics.

3. Specific objectives and contents

Learning Outcomes	Content
• To describe the concept of set, ways of representing sets, and other related concepts. • To illustrate the way of proving subsets and equality of sets. • To define set operations symbolically and prove properties of sets using definitions. • To explain the concepts of Cartesian product, relation, and functions. • To test the relations for reflexivity, symmetry, and transitivity. • To test given functions for one to one and onto, and find inverse function. • To determine whether the sets of integers, rational numbers, real numbers, and intervals are countable or not.	**Unit I: Sets, Relations and Functions [10]** 1.1 Sets and related concepts 1.2 Set theory: Proving subsets and equality 1.3 Operations on sets 1.4 Properties of sets 1.5 Cartesian product, relation and functions 1.6 Equivalence relation 1.7 Functions: one to one, onto and inverse functions 1.8 Cardinality of sets: Countable and uncountable sets
• To explain and apply sum rule and product rule of counting. • To prove the Pigeonhole principle and apply it in solving problems. • To illustrate the concepts of permutation and combinations.	**Unit II: Combinatorics [10]** 2.1 Basic principle of counting: sum rule and product rule 2.2 The pigeonhole principle

• To prove theorems on permutations and combinations [without repetitions, with repetitions, indistinguishable objects] • To solve problems associated with permutations and combinations. • Prove binomial theorem, its corollaries, and Pascal theorem, and apply them in solving associated problems.	2.3 Permutations 2.4 Combinations 2.5 Binomial coefficients and identities
• To state rules concerning counting with Venn diagrams and apply them in solving problems. • To illustrate the rules of finding number of functions, one-to-one functions, and onto functions and apply them in solving problems. • To define the Sterling number of the second kind and find it for a given situation. • To prove and apply the principle of inclusion and exclusion, its generalizations and associated corollaries. • To solve problems associated with rock polynomials.	**Unit III: Enumeration [10]** 3.1 Counting and Venn Diagrams 3.2 Counting numbers of functions, one-to-one functions and onto functions 3.3 Stirling number of the second kind 3.4 The principle of inclusion and exclusion 3.5 Rook Polynomials 3.6 Arrangements with forbidden positions
• To explain the concept of sequence and recurrence relations and apply them in defining Fibonacci numbers and compound interest. • To explain the concept of generating functions and apply it in solving problems. • To solve the first order linear recurrence relations • To solve second order linear homogeneous and non-homogeneous recurrence relations	**Unit IV: Generating Functions and Recurrence Relations [10]** **4.1** Sequence and recurrence relations 4.2 Generating functions 4.3 First order linear recurrence relations 4.4 The second order linear homogeneous recurrence relations 4.5 The second order linear non-homogeneous recurrence relations
• To illustrate the concept of Markov chain and its properties. • To prove basic limit theorem of Markov chains and apply it in solving problems. • To solve problems associated with stationary, irreducibility, periodicity, recurrence. • To prove properties associated with branching process, and ergodicity, and apply them in solving problems.	**Unit V: Markov Chains [8]** 8.1 Concept of a Markov chain 8.2 The Markov property 8.3 The basic limit theorem of Markov chains 8.4 Stationary, irreducibility, periodicity, and recurrence 8.5 Branching Processes 8.6 Ergodicity Concepts

4. Methodology and Techniques

In each of the chapters there are facts, skills, concepts, and theorems. Teacher need to support students as follows

- To facilitate concepts, engage students in generating examples and non-examples, engage them in illustrating with examples, and applying the definitions in solving problems.
- To facilitate skills, assign several questions of different cognitive level and ask them to solve the problems individually or in a group.
- To facilitate formulae, principles, and theorem proving, discuss its meaning, sketch of proof, and apply any continent method.

- Teacher may assign different problems in a group. Let the students solve the problem and ask them to present in a whole class.
- Problem based learning, inquiry based learning, problem solving method, and discovery method might be applicable.
- Problem Based Learning to help students in solving problems in the exercises.
- Support students in their ZPD using constructivist perspective.
- **Exploration**: Help students to explore the essence of the concepts and theorems.
- Use collaborative learning methods together with expository-based demonstration methods as per the nature of the content.
- **Discussion:** discuss the application of the theorems/formulas and ask students to solve the problems applying theorems.

5. Evaluation Scheme

5.1 **Internal Evaluation (40%)**

Internal Evaluation will be conducted by course teacher based on following activities.

a) Attendance and Participation in class activities: **5+5= 10 marks**

b) Assignment I: Reflective Notes and Class presentation: 5+5= 10 marks

(Reflective notes at the end of the every unit and presentation on any one topic)

c) Assignment II: **Problem Solving and Presentation 5+5=10 marks**

(Assign one problem from each unit and ask them to solve individually and present in the classroom)

d) Mid-term exam: 10 marks

5.2 External Evaluation (60%)

External Examinations: It is also a written examination and the questions will be asked covering all the topics in the session of the course. It carries 60 marks.

End Semester Examination Model

Nature of question	Total questions to be asked	Total questions to be answered	Total marks
Group A: Multiple choice	10 questions	10	10×1 = 10
Group B: Short answer type question	6 with 2 'or' questions	6	6×5 = 30
Group C: Long answer type question/case studies	2 with 1 'or' question	2	2×10 =20
Total			**60**

References

Epp, S. S. (2020). *Discrete mathematics with applications*. (8th ed.). Cengage Lerning Inc. [for unit I]

Grimaldi, R. P. (2003). *Discrete and combinatorial mathematics*. Pearson Education. [for units III and IV]

Privault, N. (2018). *Understanding Markov Chains: Examples and Applications*. Singapore: Springer. [for unit V]

Rosen, K. H. (2019). *Discrete mathematics with its applications*. (8th ed.). Mc Graw Hill. [for units I-IV]

Far Western University
Faculty of Education
B. Ed. in Mathematics Education

Course Title: Teaching Mathematics
Course No.: Math.Ed.478
Semester: Seventh
Level: Undergraduate

Nature of the Course: Theoretical
Credit hours: 3
Teaching hours: 48

d) Course Description

This course is designed for undergraduate students studying having with mathematics education as specialization. The main aim of this course is to enable students in planning for instruction, conducting teaching learning activities and evaluating student's performance. It deals with theories of learning, instructional strategies, planning instruction, and assessing students' performance. This course provides road map from planning to assessment.

e) General Objectives

Following are general objectives of this course:

- To demonstrate knowledge and skill on different learning theories concerned with mathematics.
- To show skills on developing learning outcomes of different cognitive domain.
- To demonstrate knowledge and skills on selecting and using different instructional strategies to teach different topics from secondary level mathematics.
- To develop lesson plan, unit plan, annual plan and teaching module and use them in teaching school level mathematics.
- To create various assessment tools for measuring students' performance and use the results in improving learning.

f) Specific objectives and contents

Specific Objectives	Content
• To explain meaning of learning from different perspectives [behaviorist, cognitivist, constructivist] • To explain Piaget's theory of cognitive development [four phases, process of learning], Brunner's theory [three stages and CPA approach], Gagne's theory of learning[direct objects, four phases], Glaserfeld's radical constructivism, Vygotksy's social constructivism, and David Kolb's experiential learning theory. • To explore implications of abovementioned learning theories in mathematics teaching.	**Unit I: Learning Perspectives for Mathematics [12]** 1.1 Different perspectives on learning 1.2 Piaget's theory of learning 1.3 Brunner's theory of learning 1.4 Constructivists' theory of learning: Radical constructivism and social constructivism 1.5 Gagne's theory of learning 1.6 Van Hiele model of geometric thinking 1.7 Experiential learning theory
• To explain the meaning of learning outcomes. • To describe the concept of cognitive domain, affective domain, and psychomotor domain. • To describe different levels of cognitive domain according to Bloom's revised taxonomy of educational objectives.	**Unit II: Designing Learning Outcomes [6]** 2.1 Introduction of learning outcomes 2.2 Three domains: Cognitive, affective, and psychomotor 2.3 Revised Bloom's taxonomy: Cognitive Domain

• To design learning outcomes for each cognitive level for school-level mathematics.	2.4 Designing outcomes of cognitive domain from school-level mathematics
• To explain the concept, steps (if any), role of teacher, role of students, and conditions for applying of different pedagogical approaches. • To compare and contrast different methods of teaching with respect to nature, role of teacher, role of students, and conditions of applying them. • To select an appropriate method of teaching for a particular topic at the school level of mathematics.	**Unit III: Methods of Teaching Mathematics [12]** 3.1 Inductive and deductive method 3.2 Problem-solving method 3.3 Experimental method 3.4 Demonstration method 3.5 Project-based learning 3.6 Inquiry-based learning 3.7 Art-based teaching 3.8 Constructivist learning method 3.9 Flipped learning pedagogy 3.10 Culturally Responsive Pedagogy
• To describe the meaning and importance of instructional planning. • To explain and develop a teaching module, an annual plan, a unit plan, a lesson plan for specific school-level mathematics. • To design lesson plans under different learning perspectives (e.g., 5E lesson plan, constructivist lesson plan, expository lesson plan)	**Unit IV: Instructional Planning in Mathematics [6]** 4.1 Introduction to instructional planning 4.2 Designing annual plan 4.3 Designing unit plan 4.4 Designing lesson plan 4.5 Teaching module
• To share the ideas of assessment; assessment of/for/as learning. • To explain the process of formative assessment in mathematics. • To explain characteristics and guidelines for developing objective and subjective test items. • To develop different types of objective and subjective test items [all levels of Bloom's taxonomy] • To form specification grid for different grades of school level mathematics. • To create and apply project(s) to assess students' learning outcomes in mathematics. • To develop and implement rubrics and portfolios for CAS in mathematics. • To share the way of assessing through journal writing, peer assessment, and self-assessment • To construct model question papers for different grades	**Unit V: Assessment in Mathematics [12]** 5.1 Assessment as/of/for learning, 5.2 Formative assessment in mathematics. 5.4 Assessing through objectives and subjective test items 5.5 Content validity of a test 5.6 Formation of specification grid 5.7 Assessing through projects and practical 5.8 Continuous assessment system (CAS); Portfolio-based assessment 5.9 Journal writing, Peer-assessment, and self-assessment 5. 10 Construction of model question papers

4. Methodology and Techniques

- **For unit I,** engage students in discussion, assign group work regarding understanding of theories and let them prepare and present the group work reports in a whole class. Then, discuss on the class.
- **For unit II,** discuss on the theoretical aspects of three domains. Divide students into groups, ask them to prepare objectives of different cognitive levels from school-level mathematics, and ask them to present to the whole class.

- **For unit III,** discuss on the main concepts, students' role, teacher's role, and steps of teaching methods. Assign suitable topics for each teaching method. Let the students write teaching learning activities for the selected topics.
- **For unit IV**, start a class with discussion on the concepts and procedure of different plans. Then, let them prepare annual plan and unit plan in group and lesson plan individually.
- **For unit V**, discuss on the theoretical aspects of assessments. Then engage students in preparing different assessment tools. Let them prepare different test items and model question papers.

5. Evaluation Scheme

5.1 **Internal Evaluation (40%)**

Internal Evaluation will be conducted by the course facilitator based on the following activities.

a) Attendance and Participation in class activities: **10 marks**

b) Assignment I [Reflection on theories and teaching methods] **5+5=10 marks**

(Let the students submit reflective journal on any one of the learning theory and present it in the classroom. Provide topics and ask them to write teaching learning activities under specific teaching methods)

c) Assignment II: **Developing instructional plans and Preparing Assessment tools** **5+5=10 marks**

(Ask students to develop lesson plan individually and implement the plans in a classroom. Ask them to prepare model question papers for particular grades)

d) Mid-term exam: **10 marks**

End Semester Examination Model

Nature of question	Total questions to be asked	Total questions to be answered	Total marks
Group A: Multiple choice	10	10	10×1 = 10
Group B: Short answer type question	8	6	6×5 = 30
Group C: Long answer type question/case studies	3	2	2×10 =20
Total			**60**

References

Bell, F. H. (1978). *Teaching and learning mathematics*. WMC: Brown Company Publisher

Johnston-Wilder, S., Lee, C., & Pimm, D. (2016). *Learning to teach mathematics in the secondary school: a companion to school experience*. Routledge.

Krathwohl, D. R. (2002). *A revision of Bloom's taxonomy: An overview. Theory into practice*. 41(4), 212-218. [for unit II]

Maharjan, H. B. ,Paudel, L., & Upadhyay, H. N. (2068 BS). *Teaching mathematics in secondary schools*. Buddha Publications,

Maharjan, H. B. et. al. (2068).*Teaching mathematics in secondary schools*. Kathmandu: Buddha Academic Publisher's and Distributers

Pandit, R. P. (2009).*Teaching mathematics*. Kathmandu: Indira Pandit

Upadhyay, H. P. , Upadhyay, H. N., & Luitel, S. (2070).*Exploratory teaching mathematics.* Kathmandu: SukundaPustakBhawan