**Shyama Prasad Mukherji College**

**Teaching Plan**

**Course and Year: B.Sc. (H) 2022-23**

**Semester: III**

**Taught individually or shared: Shared**

**Paper: Group Theory-I**

**Faculty: Mrs. Alpana Rastogi & Dr. Ashish Kumar Mittal**

**No. of Classes** (per week)**: 5 Lecture + 1 Tutorial**

**Course Objectives:** The objective of the course is to introduce the fundamental theory of groups and their homomorphisms. Symmetric groups and group of symmetries are also studied in detail. Fermat’s Little theorem as a consequence of the Lagrange’s theorem on finite groups.

**Course Learning Outcomes:** The course will enable the students to:

1. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
2. Link the fundamental concepts of groups and symmetrical figures.
3. Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups.
4. Explain the significance of the notion of cosets, normal subgroups and factor groups.
5. Learn about Lagrange’s theorem and Fermat’s Little theorem.
6. Know about group homomorphisms and group isomorphisms.

**Unit 1: Groups and its Elementary Properties**

Symmetries of a square, Dihedral groups, Definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), Elementary properties of groups.

**Unit 2: Subgroups and Cyclic Groups**

Subgroups and examples of subgroups, Centralizer, Normalizer, Center of a group, Product of two subgroups; Properties of cyclic groups, Classification of subgroups of cyclic groups.

**Unit 3: Permutation Groups and Lagrange’s Theorem**

Cycle notation for permutations, Properties of permutations, Even and odd permutations, Alternating groups; Properties of cosets, Lagrange’s theorem and consequences including Fermat’s Little theorem; Normal subgroups, Factor groups, Cauchy’s theorem for finite abelian groups.

**Unit 4: Group Homomorphisms**

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Cayley’s theorem, Properties of isomorphisms, First, Second and Third isomorphism theorems for groups.

**Reference:**

* 1. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited, Delhi. Fourth impression, 2015.

### Additional Reading:

1. Rotman, Joseph J. (1995). *An Introduction to The Theory of Groups* (4th ed.). Springer Verlag, New York.
2. Sharma, R. K., Shah, S.K. and Shankar, Asha Gauri (2011). Algebra I- A basic Course in Abstract Algebra. Pearson Education, Delhi
3. Shah S.K. and Garg S.C.(2017) A text book of Algebra. Vikas Publishing House Pvt. Ltd., Delhi.
4. Shah S.K. and Shankar, Asha Gauri (2013). Group theory. Pearson Education, Delhi
5. V. K. Khanna and S.K. Bhambri (2017). A course in Abstract Algebra (5th ed.) Vikas Publishing House Pvt. Ltd., Delhi.

### Teaching Plan (BMATH306: Group Theory-I):

**Week 1:** Symmetries of a square, Dihedral groups, Definition and examples of groups including permutation groups and quaternion groups (illustration through matrices).

* 1. Chapter 1.

**Week 2:** Definition and examples of groups, Elementary properties of groups.

[1] Chapter 2.

**Week 3:** Subgroups and examples of subgroups, Centralizer, Normalizer, Center of a Group, Product of two subgroups.

[1] Chapter 3.

**Weeks 4 and 5:** Properties of cyclic groups. Classification of subgroups of cyclic groups.

[1] Chapter 4

**Weeks 6 and 7:** Cycle notation for permutations, Properties of permutations, Even and odd permutations, Alternating group.

[1] Chapter 5 (up to Page 110).

**Weeks 8 and 9:** Properties of cosets, Lagrange’s theorem and consequences including Fermat’s Little theorem.

[1] Chapter 7 (up to Example 6, Page 150).

**Week 10:** Normal subgroups, Factor groups, Cauchy’s theorem for finite abelian groups.

[1] Chapters 9 (Theorem 9.1, 9.2, 9.3 and 9.5, and Examples 1 to 12).

**Weeks 11 and 12:** Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Cayley’s theorem.

[1] Chapter 10 (Theorems 10.1 and 10.2, Examples 1 to 11).

[1] Chapter 6 (Theorem 6.1, and Examples 1 to 8).

**Weeks 13 and 14:** Properties of isomorphisms, First, Second and Third isomorphism theorems.

[1] Chapter 6 (Theorems 6.2 and 6.3), Chapter 10 (Theorems 10.3, 10.4, Examples 12 to 14, and Exercises 41 and 42 for second and third isomorphism theorems for groups).

**Methodology of Teaching:**

1. **PPT Presentation by Students on different topics of the syllabus.**
2. **Increasing interest in the topic by organizing mathematical quiz programme.**
3. **Use of Mathematical Games on related topic to encourage thinking power of students in the topics.**
4. **Use of mathematical Software like Mathematica, Matlab and LaTex etc.**
5. **E-reference :** <http://abstract.ups.edu/download/aata-20130816.pdf>

<https://people.bath.ac.uk>

https://nptel.ac.in/courses/111106113

**(Mention the use of ICT, MOOCs fieldwork, visits, or any specific activities apart from lectures)**

**ASSESSMENT**

**Tentative date of assessments/ assignments (time frame):**

**Class Test 1 : 2nd week of October**

**Class Test 2 : 3rd week of November**

**Assignment : 4th week of October**

**Class test based on Whole Syllabus on 2nd week of December.**

**Criteria of Assessment: Class Test, Assignment, Presentation by students, Discussion in class. Viva in the class.**