**University of Management and Technology**

**Course Outline**

**Course code:** MTH639

**Course title**: Algebraic Graph Theory with Applications

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| Program | MS Math |
| Credit Hours | 3 |
| Duration |  |
| Prerequisites | Graph Theory |
| Resource Person | Dr. Muhammad Javaid |
| Counseling Timing  (Room#3s39 ) |  |
| Contact: 03006547620 |  |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Learning Objective:**

* Demonstrate knowledge of the syllabus material;
* Write precise and accurate mathematical definitions of objects in algebraic graph theory;
* Validate and critically assess a mathematical proof;
* Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in algebraic graph theory;
* Reason from definitions to construct mathematical proofs;
* Use of algebraic graph theory in several applications especially in chemistry and computer science at advanced level.

**Learning Methodology:**

There will be three components to the course activities.

1. *Study of the course text:*  
   Course book is freely available online. Students are expected to engage in independent study of this text or at least in certain prescribed sections of it. Consultation of other books on algebraic graph theory is also encouraged.
2. *Seminar Series*:
   * key concepts from the text and questions arising;
   * investigation of questions posed for seminar discussion;
   * Occasional presentation by students of key items from the syllabus;
   * Strategies for thinking about algebraic graph theory and about mathematics generally;
   * Proofs in algebraic graph theory;
3. *Working on Assigned Tasks:*   
   The course will include at least four sets of assigned tasks. These tasks will include some very specific problems to solve and also some more open-ended topics to investigate. They will also include presentations of specific topics to the class.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes 10%

Assignments 5%

Mid Term 25%

Attendance & Class Participation 5%

Term Project 5%

Presentations 5%

Final exam 45%

Total 100

**Recommended Text Books:**

Algebraic Graph Theory by Chris Godsil and Gordon Royle, Springer (2004)

**Reference Books:**

Algebraic Graph Theory (Norman Biggs), Cambridge University Press, (2012)

**Calendar of Course contents to be covered during semester**

**Course code………………… Course title:** Algebraic Graph Theory with Applications

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| --- | --- | --- |
| **Week** | **Course Contents** | **Reference Chapter(s)** |
| 1 | Graphs, Automorphisms and Homomorphisms, | 1.1, 1.3, 1.4 |
| 2 | Circulant Graphs, Johnson Graphs, Line Graphs, Planar Graphs | 1.5,1.6,1.7,1.8 |
| 3 | Vertex-transitive Graphs, Edge Transitive Graphs, Vertex Connectivity, Edge connectivity, | 3.1,3.2,3.3,3.4 |
| 4 | Matching, Clique number, Independent number | 3.5 |
| 5 | Matrices associated with graphs, Adjacency matrix, Generalized adjacency matrix, Degree matrix, | 8.1, 8.2 |
| 6 | Incidence matrix, Laplacian matrix, Signless Laplacian matrix  and Universal matrix etc | 8.3, 8.4 |
| 7 | Eigenvalues of graphs, Eigenvectors of Graphs, | 8.5 |
| 8 | Perron Frobenius Theorem, Rank and Binary Rank of symmetric matrices | 8.8 |
| 9 | Symplectic graphs, Spectral decomposition, | 8.11,8.12 |
| 10 | Interlacing Theorem | 9.1, 9.5 |
| 11 | Strongly Regular Graphs, Local Eigenvalues, Krein Bounds | 10.1,10.2,10.3,10.4,10.5,10.6 |

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| 10 | Switching, Switching and Strongly Regular Graphs | 11.5, 11.6 |
| 11 | Two-graphs, Two-graph on 276 vertices, Equiangular Lines | 11.1 |
| 12 | Line graphs and Eigenvalues | 12.1 |
| 13 | Laplacian of Graphs and Algebraic Connectivity of Graphs | 13.1 |
| 14 | Spectral Radius, Minimization of Graphs, | 13.2 |
| 15 | Extremal Graphs with respect to Spectrum of Graphs | 13.2 |