

## **Proposal for UG Curriculum of Mathematics Department**

### **1. Framework of the 4-year B. Tech Programme in Mathematics and Computing**

#### **A. Objective**

Mathematics and computing do possess a very longstanding relationship. While mathematics focuses more on abstract concepts and ideas, computing focuses more on concrete concepts. Modern computing demands development and application of varieties of rigorous mathematical techniques, ranging from solving complicated differential equations to statistical analysis of large scale data and drawing inference from there; from finding optimized solutions under different constraints, to stochastic modeling of potentially volatile market conditions, etc. All these however can be achieved only if one has strong background of rigorous mathematics.

The Mathematics Department at IIT Delhi has played a pioneering role in bringing Mathematics and computing together by successfully running the 5-year integrated M.Tech in Mathematics and computing Program for about two decades. **As per the recommendation of the CRC and UCIC, Department of Mathematics is modifying the 5 year integrated in Mathematics and Computing program into B.Tech + M.Tech in Mathematics and Computing Program. So this is just fitting the 5 year M.Tech in Mathematics and Computing program into B.Tech + M.Tech Mathematics and Computing program with option for M.Tech admission at the end of 3<sup>rd</sup> year - so that students have an option for Dual degree B.Tech + M.Tech in Mathematics and Computing.**

Since the Senate has not approved the Dual degree M.Tech part and the curriculum review of M. Tech programs is underway, the Department of Mathematics proposes only the B. Tech part of the proposed program.

#### **The objective of the undergraduate programme of the Department:**

*To build a broad-based theoretical background of Mathematical Sciences and practical training in computing, numerical methods, and mathematical/statistical modeling. Graduates of this programme will be ready for careers in research and development in software industries, financial institutions, and to develop a research-based career.*

#### **B. Framework**

Taking into account the strength of the department and its experience in running 5-year integrated M.Tech programme in Mathematics and Computing, the Mathematics department proposes to offer a B. Tech programme in Mathematics and computing. The programme will have the desired depth and breadth within the extended view of mathematical sciences, and ample hands on experience of computational skills. This programme will also address a broad range of applications within the field of Mathematics and computing.

The department will aim at covering all fundamental aspects of mathematics and computing as its core component and will provide varieties of electives in order to enable a student to develop interest and hone the skills of different subareas of computational methods.

### C. Proposed Credit Distribution:

#### Department Linked EA/ES & BS Courses

1. CSL 201 Data Structures (CS) - 4 credit
2. EEL 201 Digital Electronics (EE) - 3 credits
3. EEP 201 Digital Electronics Lab (EE) 1.5 credits
4. Material Science ( from Physics) 3 Credits

|       |              |
|-------|--------------|
| Total | 11.5 credits |
|-------|--------------|

#### Department Core

| Course Number  | Courses                                          | L | T | P | Total Credits |
|----------------|--------------------------------------------------|---|---|---|---------------|
| EEL 308        | Computer Architecture                            | 3 | 0 | 0 | 3             |
| EEP 308        | Digital Systems Lab (Arch + Embeded)             | 0 | 0 | 3 | 1.5           |
| MAL 122        | Real and Complex Analysis                        | 3 | 1 | 0 | 4             |
| MAL 411        | Functional Analysis                              | 3 | 0 | 0 | 3             |
| MAP 290        | System Design Laboratory                         | 0 | 0 | 4 | 2             |
| MAL 256        | Modern Algebra                                   | 3 | 0 | 0 | 3             |
| MAL 255        | Linear Algebra: Theory, Methods and Applications | 3 | 0 | 0 | 3             |
| MAL 235 (new)  | Differential Equations                           | 3 | 0 | 0 | 3             |
| MAL 180        | Discrete Mathematical Structures                 | 3 | 1 | 0 | 4             |
| CSL 740/MAL745 | Software Engineering                             | 3 | 0 | 2 | 4             |
| MAL 230        | Numerical Methods and Computation                | 3 | 0 | 0 | 3             |
| MAL445 (new)   | Computational Methods for Differential Equations | 3 | 0 | 2 | 4             |
| MAL250         | Probability and Stochastic Processes             | 3 | 1 | 0 | 4             |
| MAL390         | Statistical Methods and Algorithms               | 3 | 0 | 0 | 3             |
| MAL 210        | Optimization Methods and Applications            | 3 | 1 | 0 | 4             |
| MAL 342        | Analysis and Design of Algorithms                | 3 | 1 | 0 | 4             |
| MAL383 (new)   | Theory of Computation                            | 3 | 1 | 0 | 4             |
| MAL 358        | Operating Systems                                | 3 | 0 | 2 | 4             |
| MAL710         | Database Management Systems                      | 3 | 0 | 2 | 4             |
| Total Credit   |                                                  |   |   |   | 64.5          |

**Total Credit Requirements:**

Institute core  $55 + 11.5 = 66.5$  (Institute core + PL BS/ES)

Departmental core = 64.5

Departmental Elective = 12

Open Category = 10

Non-Graded = 15

**Total = 153 + 15 (non-graded)**

**Proposed Semester-wise scheduling of courses ( SEMESTER-I & II are IC)**

| <b>Semester</b> | <b>Lecture 1</b>                                           | <b>Lecture 2</b>                             | <b>Lecture 3</b>                  | <b>Lecture 4</b>                            | <b>Other</b>                                    | <b>Other</b>                     | <b>Other</b> |
|-----------------|------------------------------------------------------------|----------------------------------------------|-----------------------------------|---------------------------------------------|-------------------------------------------------|----------------------------------|--------------|
| <b>III</b>      | <b>PL-EL/ES 4</b>                                          | <b>PL/ELES 3</b>                             | <b>PL/ELES 4</b>                  | <b>Bio 4</b>                                | Probability & Stochastic Processes (MAL 250)    | MAP 290                          |              |
| <b>IV</b>       | Linear Algebra: Theory, Methods and Applications (MAL 255) | Discrete Mathematical Structures (MAL 180)   | EEL 308                           | <b>ENV</b>                                  | Optimization Methods and Applications (MAL 210) |                                  | EEP 308      |
| <b>V</b>        | Numerical Methods and Computations (MAL 230)               | Statistical Methods and Algorithms (MAL 390) | Real & complex Analysis (MAL 122) | Analysis and Design of Algorithms (MAL 342) | E-I                                             | Differential Equations (MAL 235) |              |
| <b>VI</b>       | Computational Methods for DE (MAL 445)                     | Modern Algebra (MAL 256)                     | Functional Analysis (MAL 411)     | Theory of Computation (MAL 383)             | E-II                                            | OC1/SP1                          |              |
| <b>VII</b>      | DBMS (MAL 710)                                             | MAL 754/CSL 740 Software Engineering         | E-III                             | Operating Systems (MAL 358)                 | OC2/SP2                                         |                                  |              |
| <b>VIII</b>     | E-IV                                                       | OC3/SP3                                      | SP4                               | SP5                                         |                                                 |                                  |              |

**Proposed Departmental Specializations**

Department aims to propose several specialization taking into account the strength of the Department and emerging areas of computing. A student in each specialization has to do 20 credits. (The OC 10 credits will be dropped.) Out of the 20 credits, one course will be a project course. Department specializations will be proposed in due course of time.

**Departmental Electives:**

A tentative list of Departmental electives is given below. More electives courses will be included after the program structures of other Departments are made available. Once the Departmental specializations are proposed, some of the Departmental elective courses will figure in the basket of Departmental Specializations.

| Course Number | Course Name                                                | L | T | P | Total Credits |
|---------------|------------------------------------------------------------|---|---|---|---------------|
| AML 710       | Computer Aided Design and Design Methods                   | 3 | 0 | 2 | 4             |
| ASL 410       | Numerical simulation of atmospheric and Oceanic Phenomenon | 3 | 0 | 2 | 4             |
| BEL 413       | Modelling and simulation of Bioprocesses                   | 3 | 0 | 2 | 4             |
| CSL374        | Computer Networks                                          | 3 | 0 | 3 | 4.5           |
| CSL728        | Compiler Design                                            | 3 | 9 | 3 | 4.5           |
| CYL410        | Computational Methods and Analysis                         | 3 | 0 | 0 | 3             |
| EEL375        | Embedded Systems                                           | 3 | 0 | 0 | 3             |
| EEL422        | Computers in Biomedicine                                   | 3 | 0 | 0 | 3             |
| EEL703        | Computer Networks                                          | 3 | 0 | 0 | 3             |
| EEL704        | Robotics and Automotion                                    | 3 | 0 | 0 | 3             |
| EEL706        | Soft Computing                                             | 3 | 0 | 0 | 3             |
| EEL707        | Multimedia systems                                         | 3 | 0 | 2 | 4             |
| EEL708        | Information Retrieval                                      | 3 | 0 | 0 | 3             |
| EEL709        | Pattern Recognition                                        | 3 | 0 | 0 | 3             |
| EEL758        | Intelligent and Knowledge Based Systems                    | 3 | 0 | 0 | 3             |
| EEL804        | Computer Vision                                            | 3 | 0 | 0 | 3             |
| EEL806        | Scientific Visualization                                   | 3 | 0 | 0 | 3             |
| EEL754        | Computer Graphics                                          | 3 | 0 | 2 | 4             |
| EEL715        | Image Processing                                           | 3 | 0 | 2 | 4             |
| MAL146        | Combinatorics                                              | 3 | 0 | 0 | 3             |
| MAL260        | Boundary Value Problems                                    | 3 | 0 | 0 | 3             |
| MAL 270       | Measure Integral and Probability                           | 3 | 0 | 0 | 3             |
| MAL 365       | Mathematical Programming Techniques                        | 3 | 0 | 0 | 3             |
| MAL 381       | Finite Element Theory and Applications                     | 3 | 0 | 0 | 3             |
| MAL 468       | Graph Theory                                               | 3 | 0 | 0 | 3             |
| MAL 311       | Parallel Algorithms                                        | 3 | 0 | 0 | 3             |
| MAL 373       | Wavelets and Applications                                  | 3 | 0 | 0 | 3             |
| MAL 466       | Multivariate Statistical Methods                           | 3 | 0 | 0 | 3             |
| MAL 375       | Programming Languages                                      | 3 | 0 | 0 | 3             |
| MAL 720       | Neurocomputing and Applications                            | 3 | 0 | 0 | 3             |
| MAL 732       | Financial Mathematics                                      | 3 | 0 | 0 | 3             |
| MAL 717       | Fuzzy Sets and Applications                                | 3 | 0 | 0 | 3             |
| MAL 376       | Graph Algorithms                                           | 3 | 0 | 0 | 3             |
| MAL 731       | Introduction to Chaotic Dynamical system                   | 3 | 0 | 0 | 3             |
| MAL 735       | Number Theory                                              | 3 | 0 | 0 | 3             |
| MAL 741       | Fractal Geometry                                           | 3 | 0 | 0 | 3             |
| MAL 733       | Stochastic of Finance                                      | 3 | 0 | 0 | 3             |
| MAL 780       | Special Topics in Computer Applications                    | 3 | 0 | 0 | 3             |
| MAL 755       | Algebraic Geometry                                         | 3 | 0 | 0 | 3             |
| MAL 782       | Data Mining and Knowledge Discovery                        | 3 | 0 | 0 | 3             |
| MAL 760       | Advanced Algorithms                                        | 3 | 0 | 0 | 3             |
| MAL 785       | Natural Language Processing                                | 3 | 0 | 0 | 3             |

|                |                                                         |   |   |   |   |
|----------------|---------------------------------------------------------|---|---|---|---|
| <b>MAL 730</b> | Cryptography                                            | 3 | 0 | 0 | 3 |
| <b>MAV 791</b> | Special Module in Dynamical System                      | 1 | 0 | 0 | 1 |
| <b>MAD 350</b> | Mini Project                                            | 3 | 0 | 0 | 3 |
| <b>MAL 146</b> | Combinatorics                                           | 3 | 0 | 0 | 3 |
| <b>MAL 465</b> | Parallel Computing                                      | 3 | 0 | 0 | 3 |
| <b>MAL 754</b> | Computer Graphics                                       | 3 | 0 | 2 | 4 |
| <b>MAL 715</b> | Image Processing                                        | 3 | 0 | 2 | 4 |
| <b>MEL420</b>  | Total Quality Management                                | 3 | 0 | 2 | 4 |
| <b>SML410</b>  | Computational Techniques for<br>Management Applications | 3 | 0 | 2 | 4 |

**HOD, Mathematics**

## Appendix

**Changes made in MT4 from MT5 :**

1. **MAL 122 real and Complex analysis was in BS course. As new BS courses are approved by Senate, this course has been moved to Departmental core.**
2. **Two new courses (i) Differential equations and (ii) Computational Methods for Differential Equations are introduced in DC in place of the course (a) Differential Equations: Theory and Methods**
3. **Functional Analysis is introduced in place of Topology and Functional Analysis.**
4. **Linear algebra: Theory, Methods, and applications is introduced in place of Linear Algebra Course**
5. **Modern Algebra is now moved from DE to DC**
6. **Theory of Computation is newly included in DC**
7. **Software Engineering has been given CSL number subject to the condition that CSE Department agree to teach; Otherwise, MAL number will continue ( Note that it is not a core course in CSE Department)**

**Summary:** Essentially two new courses are added in DC ( Sn-2 and Sn-6, one from Applied Mathematics, and one from Computing)

**Courses that are moved from DC to DE or are removed:**

- (1) **Computer Graphics: both EEL and MAL Numbers are included.**
- (2) **Image Processing: Both EEL and MAL Numbers are included**
- (3) **Colloquium, MAD 851,MAD 852,MAD853, MAD 854, MAN 150, MAT 450: are removed as per Institute Guideline**

**Note:** While designing M.Tech component of B.tech + M.tech in Mathematics and Computing, some of these courses may be made DC

**Conclusion:** Out of 155 credits, changes are only 8 credits ( introduction of two new courses in DC and moving two courses to DE) , which is 5.16 % only in compared to the existing Five year M.Tech in Mathematics and Computing Program. So the character of the program remains same. As per the recommendation of the CRC and UCIC, Department of Mathematics is modifying the 5 year integrated in Mathematics and Computing program into B.Tech + M.Tech in Mathematics and Computing Program.

