# Bachelor of Science (Honours)

# Mathematics

## Followed by

## National Education Policy- 2020

# AY: 2021- 22

# Program and Course Structure

## School of Basic Science and Research
## Department of Mathematics

# B.Sc.(H)Mathematics

## SBR0302

# Batch 2021-24

## 1.1 Vision, Mission and Core Values of the University

### Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

### Mission of the University

**1**. Transformative educational experience.
**2**. Enrichment by educational initiatives that encourage global outlook.
**3**. Develop research, support disruptive innovations and accelerate entrepreneurship.
**4**. Seeking beyond boundaries.

### Core Values

**1**. Integrity
**2**. Leadership
**3**. Diversity
**4**. Community

## 1.2 Vision and Mission of the School

### Vision of the School

Achieving excellence in the realm of science to address the challenges of evolving society.

### Mission of the School

**1**. Equip the students with knowledge and skills.
**2**. Capacity building by providing academic flexibility to student and Faculty members.
**3**. To establish centre of excellence for innovative research.
**4**. Address the deficiencies of the society pertaining to environment
**5**. To strengthen academic- industry collaboration for better. Employability.
**6**. Developing a culture for continued betterment in all facets of life.

### Core Values

1. Integrity
2. Leadership
3. Diversity
4. Community

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## 1.3 Vision and Mission Department of Mathematics

### Vision of the Department

To become a globally recognized destination for education in applied mathematics and research.

### Mission of the Department

**1**. To develop mathematical skills in students and make them employable across a wide range of professions and promote interest research.

**2**. To develop entrepreneurial skills in students to serve the society at large.

**3**. To develop skills for the applications of mathematics in the various fields.

### Core Values

1. Integrity
2. Leadership
3. Diversity
4. Community

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# B. Sc. (H) Mathematics

## 1.4 Programme Educational Objectives (PEO's)

**PEO1:** To prepare students for developing their subject knowledge in the courses of their study to enable them to shine in various fields such as sciences, engineering and technology, IT etc.
**PEO2:** To develop positive attitude and skills this will enable the students to become a multi facet personality.
**PEO3:** To prepare students for entrance examinations conducted by IIT's/Universities to pursue PG and Ph. D. programs.
**PEO4:** To develop students into confident communicators and team players.

## 1.4.1Program Outcomes (PO's)

**PO1: Mathematical knowledge:** Application of Mathematical knowledge in various fields of science, engineering and management etc.
**PO2: Nature of Mathematics:** Understand the concise, precise and rigorous nature of Mathematics.
**PO3: `Critical thinking:** Develop the skill to think critically on abstract concepts of Mathematics.
**PO4: Problem analysis:** Develop the ability to analyze a problem logically and dissect into micro-parts and thus resolving the problem to accessible components.
**PO5: Presentation skill**: Develop the skill to pleasant exposition for successful presentation for any career interview with confidence.
**PO6: Mathematical logic:** Formulates and develops mathematical arguments in logical manner.
**PO7: Team Work:** Work as a team player and strive for self-excellence.
**PO8**: **Ethics:** Realize and understand professional, ethical and cultural responsibilities.
**PO9: Communication:** Communicate effectively with an elite audience.
**PO10:Life-long learning:** Engage in life-long learning towards enduring professional development.

## 1.4.2 Mapping of PEO's with Mission Statements:

| PEO Statements | School Mission 1 | School Mission 2 | School Mission 3 | School Mission 4 | School Mission 5 | School Mission 6 |
|---|---|---|---|---|---|---|
| PEO1: | 3 | 2 | 3 | 1 | 2 | 3 |
| PEO2: | 3 | 2 | 3 | 1 | 2 | 3 |
| PEO3: | 3 | 3 | 3 | 3 | 3 | 3 |
| PEO4: | 3 | 2 | 3 | 1 | 3 | 3 |

## 1.4.3 Mapping of Program Outcome Vs Program Educational Objectives

| | PEO1 | PEO2 | PEO3 | PEO4 |
|---|---|---|---|---|
| PO1 | 3 | 3 | 3 | 2 |
| PO2 | 3 | 3 | 3 | 2 |
| PO3 | 3 | 3 | 3 | 2 |
| PO4 | 3 | 2 | 3 | 2 |
| PO5 | 2 | 3 | 2 | 3 |
| PO6 | 3 | 3 | 3 | 2 |
| PO7 | 1 | 2 | 1 | 3 |
| PO8 | 2 | 2 | 1 | 3 |
| PO9 | 2 | 2 | 2 | 3 |
| PO10 | 2 | 2 | 2 | 3 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

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## 1.4.5 Program Outcome Vs Courses Mapping Table:

### 1.4.5.1 COURSE ARTICULATION MATRIX

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| BHM 101 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| BDA 101 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| BPH 102 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| COC 101 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| BHM 151 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BPP 152 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| BDA 151 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BHM 152 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BHM 102 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| BDA 102 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| BPH 202 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| XXXX | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| COC 201 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MTH 215 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 |
| BDA 152 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BHM 153 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BHM 201 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 202 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| MSM 101 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| BPH 302 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 |
| COC 301 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| BHM 251 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BPH 352 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 |
| BHM 252 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| BHM 203 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 |
| BHM 204 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| BPH 402 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 |
| XXXX | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| COC 401 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| BHM 253 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| BHM 254 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 301 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| BHM 302 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 303 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 304 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 305 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| BHM 306 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| COC 501 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| BHM 351 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 |
| BHM 352 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 307 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| BHM 308 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| BHM 309 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| BHM 310 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| COC 601 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| BHM 353 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| BHM 354 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 |
| BHM 355 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |

**1-Slight (Low)**
**2-Moderate (Medium)**
**3-Substantial (High)**

**National Education Policy-2020**

# Year- wise Structure- B.Sc. (H) Mathematics

## Department of Mathematics

| | | Subject 1 | Subject 2 | Subject 3 | Subject 4 | Vocational | Compulsory Co-curricular | Training/Survey/ Project | Credits | (Total Credits) After completion {Minimum Credits} [Max Duration in years] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Major 1 | Major 2 | Major 3 | Minor/ Elective | Minor | Minor | Major | | |
| | | Credits (4/5/6) | Credits (4/5/6) | Credits 4/5/6 | Credits 4 | 3 Credits | 2 Credits | Credits (3/6/8) | | |
| Year | Sem. | Own Faculty | Own Faculty | Any Faculty | Other Department / Faculty | Vocational Faculty | Co-Curricular Course | Related to main Subject | | |
| 1 | I | Differential Calculus & Integral Calculus + LAB Credit: 6 (1 Th-4 +1 P- 2) | Statistics I Credit: 6 (1 Th-4 +1 P- 2) | Engg./ B. Sc. - CS/PHY/CHY/Economics/Commerce/ and others. Credit: 6 (1Th-4 + P- 2) | | Basic Statistical Analysis | Food, nutrition and hygiene | | 23 (18+3+2) | (50-52) {46} [4] **Certificate in Faculty** |
| | II | Matrices and Differential Equations & Geometry Credit: 6(1Th6 ) | Statistics II Credit: 6 (1 Th-4 +1 P- 2) | Engg./ B. Sc. - CS/PHY/CHY/Economics/Commerce/ and others. | Elective | Statistical thinkingusing Analysis Softwares | First Aid and Health | | 27 (18+3+2) + 4elective | |
| | III | Algebra & Mathematical Methods Credit: 6(1Th6) | Mathematical Modelling with Python Credit: 6 (Th-4+ P- 2) | Engg./ B. Sc. - CS/PHY/CHY /Economics/Commerce/ and others. | | Predictionand forecasting management | Human Values and Environment *stu*dies | | 23 (18+3+2) | (100-104) {92} [7] |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | IV | Differential Equation & Mechanics Credit: 6 (1Th-6 ) | MATLAB Programming and Applications Credit: 6 (Th-4 +P2) | Engg./ B. Sc.CS/PHY/CHY/Economics/ Commerce/ and others. Credit: 6 (1Th-4 +1 P- 2) | Elective | Advance Statistical Analysis | Physical Education and Yoga | | 27 (18+3+2) + 4 elective | **Diploma in Faculty** |
| 3 | V | Group and Ring Theory & Linear Algebra + **Any One of The Following** (i) Number Theory &Game Theory (ii) Graph Theory & Discrete Mathematics (iii) Differential Geometry &Tensor Analysis Credit: 10 (2Th-5) | Real Analysis + Statistical Computing and introduction to Statistical Softwares + LAB Credit: 10 (2Th- 4+ 1 Lab- 2 | | | | Analytic Ability and Digital Awareness | **PART 1** Practical hands on Industrial Training/ Survey/Project . (Based on community connect, will be conducted after 4th sem in summer) 1 (3) | 25 (20+3+2) | (150-154) {138} [10] |
| | VI | Metric Space & Complex Analysis+ Numerical Analysis & Operations Research + LAB Credit: 10(2Th- 4+ 1 Lab- 2 ) | Integral Transforms and Special Functions) +Fluid Dynamics + Lab 10(2Th- 4+ 1 Lab- 2 ) | | | | Communication Skills and Personality Development | **PART2** Practical hands on Industrial Training/ Survey/Project . (Based on community connect, will be conducted after 4th sem in summer) 1 (3) | 25 (20+3+2) | **Bachelor in Faculty** |
| | | **Total Credit up to Three years: 150** | | | | | | | | |

**National Education Policy-2020**

**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: I**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Type of Course: 1. Major,2. Minor/ Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs)** | | | |
| 1. | BHM 101 | Differential Calculus & Integral Calculus | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 1 |
| 2. | BDA 101 | Statistics I | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 2 |
| 3. | BPH 102 | General Properties of Matter | 4 | 0 | 0 | 4 | 4 | Pre-Requisite | Major 3 |
| 4. | COC 101 | Food, nutrition and hygiene | 2 | 0 | 0 | 2 | 2 | Co Requisite | Compulsory Co-curricular 1 |
| | **PRACTICALS** | | | | | | | | |
| 5. | BHM 151 | Mathematics Lab - 1 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 1 |
| 6 | BDA 151 | Statistics Lab - 1 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 2 |
| 7. | BPP 152 | Physics Lab - 2 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 3 |
| 8. | BHM 152 | Basic Statistical Analysis Using Excel | 0 | 0 | 5 | 5 | 3 | Pre - Requisite | Vocational 1 |
| **TOTAL CREDITS** | | | | | | | **23** | | |

**National Education Policy-2020**

**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: II**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Course: 1. Major,2. Minor/ Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/ Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs.)** | | | |
| 1. | BHM 102 | Matrices and Differential Equations & Geometry | 6 | 0 | 0 | 6 | 6 | Co Requisite | Major 4 |
| 2. | BDA 102 | Statistics II | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 5 |
| 3. | BPH 202 | Renewable energy resources | 4 | 0 | 0 | 4 | 4 | Pre-Requisite | Major 6 |
| 4. | XXXX | Elective | 4 | 0 | 0 | 4 | 4 | Pre-Requisite | Minor 1 |
| 5. | COC 201 | First Aid and Health | 2 | 0 | 0 | 2 | 2 | Pre-Requisite | Compulsory Co-curricular 2 |
| | **PRACTICALS** | | | | | | | | |
| 6. | BDA 152 | Statistics Lab- 2 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 4 |
| 7 | BPH 202 | Physics Lab - 4 | 0 | 0 | 4 | 4 | 2 | Pre- Requisite | Major Lab 5 |
| 8 | BHM 153 | Statistical thinking using Analysis Softwares | 0 | 0 | 5 | 5 | 3 | Pre- Requisite | Vocational 2 |
| **TOTAL CREDITS** | | | | | | | **27** | | |

**National Education Policy-2020**

**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: III**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Course: 1. Major,2. Minor/ Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/ Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs.)** | | | |
| 1. | BHM 201 | Algebra & Mathematical Methods | 6 | 0 | 0 | 6 | 6 | Co-requisite | Major 7 |
| 2. | BHM 202 | Mathematical Modelling with Python | 4 | 0 | 0 | 4 | 4 | Co-requisite | Major 8 |
| 3. | BPH 302 | Oscillation and waves | 4 | 0 | 0 | 4 | 4 | Co-requisite | Major 9 |
| 4. | COC 301 | Human Values and Environment *stu*dies | 2 | 0 | 0 | 2 | 2 | Co-requisite | Compulsory Co-curricular 3 |
| | **PRACTICALS** | | | | | | | | |
| 5. | BHM 251 | Mathematics Lab - 2 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 6 |
| 6. | BPH 352 | Physics Lab - 6 | 0 | 0 | 4 | 4 | 2 | Pre- Requisite | Major Lab 7 |
| 7. | BHM 252 | Prediction and forecasting management | 0 | 0 | 5 | 5 | 3 | Co Requisite | Vocational 3 |
| **TOTAL CREDITS** | | | | | | | **23** | | |

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**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: IV**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Course: 1. Major,2. Minor/Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/ Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs.)** | | | |
| 1. | BHM 203 | Differential Equation & Mechanics | 6 | 0 | 0 | 6 | 6 | Co Requisite | Major 10 |
| 2. | BHM 204 | MATLAB Programming and Applications | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 11 |
| 3. | BPH 402 | Laser and applications | 4 | 0 | 0 | 4 | 4 | Pre-Requisite | Major 12 |
| 4. | XXXX | Elective | 4 | 0 | 0 | 4 | 4 | Pre-Requisite | Minor 2 |
| 5. | COC 401 | Physical Education and Yoga | 2 | 0 | 0 | 2 | 2 | Co Requisite | Compulsory Co-curricular 4 |
| | **PRACTICALS** | | | | | | | | |
| 6. | BHM 253 | Mathematics Lab - 3 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 8 |
| 7. | BPH 352 | Physics Lab - 8 | 0 | 0 | 4 | 4 | 2 | Pre-Requisite | Major Lab 9 |
| 8. | BHM 254 | Advance Statistical Analysis | 0 | 0 | 5 | 5 | 3 | Co Requisite | Vocational 4 |
| **TOTAL CREDITS** | | | | | | | **27** | | |

**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: V**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Course: 1. Major,2. Minor/ Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/ Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs.)** | | | |
| 1. | BHM 301 | Group and Ring Theory & Linear Algebra | 5 | 0 | 0 | 5 | 5 | Co Requisite | Major 13 |
| 2. | BHM 302/ BHM 303/ BHM 304 | Number Theory &Game Theory /Graph Theory & Discrete Mathematics / Differential Geometry &Tensor Analysis | 5 | 0 | 0 | 5 | 5 | Co Requisite | Major 14 |
| 3. | BHM 305 | Real Analysis | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 15 |
| 4. | BHM 306 | Statistical Computing and introduction to Statistical Softwares | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 16 |
| 5. | COC 501 | Analytic Ability and Digital Awareness | 2 | 0 | 0 | 2 | 2 | Co Requisite | Compulsory Co-curricular 5 |
| | **Practical/ Project** | | | | | | | | |
| 6. | BHM 351 | Mathematics Lab - 4 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 9 |
| 7. | BHM 352 | **Part- I:** Community connect (2) + Summer internship/Industrial Training/ Survey/Project (1) (Will be completed after 4th Sem) | 0 | 0 | 6 | 6 | 3 | Co Requisite | Sumer internship/ Industrial Training/ Survey/Project |
| **TOTAL CREDITS** | | | | | | | **25** | | |

**National Education Policy-2020**

**Program Structure Template**
**B. Sc. (H) Mathematics**
**Batch: 2021-2024**
**TERM: VI**

| S. No. | SUBJECT CODE | Title of Paper | Teaching Load | | | | CREDITS | PRE-REQUISITE/ CO-REQUISITE | Course: 1. Major,2. Minor/ Elective, 3.Vocational 4. Compulsory Co-curricular 5. Training/ Survey /Project |
|---|---|---|---|---|---|---|---|---|---|
| | **THEORY** | | **L** | **T** | **P** | **TOTAL (hrs.)** | | | |
| 1. | BHM 307 | Metric Space & Complex Analysis | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 17 |
| 2. | BHM 308 | Numerical Analysis & Operation Research | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 18 |
| 3. | BHM 309 | Integral Transforms and Special Functions) | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 19 |
| 4. | BHM 310 | Fluid Dynamics | 4 | 0 | 0 | 4 | 4 | Co Requisite | Major 20 |
| 5. | COC 601 | Communication Skills and Personality Development | 2 | 0 | 0 | 2 | 2 | Pre- Requisite | Compulsory Co-curricular 6 |
| | **Practical/ Project** | | | | | | | | |
| 6. | BHM 353 | Mathematics Lab - 5 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 10 |
| 7. | BHM 354 | Mathematics Lab - 6 | 0 | 0 | 4 | 4 | 2 | Co Requisite | Major Lab 11 |
| | BHM 355 | **Part- II:**Community connect (2) + Summer internship/Industrial Training/ Survey/Project (1) (Will be completed after 4th Sem) | 0 | 0 | 6 | 6 | 3 | Co Requisite | Sumer internship/ Industrial Training/ Survey/Project |
| **TOTAL CREDITS** | | | | | | | **25** | | |

**TOTAL CREDIT UP TO THREE YEARS: 150**

**National Education Policy-2020**

# B.Sc. (H) MATHEMATICS

Detailed Syllabus For

# CERTIFICATE COURSE

# IN

# APPLIED MATHEMATICS

# THEORY COURSES

(Semester- I)

## Differential Calculus & Integral Calculus (BHM 101)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2021-22** |
| **Branch: Maths** | | **Semester: I** |
| 1 | Course Code | BHM 101 |
| **2** | Course Title | **Differential Calculus & Integral Calculus** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 4-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1.To familiarize the students with basic concepts of differential calculus and their applications.<br>2.To understand the basic concept of Integral calculus and their applications. |
| 6 | Course Outcomes | CO1: The programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well. (K1, K2, K3).<br>CO2: By the time students complete the course they will have wide ranging application of the subject and have the knowledge of real valued functions such as sequence and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric curves. (K1,K2, K3).<br>CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns to solve a variety of practical problems in science and engineering. (K2,K3, K4.)<br>CO4: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics. (K2,K3, K4).<br>CO5: Describe and use the concepts of Improper integrals, their classification and convergence, Comparison tests. (K3,K4,K5).<br>CO6: Explain the basic concepts of Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface and find out Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes and related problems. (K4,K5,K6). |
| 7 | Course Description | This course is an introduction to the fundamental of Mathematics. The primary objective of the course is to develop the basic understanding of<br>convergence of sequence and series, curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric curves, Vector Differentiation, Gradient, Divergence and Curl. |
| 8 | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | | |
| | A | **Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).**<br>Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, su-bsequence, Series of non-negative terms, convergence and divergence. | CO1 |
| | B | Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence. | CO1 |
| | C | Limit, continuity and differentiability of function of single variable, Cauchy's | CO1 |

| | | | |
|---|---|---|---|
| | | definition, Heine's definition ,equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, indeterminate forms. | |
| | **Unit 2** | | |
| | A | Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders. | CO2 |
| | B | Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series, Partial differentiation, Euler's theorem on homogeneous function. | CO2 |
| | C | Tangent and normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms. | CO2 |
| | **Unit 3** | | |
| | A | Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus. | CO3 |
| | B | Mean value theorems of integral calculus, Differentiation under the sign of Integration. | CO3, CO4 |
| | C | Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test. Beta and Gamma functions. | CO3, CO4 |
| | **Unit 4** | | |
| | A | Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem. | CO5 |
| | B | Multiple integrals, change of order of double integration. | CO5 |
| | C | Dirichlet's theorem, Liouville's theorem for multiple integrals. | CO5 |
| | **Unit 5** | **Vector Algebra** | |
| | A | Vector Differentiation, Gradient, Divergence and Curl. | CO6 |
| | B | Normal on a surface, Directional Derivative. | CO6 |
| | C | VectorIntegration, Theorems of Gauss, Green, Stokes and related problems. | CO6 |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA: 25% / MTE: 25% / ETE: 50% | |
| | Text book/s* | 1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons Inc.<br>2. 1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons<br>3. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.<br>4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.<br>5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002. .<br>8.Jain, M.K., and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publications | |
| | Other References | 1. Thomas, B.G., and Finny R.L., "Calculus and Analytical geometry", Pearson Education 2007, Asia, Adison Wisley. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C101.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C101.2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| C101.3 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C101.4** | **2** | **3** | **2** | **2** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C101.5** | **3** | **3** | **2** | **2** | **2** | **1** | **2** | **1** | **2** | **1** |
| **C101.6** | **3** | **3** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **1** |

## Statistics I (BDA 101)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B.Sc.(H)** | | **Academic Year: 2021-22** | |
| **Branch: Maths** | | **Semester: I** | |
| 1 | Course Code | BDA 101 | |
| **2** | Course Title | **Statistics I** | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To introduce basic statistical concepts, logics and analytical tools, analyze and communicate quantitative data verbally, graphically, symbolically and numerically.<br>2. To make students familiar with the concept of Probability and Statistics and display data by means of various tables, charts, and graphs. | |
| 6 | Course Outcomes | CO1: Describe the process and particular steps in designing studies, collecting and analyzing data, interpreting and presenting results; and develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries. (K2, K5).<br>CO2: Describe the properties of discrete and continuous distribution functions. (K2).<br>CO3: Calculate the measures of central tendency and dispersion of a data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3)<br>CO4: Calculate and interpret the correlation between two variables and Calculate the simple linear regression equation for a set of data and know the basic assumptions behind regression analysis. (K2, K3).<br>CO5: Understand the line of best fit as a tool for summarizing a linear relationship and predicting future observed values, develop the ability to use formal mathematical argument in the context of probability. (K2, K5)<br>CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5). | |
| 7 | Course Description | This is an introductory course in statistics. Students are introduced to the fundamental concepts involved in using sample data to make inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation. | |
| 8 | **Outline syllabus** | | **CO Mapping** |
| | **UNIT 1** | **Presentation of data** | |
| | A | Classification, tabulation, diagrammatic & graphical representation of grouped data. | CO1, CO6 |
| | B | Frequency distributions, cumulative frequency distributions | CO1, CO2, CO6 |
| | C | Histogram, Ogives, frequency polygon, Tree and leaf diagram. | CO1, CO6 |
| | **UNIT 2** | **Descriptive statistics** | |

| | | | | | |
|---|---|---|---|---|---|
| | A | Measures of central tendency – arithmetic mean, median, quartiles, mode, harmonic mean, geometric mean. | | | CO1, CO3, CO6 |
| | B | Their properties, merits and demerits | | | CO1, CO3, CO6 |
| | C | Measures of dispersion – range, quartile deviation, mean deviation, standard deviation and coefficient of variation. | | | CO1, CO3, CO6 |
| | **UNIT 3** | **Moments** | | | |
| | A | Moments, Skewness, Measures of skewness: Karl Pearson's coefficient of skewness. | | | CO1, CO3, CO6 |
| | B | Quartile coefficient of skewness, Measure of skewness based on moments. | | | CO1, CO3, CO6 |
| | C | Kurtosis, measure of Kurtosis. | | | CO1, CO3, CO6 |
| | **UNIT 4** | **Bi-variate data analysis** | | | |
| | A | Bivariate data, principles of least squares, fitting of polynomial curves and fitting of curves reducible to polynomial form. | | | CO1, CO4, CO6 |
| | B | Correlation: Spearman's rank correlation, Partial and Multiple Correlation (only two independent variables case). | | | CO1, CO4, CO6 |
| | C | Regression lines. | | | CO1, CO4,CO5, CO6 |
| | **UNIT 5** | **Probability** | | | |
| | A | Probability: Introduction, random experiment, outcomes, sample space, events, various definitions of probability, laws of total and compound probability. Boole's inequality. Conditional probability, independence of events. Bayes theorem and its applications. | | | CO1, CO5, CO6 |
| | B | Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density function (p.d.f) and cumulative distribution function (c.d.f), illustrationsandpropertiesofrandomvariables,univariatetransformationswithillustrations. | | | CO1, CO5, CO6 |
| | C | Mathematical Expectation: Expectation of single and bivariate random variables, properties of expectation, conditional expectation and its properties. Moments and cumulants. Moment generating function, probability generating function. | | | CO1, CO5, CO6 |
| | Mode of examination | Theory | | | |
| | Weightage/ marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text books | 1. Gupta, S.C and Kapoor, V.K, "Fundamental of Mathematical Statistics". | | | |
| | Other references | 1.Daniel, Wayne W., "Biostatistics": Basic concept and Methodology for Health Science.<br>2.Grewal, B.S, "Higher Engineering Mathematics". | | | |

**COURSE PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C101.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C101.2 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 2 |
| C101.3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 |
| C101.4 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| C101.5 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |
| C101.6 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 |

# THEORY COURSES

(Semester- II)

## Matrices and Differential Equations & Geometry (BHM 102)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021-2024** |
| **Program: B. Sc (H)** | | **Academic Year: 2021-22** |
| **Branch: Maths** | | **Semester: II** |
| 1 | Course Code | BHM 102 |
| 2 | Course Title | **Matrices and Differential Equations & Geometry** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 40- 0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To familiarise the students with basic concepts of matrices, determinants and solving the system of linear equations.<br>2. To understand the basic concept of differential equations, formation of differential equations and their applications.<br>3. To understand the basic concept of theory of geometry; general equation of second degree, system of conics, Straight line in three dimension and their properties. |
| 6 | Course Outcomes | **CO1:** The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give in depth knowledge of geometry, calculus, algebra and other theories. (K1,K2)<br>**CO2:** The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. The course in differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical |

| | | | | | |
|---|---|---|---|---|---|
| | | meaning of differential equation. (,K2,K3)<br>**CO3:** The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry. (K1,K2,K3).<br>**CO4:** On successful completion of the course students have gained knowledge about regular geometrical figures and their properties. They have the foundation for higher course in Geometry. (K2,K3,K4).<br>**CO5:** Describe the Sphere, Cone and Cylinder and evaluate the Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension. (K3,K5).<br>**CO6:** Describe and analyze the basic concepts of Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree equations and it's application. (K3,K4,K5). | | | |
| 7 | Course Description | This course is an introduction to the fundamental of Mathematics. The primary objective of the course is to develop the basic understanding of matrices, differential equations, geometry and their applications. | | | |
| 8 | **Outline syllabus** | | | | **CO Mapping** |
| | **Unit 1** | **Matrices** | | | |
| | A | Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations. | | | CO1,CO6 |
| | B | System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. | | | CO1,CO6 |
| | C | Eigen values, Eigen vectors and characteristic equation of a matrix, Caley Hamilton theorem and its use in finding inverse of a matrix, Complex functions and separation into real and imaginary parts, Exponential and Logarithmic functions Inverse trigonometric and hyperbolic functions. | | | CO1,CO6 |
| | **Unit 2** | **Differential Equations** | | | |
| | A | Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree. | | | CO2,CO6 |
| | B | Equation in which the variables are separable, Homogeneous equations. | | | CO2,CO6 |
| | C | Linear equations and equations reducible to the linear form. | | | CO2,CO6 |
| | **Unit 3** | **Differential Equations** | | | |
| | A | Exact differential equations and equations reducible to the exact form | | | CO2,CO6 |
| | B | First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories. | | | CO3,CO6 |
| | C | Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form. | | | CO3,CO6 |
| | **Unit 4** | **Geometry** | | | |
| | A | General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties. | | | CO4,CO6 |
| | B | Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form). | | | CO4,CO6 |
| | C | Straight line in three dimension. | | | CO4,CO6 |
| | **Unit 5** | **Geometry** | | | |
| | A | Sphere, Cone and Cylinder. | | | CO5,CO6 |
| | B | Central conicoids, Paraboloids, Plane section of conicoids, Generating lines. | | | CO5,CO6 |
| | C | Confocal conicoids, Reduction of second degree equations. | | | CO5,CO6 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **1**. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person | | | |

| | | | |
|---|---|---|---|
| | | **2**. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa<br>**3**. D.A. Murray, Introductory Course in Differential Equations, Orient Longm<br>**4.** Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.<br>**5.** P.R. Vittal, Analytical Geometry 2d & 3D, Pearson.<br>**6.** S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.<br>**7.** R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C102.1** | **2** | **2** | **2** | **2** | **1** | **1** | **1** | **2** | **1** | **2** |
| **C102.2** | **2** | **1** | **2** | **1** | **2** | **1** | **1** | **1** | **1** | **2** |
| **C102.3** | **1** | **2** | **1** | **1** | **2** | **2** | **2** | **1** | **2** | **1** |
| **C102.4** | **2** | **2** | **2** | **1** | **1** | **2** | **2** | **2** | **1** | **1** |
| **C102.5** | **2** | **1** | **2** | **2** | **2** | **1** | **1** | **2** | **2** | **2** |
| **C102.6** | **1** | **1** | **1** | **2** | **1** | **1** | **1** | **1** | **1** | **1** |

# Statistics II (BDA 105)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2021-2024** |
| **20Program: B.Sc.(H).** | | **Academic Year: 2021-22** |
| **Branch: Physics** | | **Semester: II** |
| 1 | Course Code | BDA 105 |
| 2 | Course Title | Statistics II |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 4-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | To make students familiar with the concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of population mean and total, variances of these estimates along with the brief of present official statistical system in India, methods of collection of official statistics, their reliability and limitations has been introduced. |
| 6 | Course Outcomes | CO1: Explain and illustrate the concepts of sample and population. (K2, K3, K4)<br>CO2: Describe the properties of complete enumeration versus sampling; explain random sampling with and without replacement. (K1, K2, K3)<br>CO3: Describe estimates of population mean, explain its application and estimates of theses variances and sample size determination. (K2, K3, K4)<br>CO4: Describe stratified random sampling, estimates of population mean and total and explain its application; and illustrate systematic sampling. (K2, K3, K4). |

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|---|---|---|---|---|---|
| | | CO5: Describe the ratio and regression methods of estimation and evaluate variances in terms of correlation coefficient between X and Y for regression method and their comparison with SRS. (K2, K3, K6).<br>CO6: Describe and analyze the basic concepts present official statistical system in India, methods of collection of official statistics. (K1,K2, K4). | | | |
| 7 | Course Description | This course is an initiate the advance concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of population mean and total, variances of these estimates along with the brief of present official statistical system in India, methods of collection of official statistics, their reliability and limitations has been introduced. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | Unit 1 | | | | |
| | A | Concept of sample and population, complete enumeration versus sampling | | | CO1 |
| | B | Sampling and non-sampling errors, requirements of a good sample, | | | CO1 |
| | C | Simple random sampling with and without replacement. | | | CO2 |
| | Unit 2 | | | | |
| | A | Estimates of population mean, total and proportion, | | | CO3 |
| | B | Variances of these estimates | | | CO3 |
| | C | Estimates of theses variances and sample size determination. | | | CO3 |
| | Unit 3 | | | | |
| | A | Stratified random sampling, estimates of population mean and total variances of these estimates. | | | CO4 |
| | B | Proportional and optimum allocations and their comparison with SRS. | | | CO4 |
| | C | Systematic Sampling, estimates of population mean and total, variances of these estimates. | | | CO4 |
| | Unit 4 | | | | |
| | A | Ratio and regression methods of estimation, estimates of population mean and total (for SRS of large size), | | | CO5 |
| | B | Variances of these estimates and estimates of theses variances, | | | CO5 |
| | C | Variances in terms of correlation coefficient between X and Y for regression method and their comparison with SRS. | | | CO5 |
| | Unit 5 | | | | |
| | A | Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. | | | CO5,CO6 |
| | B | Principal publications containing data on the topics such as population, industry and finance. | | | CO5,CO6 |
| | C | Various official agencies responsible for data collection and their main functions. | | | CO5,CO6 |
| | Mode of examination | Theory | | | |
| | Weightage/ Marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1.Goon A.M., Gupta M.K. and Dasgupta B (2001): Fundamentals of Statistics (Vol.2), Word Press.<br>2. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta | | | |

| | | | |
|---|---|---|---|
| | | 3. Des Raj and Chandhok P.(1998): Sample Survey Theory, Narosa Publishing House.<br>4. Cochran W.G (1984):Sampling Techniques ( 3rd Ed.), Wiley Eastern. | |
| | Other References | 1. Mukhopadhyay P.(1998): Theory and Methods of Survey Sampling, Prenctice Hall.<br>2. Sampat S.(2001): Sampling Theory and Methods, Narosa Publishing House.<br>3. Guide to current Indian Official Statistics, Central Statistical Organization, GOI, New Delhi.<br>4. Saluja, M.P. (1972): Indian official statistical systems, Statistical Pub. Society, Calcutta. | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C105.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C105.2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| C105.3 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 |
| C105.4 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| C105.5 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |
| C105.6 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 1 |

# B.Sc. (H) MATHEMATICS

Detailed Syllabus For

# DIPLOMA

# IN

# MATHEMATICS

# THEORY COURSES
(Semester- III)

## Algebra & Mathematical Methods (BHM 201)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch : 2021-2024** | |
| **Program: B. Sc(H)** | | **Academic Year: 2022-23** | |
| **Branch: Maths** | | **Semester: III** | |
| 1 | Course Code | BHM 201 | |
| 2 | Course Title | **Algebra & Mathematical Methods** | |
| 3 | Credits | 6 | |
| 4 | Contact Hours (L-T-P) | 6-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To familiarise students with basics algebra, Group, field, Ring and its applications, vector space, Linear transformation and its properties, matrix representation of a linear transformation.<br>2. To make students familiar with the concepts of successive differentiation along with the concepts of partial differentiation, basic integration & multiple integration. Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functional containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives, | |
| 6 | Course Outcomes | CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group, Ring theory and their properties. (K1,K2)<br>CO2: A student learning this course gets a concept of Group, Ring, Integral Domain and their properties. This course will lead the student to basic course in advanced mathematics and Algebra. (K1,K2,K3)<br>CO3: The course gives emphasis to enhance students' knowledge of functions of two variables, Laplace Transforms, Fourier Series. (K2,K3,K4)<br>CO4: On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going for higher studies and research. (K3,K4)<br>CO5: Describe the Fourier Series, Fourier integral and evaluate the expansion of functions in terms of Fourier series, Fourier integral. (K3,K4)<br>CO6: Describe and analyze the basic concepts of Calculus of variations and it's application. (K5,K6) | |
| 7 | Course Description | This course is an introduce of basic Algebra; Group, Ring and Field and its applications with Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism.This course is an introduce the concepts of successive differentiation along with the concepts of partial differentiation, Laplace transform, Integral transform, Fourier series and Fourier transform. Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives, Functionals dependent on more than one independent variable, Variational problems in parametric form | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | | |
| | A | **Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).** | CO1, CO6 |

| | | | |
|---|---|---|---|
| | | Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic group | |
| | B | Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition. | CO1, CO6 |
| | C | Lagrange's theorem and its consequences, Fermat and Euler theorems. | CO1, CO6 |
| | **Unit 2** | | |
| | A | Normal subgroups, Quotient groups, Homomorphism and isomorphism. | CO2, CO6 |
| | B | Fundamental theorem of homomorphism. | CO2, CO6 |
| | C | Theorems on isomorphism. | CO2, CO6 |
| | **Unit 3** | | |
| | A | Rings, Subrings, Integral domains and fields. | CO3, CO6 |
| | B | Characteristic of a ring, Ideal and quotient rings, Ring homomorphism. | CO3, CO6 |
| | C | Field of quotient of an integral domain. | CO3, CO6 |
| | **Unit 4** | | |
| | A | Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem. | CO4, CO6 |
| | B | Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians. | CO4, CO6 |
| | C | Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function. | CO4, CO6 |
| | **Unit 5** | | |
| | A | Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms. | CO5, CO6 |
| | B | Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral. | CO5, CO6 |
| | C | Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functional containing first order derivative and oneindependent variable, Extremal, Functional dependent on higher order derivatives, Functional dependent on more than one independent variable, Variational problems in p | CO5, CO6 |
| | Mode of examination | Theory | |
| | Weightage/ Marks Distribution | CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks | |
| | Text book/s* | **1.** J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley<br>**2.** I. N. Herstein, Topics in Algebra, John Wiley & Sons<br>**3.** Suggested digital plateform: NPTEL/SWAYAM/MOOCS<br>**4.** T.M. Apostal, Mathematical Analysis, Person<br>**5.** G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGrawHill<br>**6.** Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley &Sons. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C 201.1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 |
| C201.2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 1 |
| C201.3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 |
| C201.4 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 2 | 1 |
| C201.5 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 |
| C201.6 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 2 | 1 |

## Mathematical Modelling with Python (BHM 201)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch : 2021-2024** | |
| **Program: B.Sc.(H)** | | **Academic Year: 2022-23** | |
| **Branch: Maths** | | **Semester: III** | |
| 1 | Course Code | BHM 201 | |
| 2 | Course Title | **Mathematical Modelling with Python** | |
| 3 | Credits | 4 | |
| 4 | ContactHours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To Learn simple data types, and expressions.<br>2. To learn the control structures of Python programming.<br>3. To know the scope of the variables used in functions.<br>4. To Write simple programs in Python.<br>5. To learn objects, classes, and other object-oriented features.<br>6. To Solve ODE and equation with Python. | |
| 6 | Course Outcomes | **The students will be able to** :<br>CO 1. Identify the concept of python and visualization of data types different types of data.<br>CO 2. write loops and decision statements in Python.<br>CO 3. explore Python code structure, including the use of functions.<br>CO 4. Implement lists, tuples, and dictionaries in Python programs.<br>CO 5. design object- oriented programs with Python classes.<br>CO 6. Use of Python as a tool to Solve equations and ODE. | |
| 7 | Course Description | | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **MODULE I INTRODUCTION TO PYTHON** | |
| | A | Basic Elements of Python – Object, Expression and Numeric Types – Variables and Assignments. | CO1 |
| | B | Data types - Input statements – Input Statements. | CO2 |
| | C | Branching Programs – Looping Programs. | CO2 |
| | **Unit 2** | **FUNCTIONS AND STRUCTURES** | |
| | A | Functions and Scoping – Function Definitions – Keyword Arguments and Default. | CO3 |

| | | | |
|---|---|---|---|
| | B | values – Scoping – Specifications – Recursion –Global Variables. | CO3 |
| | C | Modules –Tuples – Lists – Dictionaries. | CO3 |
| | **Unit 3** | **CLASSES AND OBJECTS** | |
| | A | Abstract Data Types – Classes – Inheritance. | CO3 |
| | B | Multiple level of Inheritance –Substitution Principles. | CO3 |
| | C | Encapsulation and Information Hiding. | CO4 |
| | **Unit 4** | **Application of Python In Data Science** | |
| | A | Data Science – Python for Data Analysis. | CO5 |
| | B | Essential Python Libraries. | CO5 |
| | C | Installation and<br>setup – Dataset Retrieval | CO5 |
| | **Unit 5** | **Application of Python In Mathematical Modelling** | |
| | A | Method for solving equations. | CO5/CO6 |
| | B | Solving equations and Ordinary differential equations using Python, | CO5/CO6 |
| | C | Plotting graphs | CO5/CO6 |
| | Mode of examination | Theory | |
| | Weightage/ Marks Distribution | CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks | |
| | Text book/s* | 1. John V. Guttag, "Introduction to Computation and Programming Using Python: With Application to Understanding Data", 2nd Edition, MIT Press, ISBN: 978-0262529624, 2016.<br>2. Bill Lubanovic, "Introducing Python: Modern Computing in Simple Package", O'Reilly Media, 1st Edition , ISBN: 9781449359362, 2014. | |
| | Other References | 3. Pratik Desai ,"Python Programming for Arduino",1st edition, Packt publishing, ISBN:9781783285938, 2015. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| CO↓ PO→ | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C202.1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| C202.2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| C202.3 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 |
| C202.4 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 |
| C202.5 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| C202.6 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |

# THEORY COURSES

(Semester- IV)

## Differential Equations & Mechanics (BHM 203)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2022-23** |
| **Branch: Mathematics** | | **Semester: IV** |
| 1 | Course Code | BHM 203 |
| 2 | Course Title | **Differential Equations & Mechanics** |
| 3 | Credits | 6 |
| 4 | Contact Hours (L-T-P) | 6-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | Familiarise students with basic concepts of partial differential equations and introduce students to how to solve linear Partial Differential with different methods. Learn to solve first-order partial differential equations and formation of PDEs. Explore the methods to solve Linear homogeneous and non-homogeneous PDEs with constant coefficients. Students will also master the technique of separation of variables to solve PDEs and able to derive heat and wave equations.Familiarise students with basic concepts of mechanics. Give an idea of the Hook's Law. Given an understanding of a constrained motion, motion in a resisting medium. Discuss the concept of uniform catenary, centre of Gravity. |
| 6 | Course Outcomes | **CO1:** The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of first order and second order and to have qualitative applications. (K1,K2,K3).<br>**CO2:** A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem. (K2,K3,K4).<br>**CO3:** The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces. (K2,K3).<br>**CO4:** The student, after completing the course can go for higher problems in mechanic such as hydrodynamics, this will be helpful in getting employment in industry. (K3,K4).<br>**CO5**: Describe the Virtual work, Stable and Unstable equilibrium, and evaluate the Catenary, Catenary of uniform strength. (K3,K4,K5).<br>**CO6**: Describe and analyze the basic concepts of Motion of particles of varying mass and it's application. (K4,K5,K6). |
| 7 | Course | This course is an introduce the basic concepts of partial differential equations and introduce students to how to solve linear Partial Differential with different methods. Learn to solve first- |

| | | | |
|---|---|---|---|
| | Description | order partial differential equations and formation of PDEs. Explore the methods to solve Linear homogeneous and non-homogeneous PDEs with constant coefficients. Students will also master the technique of separation of variables to solve PDEs and able to derive heat and wave equations. This course will cover the basic concepts of mechanics. Give an idea of the Hook's Law. Given an understanding of a constrained motion, motion in a resisting medium. Discuss the concept of uniform catenary, centre of Gravity. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | **Differential Equation** | |
| | A | Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient. | CO1 |
| | B | variation of parameters, Series solutions of differential equations, Power series method. | CO1 |
| | C | Bessel, Legendre and Hyper geometric functions and their properties, recurrence and generating relations. | CO1 |
| | **Unit 2** | **Partial Differential Equation** | |
| | A | Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution. | CO2 |
| | B | Partial differential equation of first order and degree greater than one. | CO2 |
| | C | Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces. | CO2 |
| | **Unit 3** | **Partial Differential Equation** | |
| | A | Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients. | CO2,CO6 |
| | B | Classification of linear partial differential equations of second order. | CO2 |
| | C | Solution of second order partial differential equations with variable coefficients, Monge's method of solution. | CO2 |
| | **Unit 4** | **Mechanics** | |
| | A | Frame of reference, work energy principle, Forces in three dimensions. | CO3 |
| | B | Poinsot's central axis, Wrenches, Null lines and planes. | CO3 |
| | C | Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength. | CO4, CO6 |
| | **Unit 5** | **Mechanics** | |
| | A | Velocities and accelerations along radial and transverse directions. | CO5 |

| | | | | | |
|---|---|---|---|---|---|
| | B | Velocities and accelerations along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. | | | CO5, CO6 |
| | C | Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves. | | | CO5, CO6 |
| | Mode of examination | Theory | | | |
| | Weightage/ Marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **1.** G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill<br>**2.** B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa<br>**3.** Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication<br>**4.** R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers<br>**5.** R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers<br>**6.** A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill | | | |
| | Other References | **1.** L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.<br>**2.** Suggested digital plateform:NPTEL/SWAYAM/MOOCs<br>**3.** J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill<br>**4.** Suggested digital plateform:NPTEL/SWAYAM/MOOCs | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C203.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C203.2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** |
| **C203.3** | **2** | **2** | **2** | **3** | **3** | **2** | **1** | **1** | **2** | **2** |
| **C203.4** | **2** | **3** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C203.5** | **3** | **3** | **2** | **2** | **2** | **1** | **2** | **1** | **2** | **1** |
| **C203.6** | **3** | **3** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** |

National Education Policy-2020

# MAT LAB Programming and Applications (BHM 204)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** |
| **Program: B. Sc.** | | **Academic Year: 2022 - 23** |
| **Branch: Chemistry/Bio-chemistry** | | **Semester: IV** |
| 1 | Course Code. | BHM 204 |
| 2 | Course Title | **MAT LAB Programming and Applications** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 4-0-0 |
| | Course status | Compulsory |
| 5 | Course Objectives | 1. Understanding the MATLAB environment.<br>2. Being able to do simple calculations using MATLAB.<br>3. Being able to carryout simple numerical computations and analyses using MATLAB. |
| 6 | Course Outcomes | The students will be able to :<br>CO1: To understand the matrix generation basic notation in MATLAB.<br>CO2: To Understand the concept of Array Operators<br>CO3: Understand the applications of basic Commands of MATLAB<br>CO4: To Understand Plotting Commands.<br>CO5: To Understand the procedure of solving equations, ODE PDE etc.<br>CO6: To understand real-life problems with help of MATLAB. |
| 7 | Course Description | |
| 8 | Outline syllabus: | |

| | | |
|---|---|---|
| **UNIT 1** | **MODULE I INTRODUCTION TO MATLAB** | CO Mapping |
| A | MATLAB installation. | CO1, CO2 |
| B | Vector and Matrix generation. | CO1 |
| C | symbols Array operations and manipulation, Inbuilt functions | CO1 |
| **UNIT 2** | **Relational and Logical Operators** | |
| A | Flow Control Using various statements. | CO3 |
| B | loops including If-end statement, if else end statement. . | CO3 |
| C | Nested If-else end statement, For-end and While-end loops with break commands. | CO3 |
| **UNIT 3** | **m-files** | |
| A | Script files and functions. | CO3, CO4 |
| B | Concept of local and global variable, few examples of inbuilt functions. | CO3, CO4 |
| C | Editing and saving m files. | CO3, CO4 |
| **UNIT 4** | **Two dimensional graphics** | |

| | | | | |
|---|---|---|---|---|
| A | Basic Plots, Changes in axis and annotation in a figure. | | | CO5 |
| B | Multiple plots in a figure. | | | CO5 |
| C | saving and printing figures. | | | CO5 |
| **UNIT 5** | **Application of MATLAB** | | | |
| A | Generating MATLAB codes. | | | CO6 |
| B | Generating MATLAB code for Solving system of equations(linear, One variable etc.). | | | CO6 |
| C | Solving ordinary differential equation using in built functions. | | | CO6 |
| | Mode of Examination | Theory | | |
| | Weightage distribution | CA | MTE | ETE |
| | | 25 Marks | 25 Marks | 50 Marks |
| | Text books | 1. MATLAB An Introduction with Applications By: Amos Gilat, Wiley | | |
| | Other references | Suggested digital plate form: NPTEL/SWAYAM/MOOCs. | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C204.1** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** | **1** | **1** |
| **C204.2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** |
| **C204.3** | **2** | **2** | **2** | **3** | **3** | **2** | **1** | **1** | **2** | **2** |
| **C204.4** | **2** | **3** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C204.5** | **3** | **2** | **2** | **2** | **2** | **1** | **2** | **1** | **2** | **1** |
| **C204.6** | **3** | **3** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** |

# B.Sc. (H) MATHEMATICS

Detailed Syllabus For

# DEGREE

# IN

# MATHEMATICS

## THEORY COURSES
(Semester- V)

# Group and Ring Theory &Linear Algebra (BHM 301)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** | |
| **Program: B. Sc.(H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: V** | |
| 1 | Course Code. | BHM 301 | |
| **2** | **Course Title** | **Group and Ring Theory &Linear Algebra** | |
| 3 | Credits | 5 | |
| 4 | Contact Hours (L-T-P) | 5-0-0 | |
| | Course status | Compulsory | |
| 5 | Course Objectives | To familiarise students with the concepts of Automorphism, inner Automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic Subgroups, The Sylow theorems and consequences, The Sylow theorems andconsequences,Division algorithm and consequences, Principal ideal domains, Factorization of Polynomials.<br>2. To familiarise students with basics algebra of matrices, and its applications, vector space.The Algebra of linear transformations, rank nullity theorem, their representation as matrices, Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms. | |
| | Course Outcomes | **CO1:** Liner algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications. (K1,K2)<br>**CO2:** Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up further applications in the relevant fields. (K2,K3)<br>**CO3:** The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature. (K1,K2,K3).<br>**CO4:** Explain the divisibility in integral domains and evaluate unique factorization domains, Euclidean domains. (K3,K4)<br>**CO5**: Describe the Linear transformations and evaluate rank nullity theorem, their representation as matrices. (K4,K5)<br>**CO6**: Describe and analyze the basic concepts of Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms and it's application. (K4,K5). | |
| 7 | Course Description | This course is an introduce basics Automorphism, inner Automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to Automorphism groups etc.<br>This course is an introduce basics algebra of matrices, and its applications, vector space, Linear transformation and its properties, matrix representation of a linear transformation. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | | |
| | A | **Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).**<br>Automorphism, inner automorphism, Automorphism groups, Automorphism | CO1 |

| | | | |
|---|---|---|---|
| | | groups of finite and infinite cyclic groups. | |
| | B | Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups. | CO1, CO6 |
| | C | Conjugacy classes, The class equation, *p*-groups. | CO1, CO6 |
| | **Unit 2** | | |
| | A | The Sylow theorems and consequences, Applications of Sylow theorems; Finite simple groups. | CO2 |
| | B | Non simplicity tests; Generalized Cayley's theorem, Index theorem, Embedding theorem and applications. | CO2 |
| | C | Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains. | CO3, CO6 |
| | **UNIT 3** | | |
| | A | Factorization of polynomials, Reducibility tests, Irreducibility tests. | CO3 |
| | B | Eisenstein criterion, Unique factorization in Z[x]. | CO3, CO6 |
| | C | Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains. | CO3, CO6 |
| | **Unit 4** | | |
| | A | Vector spaces, Subspaces, Linear independence and dependence of vectors. | CO4 |
| | B | Basis and Dimension, Quotient space. | CO4 |
| | C | Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices. | CO4, CO6 |
| | **Unit 5** | | |
| | A | Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem. | CO5 |
| | B | Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases. | CO5, CO6 |
| | C | Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms. | CO5, CO6 |
| | Mode of examination | Theory | |
| | Weightage/ Marks Distribution | CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks | |
| | Text book/s* | 1. Hoffman, K &Kunze, R. , Linear Algebra, 2nd edition, Prentice Hall of India, 1975.<br>2.Lipshutz, S., Lipsom, M., Linear algebra, 3rd edition, Schaum series, 2001. | |
| | Other References | 1. Strang, G., Linear Algebra and its applications, 3rd edition, Thomson,1998.<br>2. Kreyszig , E., Advanced Engineering Mathematics, John Wiley & Sons.<br>3. Suggested digitalplateform:NPTEL/SWAYAM/MOOCs. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C301.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C301.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C301.3** | **2** | **3** | **2** | **2** | **2** | **2** | **1** | **1** | **2** | **2** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C301.4** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C301.5** | **3** | **2** | **2** | **3** | **2** | **1** | **2** | **1** | **2** | **1** |
| **C301.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **1** | **2** | **2** |

## Number Theory & Game Theory (BHM 302)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B. Sc. (H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: V** | |
| 1 | Course Code | BHM 302 | |
| **2** | **Course Title** | **Number Theory & Game Theory** | |
| 3 | Credits | 5 | |
| 4 | Contact Hours (L-T-P) | 5-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To make students familiar with the basic concepts of number theory, congruence.Also students are able to understand public & private key Game theory. | |
| 6 | Course Outcomes | **CO1:** Upon successful completion, students will have the knowledge and skills to solve problems in elementary number theory and also apply elementary number theory to cryptography. (K2,K3)<br>**CO2:** This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision making process of interdependent subjects. It is aimed at explaining and predicting how individuals behave in a specific strategic situation, and therefore help improve decision making. (K2,K3).<br>**CO3:** A situation is strategic if the outcome of a decision problem depends on the choices of more than one person. Most decision problems in real life are strategic. (K2,K3,K4).<br>**CO4:** To illustrate the concepts, real-world examples, case studies, and classroom experiments might be used. (K3,K4,K5).<br>**CO5**: Describe the Generating Function Models and evaluate the Recurrence Relations. (K4,K5).<br>**CO6**: Describe and analyze the concepts of game theory and it's application. (K4,K5,K6). | |
| 7 | Course Description | This course is an introduction to basics of number theory and Game theory with various functions and symbols. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |
| | A | **Theory of Numbers:**Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; | CO1 |

| | | | |
|---|---|---|---|
| | | Fermat's quotients and their elementary consequences. | |
| | B | solutions of congruences; Chinese remainder theorem;Euler's phi-function. | CO1 |
| | C | **Congruences:** Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol. | CO2 |
| | **Unit 2** | | |
| | A | quadratic reciprocity law; proofs of various formulations; Jacobi symbol. | CO3 |
| | B | **Diophantine Equations:** Solutions of ax + by = c, + = ; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of diophantine equations. | CO3 |
| | C | **Generating Functions and Recurrence Relations:** Generating Function Models, Calculating coefficient of generating functions, Partitions, | CO3 |
| | **Unit 3** | | |
| | A | Exponential Generating Functions, A Summation Method. | CO4 |
| | B | Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations. | CO4 |
| | C | Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions. | CO4 |
| | **Unit 4** | | |
| | A | Introduction, overview, uses of game theory. | CO5 |
| | B | some applications and examples, and formal definitions of the normal form, payoffs, strategies, pure strategy Nash equilibrium. | CO5 |
| | C | Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence. | CO5 |
| | **Unit 5** | | |
| | A | Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving Rectangular Games. | CO6 |
| | B | Relationship between rectangular game and Linear Programming Problem, Solving rectangular game by Simplex method, reduction of m x n game. | CO6 |
| | C | solution of 2x2, 2 x s, and r x 2 cases by graphical method, algebraic and linear programming solution of m x n games. | CO6 |
| | Mode of examination | Theory | |

| | | | | | |
|---|---|---|---|---|---|
| | Weightage/ Marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **1.** Niven, I., Zuckerman, H. S. and Montegomery, H. L. (2003) An Int. to the Theory of Numbers (6th edition) John Wiley and sons, Inc., New York.<br>**2.** Burton, D. M. (2002) Elementary Number Theory (4th edition) Universal Book Stall, New Delhi.<br>**3.**Balakrishnan, V. K. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory, Schaum's Outline.<br>4. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003<br>5. Vijay Krishna, Game Theory, Academic Press.<br>6. Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006 | | | |
| | Other References | **7.**Balakrishnan,V. K. (1996) Introductory Discrete Mathematics, Dover Publications.<br>**8.**Suggested digital plateform:NPTEL/SWAYAM/MOOCs.<br>9. Prajit Dutta, Strategies and Games, MIT Press, (Website 1)<br>http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C302.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C302.2** | **2** | **3** | **3** | **3** | **2** | **2** | **2** | **2** | **1** | **2** |
| **C302.3** | **2** | **3** | **2** | **2** | **3** | **2** | **1** | **1** | **2** | **2** |
| **C302.4** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C302.5** | **3** | **2** | **2** | **3** | **2** | **1** | **2** | **1** | **2** | **1** |
| **C302.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **1** | **2** | **1** |

## Graph Theory & Discrete Mathematics (BHM 303)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021-2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2023-24** |
| **Branch: Mathematics** | | **Semester: V** |
| 1 | Course Code | BHM 303 |
| 2 | Course Title | **Graph Theory & Discrete Mathematics** |
| 3 | Credits | 5 |
| 4 | Contact Hours (L-T-P) | 5-0-0 |

| | | | |
|---|---|---|---|
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. The objective of the course is to explain basic concepts in combinatorial graph theory. Define how graphs serve as models for many standard problems. Discuss the concept of graph, tree, Euler graph, cut set and Combinatories. See the applications of graphs in science, business and industry.<br>2. This course is aimed to provide an advance understanding to the sets and propositions, relations and functions, permutation and combination, graphs, groups and rings. | |
| 6 | Course Outcomes | **CO1:** Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications. (K1,K2,K3).<br>**CO2:** After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring.. After successful completion of this course the student will have the knowledge graph coloring, color problem, vertex coloring. (K2,K3,K4).<br>**CO3:** After successful completion, students will have the knowledge of Logic gates, Karnaugh maps and skills to proof by using truth tables. After Successful completion of this course students will be able to apply the basics of the automation theory, transition function and table. (K2,K3).<br>**CO4:** This course covers the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, counting, relations, hasse diagram and Boolean algebra. After successful completion of this course the student will have the knowledge in Mathematical reasoning, combinatorial analysis, discrete structures and Applications. (K3,K4).<br>**CO5**: Explain the Tree, Binary and Spanning trees and evaluate the vertex coloring and important properties. (K4,K5).<br>**CO6**: Describe and analyze the concepts of the discrete mathematics and it's application. (K3,K4,K6). | |
| 7 | Course Description | This course will cover the fundamental concepts of Graph Theory: simple graphs, digraphs, Eulerian and Hamiltonian graphs, trees, matchings, networks, paths and cycles, graph colorings, and planar graphs. Famous problems in Graph Theory include: Minimum Connector Problem (building roads at minimum cost), the Marriage Problem (matching men and women into compatible pairs), the Assignment Problem (filling n jobs in the best way), the Network Flow Problem (maximizing flow in a network), the Committee Scheduling Problem (using the fewest time slots), the Four Color Problem (coloring maps with four colors so that adjacent regions have different colors), and the Traveling Salesman Problem (visiting n cities with minimum cost).This course is given the deep knowledge of sets and propositions, relations and functions, permutation and combination, graphs, groups and rings. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | | |
| | A | Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology. | CO1, CO6 |
| | B | representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph. | CO1, CO6 |
| | C | Walk and unilateral components, unicursal graph, Hamiltonian path and circuits. | CO1, CO6 |
| | **Unit 2** | | |
| | A | Graph colouring, chromatics number, isomorphism andhomomorphism of graphs, Incidence relation and degree of the graph. | CO2, CO6 |
| | B | Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix. | CO2, CO6 |
| | C | Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm. | CO2, CO6 |

| | | | |
|---|---|---|---|
| | **Unit 3** | | |
| | A | Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties. | CO3, CO6 |
| | B | **Propositional Logic-** Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive). | CO3, CO6 |
| | C | modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contra positive, contradiction, direct proof by using truth table. | CO3, CO6 |
| | **Unit 4** | | |
| | A | **Relation**- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation. | CO4, CO6 |
| | B | **Boolean Algebra-** Basic definitions, Sum of products and products of sums, Logic gates and Karnaugh maps. | CO4, CO6 |
| | C | **Graphs-** Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatics number, isomorphism and homomorphism of graphs. | CO4, CO6 |
| | **Unit 5** | | |
| | A | **Combinatories-** Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations). | CO5,CO6 |
| | B | Generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.) | CO5,CO6 |
| | C | **Finite Automata-** Basic concepts of automation theory, Deterministic Finite Automation (DFA), transition function, transition table, Non Deterministic Finite Automata (NDFA), Mealy and Moore machine, Minimization of finite automation. | CO5,CO6 |
| | Mode of examination | Theory | |
| | Weightage/ Marks Distribution | CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks | |
| | Text book/s* | **1.** "Graph Theory with Applications to Engineering and Computer Science" by Narsingh Deo<br>**2.** "Introduction to Graph Theory" by Douglas B West.<br>3. Discrete Mathematics by C. L.Liu.<br>4. Discrete Mathematics with computer application by Trembley and Manohar.<br>5.Discrete Mathematics and Its Applications by Kenneth H. Rosen | |
| | Other References | **1.** "Graph Theory with Algorithms and Its Applications: In Applied Science and Technology" by Santanu Saha Ray.<br>**2.** Suggested digital plateform:NPTEL/SWAYAM/MOOCs<br>3. Course Books published in Hindi may be prescribed by the Universities. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C303.1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C303.2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 |
| C303.3 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| C302.4 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 |
| C303.5 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| C303.6 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 |

## Differential Geometry & Tensor Analysis (BHM 304)

| **School: SBSR** | | **Batch: 2021-2024** |
|---|---|---|
| **Program: B.Sc.(H)** | | **Academic Year: 2023-2024** |
| **Branch: Mathematics** | | **Semester: V** |
| 1 | **Course Code** | **BHM 304** |
| 2 | **Course Title** | **Differential Geometry & Tensor Analysis** |
| 3 | **Credits** | **5** |
| 4 | **Contact Hours (L-T-P)** | **5-0-0** |
| | **Course Status** | **Compulsory** |
| 5 | **Course Objective** | 1. Familiarise students with basic concept of local theory of curves: space curves, e.g.,plane curves, tangent and normal and binormal; Osculating plane, normal lines and normal plane, curvature and torsion, rectifying plane; Helices, arc length, Serret- Frenet formulae. Have an idea of Bertrand curves and its properties, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields, Fundamental theorems forspace curves, involutes and evolutes of curves, Metric-first fundamental form and second fundamental form.<br>2. Have an understanding of Normal curvature, quadratic form of normal curvature, mean curvature, Gaussian curvature and minimal surface, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula.<br>3. Know about Tensor calculus, Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, inner product and outerproduct of two tensor. To know Contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors, Quotient theorem, Reciprocal tensors, metric tensor, conjugate metric tensor with examples. Christoffel's symbols, covariant differentiation and Riemannian curvature tensor. |
| 6 | **Course Outcomes** | **CO1:** After Successful completion of this course, students should be able to determine andcalculate curvature of curves in different coordinate systems. (K2,K3)<br>**CO2:** This course covers the Local theory of Curves, Local theory of surfaces, Geodesics, Geodesics curvature, Geodesic polars, Curvature of curves on surfaces, Gaussian curvature,Normal curvature etc. (K2,K3)<br>**CO3:** After Successful completion of this course, students should have the knowledge of tensor algebra, different types of tensors, Riemannian space, Ricci tensor, Einstein space and Einstein tensor etc. (K2,K3,K4).<br>CO4: Explain Gauss-Bonnet theorem, Gaussian curvature, normal curvature and evaluate curvature of curves on surfaces. (K2,K3,K4)<br>CO5: Describe Meusneir's theorem, mean curvature, Gaussian curvature and evaluate umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem. (K3,K4,K5)<br>CO6: Explain and analyze the basic concepts of the tensor analysis and it's application. (K4,K5,K6). |
| 7 | **Course** | This course is an introduction to differential geometry and tensor analysis. The primary |

| | | | | |
|---|---|---|---|---|
| | **Description** | objective of the course is to develop the advance understanding of differential geometry and tensor analysis. | | |
| 8 | Outline syllabus: | | | |
| **UNIT 1** | | | | CO Mapping |
| A | Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal andbinormal, Osculating Plane, normal plane and rectifying plane, Osculating circle, osculating sphere Helices. | | | CO1, CO6 |
| B | Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces. | | | CO1, CO2 |
| C | Involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves. | | | CO1, CO2 |
| **UNIT 2** | | | | |
| A | Local Theory of Surfaces- Parametric patches on surface curve of a surface, family of surfaces (one parameter), edge of regression, rues surfaces, skew ruled surfaces and developable surfaces, surfaces of revolution, Helicoids. | | | CO1, CO2, |
| B | Metric-first fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties. | | | CO2, CO2, |
| C | Geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, Geodesic polars. | | | CO2, CO6 |
| **UNIT 3** | | | | |
| A | Gauss-Bonnet theorem, curvature of curves on surfaces. | | | CO2, CO6 |
| B | Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature. | | | CO2, CO4, |
| C | Gaussian curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem. | | | CO2, CO4, |
| **UNIT 4** | | | | |
| A | Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensorssymmetric tensor, inner product, associated tensor with examples. | | | CO3, CO4 |
| B | Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors. | | | CO2, CO3, CO4 |
| C | Christoffel's symbols, Law of transformation of Christoffel's symbols, Covariant differentiation, non- commutativity of Covariant derivative. | | | CO2, CO5 |
| **UNIT 5** | | | | |
| A | Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector, irrotational vector, with examples. | | | CO3, CO6, |
| B | Riemannian space, Riemannian curvatures and their properties, geodesics, geodesic curvature. | | | CO2, CO6 |
| C | Geometrical interpretation of curvature tensor, Ricci tensor, scalar curvature, Einstein space and Einstein tensor. | | | CO5, CO6 |
| | Mode of Examination | Theory | | |
| | Weightage/ Marks distribution | CA | MTE | ETE |
| | | 25 Marks | 25 Marks | 50 Marks |
| | Text books | 1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.<br>2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.<br>3. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.<br>4. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.<br>5. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.<br>6. B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003.<br>7. Tensors- Mathematics of Differential Geometry by Z. Ahsan, PHI,2015<br>9. David C. Kay, Tensor Analysis, Schaum's Outline Series, McGraw Hill 1988. | | |

| | | |
|---|---|---|
| | Other references | 1. An Introduction to Differential Geometry (with the use of tensor Calculus), L. P. Eisenhart, Princeton University Press, 1940.<br>2. Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continua, 2nd Edition, I. S. Sokolnikoff, John Wiley and Sons., 1964.<br>3. R. S, Mishra, A Course in Tensors with Applications to Reimannian Geometry, Pothishala Pvt. Ltd, Allahabad.<br>4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C304.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **1** | **1** | **1** |
| **C304.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C304.3** | **2** | **3** | **2** | **2** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C304.4** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C304.5** | **3** | **2** | **2** | **3** | **2** | **1** | **2** | **1** | **2** | **2** |
| **C304.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** |

## Real Analysis (BHM 305)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B.Sc.(H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: V** | |
| 1 | Course Code | **BHM 305** | |
| **2** | **Course Title** | **Real Analysis** | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To make students familiar with the basic concepts of real analysis. The notion of limit, continuity, differentiability, sequences, infinite series & their convergence has been also introduced. | |
| 6 | Course Outcomes | **CO1:** Discuss the basic concepts of set theory on R, open & closed sets, bounded & unbounded sets, countable & uncountable sets and calculate the limit points of sets. (K2, K3)<br>**CO2:** Describe the concept of Limit, Continuity, and Continuous & Discontinuous functions, Uniform continuous functions and calculate same. (K2, K3)<br>**CO3:** Define the definition of derivatives, increasing & decreasing functions, explain Darboux's theorem, Rolle's theorem, Men Value Theorem & its applications. (K1, K4)<br>**CO4:** Calculate and analyze the convergent sequences, limit point of sequence, non-convergent sequence, and monotonic sequences. (K3,K4)<br>**CO5:** Explain the concept of series and illustrate the test for series.(K2, K3, K4)<br>**CO6:** Evaluate Positive terms series, Alternating series, Series with arbitrary terms. (K6) | |
| 7 | Course Description | This is an introductory course of real analysis. Students are introduced to the fundamental concepts of real analysis. The notion of limit, continuity, differentiability, sequences, infinite series & their convergence has been also introduced. | |
| 8 | Outline syllabus | **Real Analysis** | CO Mapping |

| | | | |
|---|---|---|---|
| | **Unit 1** | **ELEMENTS OF POINTS SET THEORY ON R** | |
| | A | Sets, Intervals: Open and closed, Bounded and unbounded sets, Supremum and infimum. | CO1 |
| | B | Neighborhood of a point, Open and Closed sets, Limits points of a set, Bolzano – Weierstrass Theorem (statement) | CO1 |
| | C | Countable and Uncountable sets | CO1 |
| | **Unit 2** | **LIMIT & CONTINUITY OF FUNCTIONS ON R** | |
| | A | Limit of a function, Theorems on algebra of limits, Limit or a function | CO2 |
| | B | Sequential approach, Cauchy's criteria for finite limits | CO2 |
| | C | Continuous functions, Discontinuous functions, Properties of continuous functions on closed intervals, Uniform continuous functions and related results | CO2 |
| | **Unit 3** | **DIFFERENTIATION OF FUNCTIONS ON R** | |
| | A | Definitions of derivatives and related results, increasing and decreasing functions | CO3 |
| | B | Darboux's theorem, Rolle's Theorem, | CO3 |
| | C | Mean value theorems of differential calculus and their applications | CO3 |
| | **Unit 4** | **SEQUENCES** | |
| | A | Sequences, Bounded and convergent sequences | CO4 |
| | B | Limit Points of a sequence, Bolzano – Weierstrass Theorem, Limit inferior and superior, | CO4 |
| | C | Non-convergent (divergent) sequence, Cauchy's general principle of convergence, monotonic sequences. | CO4 |
| | **Unit 5** | **INFINTE SERIES & THEIR CONVERGENCE** | |
| | A | Series of positive terms: p- test, the comparison, Cauchy's root and D' Alembert ratio tests (without proof), Logarithmic and Integral test | CO5, CO6 |
| | B | Alternating series, Leibnitz test, absolute and conditional convergence | CO5, CO6 |
| | C | Series of arbitrary terms, Abel's and Dirichlet's tests. | CO5, CO6 |
| | Mode of examination | Theory | |
| | Weightage/ Marks Distribution | CA: 25Marks; MTE: 25Marks; ETE: 50Marks | |
| | Text book | 1. S.C. Malik and SavitaArora: Mathematical Analysis, Second Edition, Wiley EasternLimited, New Age International Limited, New Delhi, 1994. | |
| | Other References | 2.D. Somasundram and B. Chaudhary: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.<br>3.Rudin, Walter, Principles of Mathematical Analysis, third edition, InternationalSeries in Pure and Applied Mathematics. McGraw-Hill Book Co., New York-Auckland-D usseldorf, 1976.<br>4.T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C305.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C305.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C305.3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** | **2** |
| **C305.4** | **2** | **2** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **2** |
| **C305.5** | **3** | **2** | **2** | **3** | **2** | **2** | **2** | **3** | **2** | **2** |
| **C305.6** | **3** | **3** | **2** | **3** | **3** | **3** | **2** | **2** | **2** | **2** |

## Statistical Computing and introduction to Statistical Softwares (BHM 306)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** | |
| **Program: B. Sc. (H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: V** | |
| 1 | Course Code | **BHM 306** | |
| 2 | Course Title | **Statistical Computing and introduction to Statistical Softwares** | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To understand programming R and its roles in problem solving.<br>To understand basic data structures and develop the databy using R andSPSS. | |
| 6 | Course Outcomes | After completing this course a student will have:<br>**CO1**. Basic Knowledge of SPSS and R programming with some basic notions for developing their own simple programs and visualizing graphics in R (K1, K2).<br>**CO2**. Ability to perform data analysis for both univariate and multivariate data sets usingR as well as SPSS (K2, K3).<br>**CO3:**Define the Graphs using R, for Inferential Statistics- Parametric test. (K1, K4)<br>**CO4:** Calculate and analyze the Wilcoxon signed rank sum test, Mann Whitney U test, Kruskal Wallis test using R(K3,K4).<br>**CO5:** Explain the concept of SPSS Environment, entering data, Importing and Exporting data, Data Preparation and Data Transformation.(K2, K3, K4)<br>**CO6:** Evaluate Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression (K6). | |
| 7 | Course Description | This course is an introduce basics programming in R, and its applications in data analysis. Also in data preparation and transportation by using SPSS. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | | |
| | A | Introduction to Computer: Generation of Computer, Basic Structure ofComputer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for simple statistical problems. | CO1 |
| | B | Introduction to R Programming and R Studio, Installing R, R as a calculator. | CO2 |
| | C | Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists. | CO2 |
| | **Unit 2** | | |

| | | | | | |
|---|---|---|---|---|---|
| | A | Data inputs: Entering data from the keyboard, Importing Data from Excel, SPSS. | | | CO1, CO3 |
| | B | SAS, STATA, creating new variables, recoding variable, renaming variables. | | | CO3 |
| | C | Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test. | | | CO3 |
| | **Unit 3** | | | | |
| | A | Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kruskal Wallis test, Analysis of Variance (Oneway & Two way Anova), Karl Pearson correlation coefficient. | | | CO4 |
| | B | Using R:Linear Regression : Simple and Multiple regression. | | | CO4 |
| | C | SPSS Environment, entering data, Importing and Exporting data, Data Preparation, Data Transformation. | | | CO4 |
| | **Unit 4** | | | | |
| | A | Descriptive Statistics, Explore, Graphs using SPSS . | | | CO3, CO5 |
| | B | Graphs using SPSS, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean. | | | CO5 |
| | C | Graphs using SPSS, Inferential Statistics- Parametric test: t-test for difference between means, paired t-test. | | | CO5 |
| | **Unit 5** | | | | |
| | A | Using SPSS: Non-parametric tests, Analysis of Variance (One-way & Two way Anova). | | | CO6 |
| | B | Using SPSS: Karl Pearson correlation coefficient. | | | CO6 |
| | C | Using SPSS: Linear Regression : Simple and Multiple regression. | | | CO6 |
| | Mode of examination | Theory | | | |
| | Weightage/ Marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1.Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer.<br>2.Crawley, M.J. (2017). The R Book, John Wiley & Sons.<br>3.Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems<br>4.Organization, Programming and Applications, Prentice-Hall.<br>5.Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.<br>6.Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems<br>Margan G A: SPSS for Introductory Statistics; Uses and Interpretation. | | | |
| | Other References | 1. http://heecontent.upsdc.gov.in/SearchContent.aspx<br>2. https://swayam.gov.in/explorer?searchText=statistics | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C306.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C306.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C306.3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** | **2** |
| **C306.4** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |

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|---|---|---|---|---|---|---|---|---|---|---|
| **C306.5** | **3** | **2** | **2** | **3** | **2** | **1** | **2** | **2** | **2** | **3** |
| **C306.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** |

## Summer internship/Industrial Training/ Survey/Project (BHM 352)+Community Connect (CCU 401)

<table>
<tr><td colspan="2">SCHOOL:<br>School of Basic Sciences and Research</td><td>TEACHING DEPARTMENT:<br>Mathematics + Community Connect</td><td>ACADEMIC SESSION : 2023- 23</td><td>FOR STUDENTS BATCH – B. Sc and M. Sc.(2017-18 & 2018-19 onwards)</td></tr>
<tr><td>1</td><td>Course Number</td><td colspan="3">BHM 352 (Course Code: CCU401/ Course ID: 30804) SEMESTER: V</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="3">Summer internship/Industrial Training/ Survey/Project (BHM 352)+Community Connect</td></tr>
<tr><td>3</td><td>Credits</td><td colspan="3">3</td></tr>
<tr><td>3.01</td><td>(L-T-P)</td><td colspan="3">0-0-6</td></tr>
<tr><td>4</td><td>Learning Hours</td><td colspan="3"><table><tr><td>Contact Hours</td><td>30</td></tr><tr><td>Project/Field Work</td><td>20</td></tr><tr><td>Assessment</td><td>00</td></tr><tr><td>Guided Study</td><td>10</td></tr><tr><td>Total hours</td><td>60</td></tr></table></td></tr>
<tr><td>5</td><td>Course Objectives</td><td colspan="3">1. To expose our students to different social issues faced by the people in different sections of society.<br>2. To connect their class-room learning with problem solving skills in real life scenario.</td></tr>
<tr><td>6</td><td>Course Outcomes</td><td colspan="3">After completion of this course students will be able to:<br>1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner.<br>2. Get practical exposure of all round development which complements their class room learning<br>3. These activities will add value to students, faculty members, school and university.</td></tr>
<tr><td>7</td><td>Theme</td><td colspan="3">Major themes for research:<br><br>1.Survey and self-learning: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.<br>2.Survey and solution providing: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc.<br>3.Survey and reporting: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Program,BetiBachao, BetiPadhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima</td></tr>
</table>

| | | |
|---|---|---|
| | | Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva Vandana Yojana, and Ayushman Bharat Yojana. |
| **8.1** | **Guidelines for Faculty Members** | It will be a group assignment.<br>There should be not more than 10 students in each group.<br>The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report.<br>The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions).<br>The faculty will guide the student to prepare the PPT.<br>The topic of the research should be related to social, economical or environmental issues concerning the common man.<br>The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs.<br>The student should**submit the report**to CCC-Coordinator signed by the faculty guide by 15 April 2019.<br>The students have to send the hard copy of the **report and PPT**, and then only they will be allowed for ETE. |
| **8.2** | **Role of CCC-Coordinator** | The CCC Coordinator will supervise the whole process and assign students to faculty members.<br>1. PG-M.Sc.-Semester II – the students will be allocated to faculty member (mentors/faculty member) in even term.<br>2. UG- B.Sc.(H).-Semester III - the students will be allocated to faculty member (mentors/faculty member) in odd term. |
| **8.3** | **Layout of the Report** | Abstract(250 words)<br>a. Introduction<br>b. Literature review(optional)<br>c. Objective of the research<br>d. Research Methodology<br>e. Finding and discussion<br>f. Conclusion and recommendation<br>g. References<br>Note: Research report should base on primary data. |
| **8.4** | **Guideline for Report Writing** | **Title Page: The following elements must be included:**<br>• Title of the article;<br>• Name(s) and initial(s) of author(s), preferably with first names spelled out;<br>• Affiliation(s) of author(s);<br>• Name of the faculty guide and Co-guide<br>**Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper.<br>**Text: Manuscripts should be submitted in Word.**<br>• Use a normal, plain font (e.g., 12-point Times Roman) for text.<br>• Use italics for emphasis.<br>• *Use the automatic page numbering function to number the pages.*<br>• *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions)<br>**Reference list:**<br>The list of references should only include works that are cited in the text and that have been published or accepted for publication.<br>The entries in the list should be in alphabetical order.<br>Journal article<br>Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) |

| | | |
|---|---|---|
| | | Article by DOI<br>Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z<br>Book<br>Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992)<br>Book chapter<br>Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002)<br>Online document<br>Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007<br>Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see<br>www.issn.org/2-22661-LTWA-online.php<br>For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list.<br>EndNote style (zip, 2 kB)<br>**Tables: All tables are to be numbered using Arabic numerals.**<br>**Figure Numbering: All figures are to be numbered using Arabic numerals**.<br>The soft copy of final report should be submitted by email to Dr. Piali Haldar (piali.haldar@sharda.ac.in)within 16th **April2019 along with hard copy signed by faculty guide.** |
| **8.5** | **Format:** | **The report should be Spiral/ hardbound**<br>The Design of the Cover page to report will be given by the Coordinator- CCC Cover page Acknowledgement Content Project report Appendices |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C352.1 | - | - | 1 | 1 | 1 | - | 2 | 1 | - | 2 |
| C352.2 | - | - | 2 | 1 | 1 | - | 2 | 2 | - | 2 |
| C352.3 | - | - | 1 | 1 | 2 | - | 2 | 1 | - | 2 |

# THEORY COURSES

(Semester- VI)

## METRIC SPACES & COMPLEX ANALYSIS (BHM 307)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2023-24** |
| **Branch: Mathematics** | | **Semester: VI** |
| 1 | Course Code | BHM 307 |
| **2** | **Course Title** | **METRIC SPACES & COMPLEX ANALYSIS** |

| | | | |
|---|---|---|---|
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. Familiarise students with basic concepts of metric spaces. Give an idea of the Metric space of the real line; subsets of the real line and limit points of sets. Have an understanding of a basis and sub-basis of a Metric space. Discuss a continuous function between two metric spaces and a homeomorphism between them. Know connectedness and compactness and appreciate these concepts in the context of properties of a continuous function.<br>2. This course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. | |
| 6 | Course Outcomes | **CO1:** The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics. (K1,K2).<br>**CO2:** After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research. (K2,K3).<br>**CO3:** Students will be able to know the concepts of metric space, basic concepts and developments of complex analysis which will prepare the students to take up further applications in the relevant fields. (K2,K3,K4).<br>**CO4:** Explain the concept of connectedness, connected subsets, connectedness and continuous mappings, analyze compactness, compactness and boundedness and evaluate continuous functions on compact spaces. (K3,K4)<br>**CO5**: Discuss the concept of Cauchy's Theorems and Fundamental Theorem of Algebra and its application. (K4,K5)<br>**CO6:** Describe series and residues and its application. (K4,K5,K6) | |
| 7 | Course Description | This course will cover the basic concepts of metric spaces. Give an idea of the Metric space of the real line; subsets of the real line and limit points of sets. Have an understanding of a basis and sub-basis of a Metric space. Discuss a continuous function between two metric spaces and a homeomorphism between them. Know connectedness and compactness and appreciate these concepts in the context of properties of a continuous function.<br>This course is an introduce the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |
| | A | **Basic Concepts:**Metric spaces**:** Definition and examples, Sequences in metric spaces. | CO1 |
| | B | **Basic Concepts:** Cauchy sequences, Complete metric space. | CO1 |
| | C | **Topology of Metric Spaces:** Open and closed ball, Neighborhood, Open set. | CO1 |

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| | **Unit 2** | | |
| | A | **Topology of Metric Spaces:** Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set,<br>Cantor'stheorem, Subspaces, Dense set. | CO2 |
| | B | **Continuity & Uniform Continuity in Metric Spaces:**Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity. | CO2 |
| | C | **Continuity & Uniform Continuity in Metric Spaces:** Homomorphism, Contraction mapping, Banach fixed point theorem. | CO2 |
| | **Unit 3** | | |
| | A | **Connectedness and Compactness:** Connectedness, Connected subsets of , Connectedness. | CO3 |
| | B | **Connectedness and Compactness:** continuous mappings,Compactness, Compactness. | CO3 |
| | C | **Connectedness and Compactness:** boundedness, Continuous functions on compact spaces. | CO3 |
| | **Unit 4** | | |
| | A | **Analytic Functions and Cauchy-Riemann Equations:** Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives. | CO4 |
| | B | **Analytic Functions and Cauchy-Riemann Equations:** Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples. | CO4 |
| | C | **Elementary Functions and Integrals:** Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, | CO4 |
| | **Unit 5** | | |
| | A | **Elementary Functions and Integrals:** Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for modulo of contour integrals. | CO5, CO6 |
| | B | **Cauchy's Theorems and Fundamental Theorem of Algebra:** Anti derivatives, Proof of anti derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra. | CO5, CO6 |
| | C | **Series and Residues:** Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at | CO5, CO6 |

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| | | infinity; Types of isolated singular points, Residues at poles and its examples. | | | |
| | Mode of examination | Theory | | | |
| | Weightage/ Marks Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **Suggested Readings ( Metric Space):**<br>1. Mathematical Analysis by Shanti Narain.<br>2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.<br>3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.<br>**Suggested Readings (Complex Analysis):**<br>1. Function of Complex Variable by Shanti Narain.<br>2. Complex variable and applications by Brown & Churchill. | | | |
| | Other References | 1. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi.<br>2. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.<br>3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS. | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C208.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **2** | **1** |
| **C208.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C208.3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** | **2** |
| **C208.4** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **2** |
| **C208.5** | **1** | **1** | **2** | **2** | **2** | **1** | **2** | **2** | **2** | **3** |
| **C208.6** | **3** | **2** | **3** | **1** | **2** | **2** | **2** | **1** | **2** | **1** |

## Numerical Analysis & Operation Research (BHM 308)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2023-24** |
| **Branch: Mathematics** | | **Semester: VI** |
| 1 | Course Code | BHM 308 |
| **2** | **Course Title** | **Numerical Analysis &Operation Research** |
| 3 | Credits | 4 |

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|---|---|---|---|
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. 2.To improve the student's skills in numerical methods by using the MATLAB.3. To provide the students are able to formulate a real-world problem as a mathematical programming model, understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand, relationship between a linear program and its dual, including strong duality and complementary slackness and solve specialized linear programming problems like the transportation and assignment problems. | |
| 6 | Course Outcomes | **CO1:** The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in daily life. At the end of the course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation. (K1,K2,K3.)<br>**CO2:** The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course in Numerical Analysis in higher Mathematics. (K2,K3).<br>**CO3:** The student will be able to solve various problems based on convex sets and linear programming. After successful completion of this paper will enable the students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research. (K2,K3,K4)<br>**CO4:** Identify and develop operational research models from the verbal description of the real system. (K3,K4)<br>**CO5:** Discuss the concept of duality and formulate and solve Dual of LPP. (K3,K4,K5)<br>**CO6:** Describe the numerical differentiation and evaluate the differentiation. (K4,K5,K6) | |
| 7 | Course Description | This course is an introduction to the numerical analysis. The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems in MATLAB.<br>Operations research (OR) have many applications in science, engineering, economics, and industry and thus the ability to solve OR problems are crucial for both researchers and practitioners. Being able to solve the real life problems and obtaining the right solution requires understanding and modelling the problem correctly and applying appropriate optimization tools and skills to solve the mathematical model. The goal of this course is to teach students to formulate, analyze, and solve mathematical models that represent real-world problems.. In particular, we will cover linear programming. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | | |
| | A | Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots. | CO1 |
| | B | Interpolation, Lagrange and Hermite interpolation. | CO1 |
| | C | Difference schemes, Divided differences, Interpolation formula using differences. | CO1 |
| | **Unit 2** | | |
| | A | Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas. Gaussian Quadrature Formulas. | CO2 |
| | B | System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition). | CO2 |
| | C | Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method. | CO2 |
| | **Unit 3** | | |
| | A | Numerical solution of Ordinary differential equations: Euler method, single step methods. | CO3 |
| | B | Runge-Kutta method, Multi-step methods: Milne-Simpson method, Types of approximation: Last Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation. | CO3 |
| | C | Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type. | CO3 |

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| | **Unit 4** | | | | |
| | A | Introduction, Linear programming problems, statement and formation of general linear programming problems, graphical method, slack and surplus variables, standard and matrix forms of linear programming problem, basic feasible solution. | | | CO4 |
| | B | Convex sets, fundamental theorem of linear programming, basic solution, Simplex method. | | | CO4 |
| | C | Introduction to artificial variables, two phase method Big-M method and their comparison. | | | CO4 |
| | **Unit 5** | | | | |
| | A | Resolution of degeneracy, duality in linear programming problems. | | | CO5 |
| | B | Primal dual relationships, revised simplex method, sensitivity analysis. | | | CO6 |
| | C | Transportation problems, assignment problems. | | | CO6 |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **Suggested Readings(Part-A Numerical Analysis):**<br>1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.<br>2. An Introduction to Numerical Analysis by EndreSuli, David F. Mayers, Cambridge University Press, 2003.<br>3. Applied Numerical Analysis by C. F. Gerald, Pearson Education, 2009.<br>4. Elements of Numerical Analysis by R. S. Gupta, Macmillan India Ltd, 2009.<br>**Suggested Readings(Part-B Operation Research):**<br>**1.**Taha, Hamdy H, "Opearations Research- An Introduction ", Pearson Education.<br>**2.**Kanti Swarup , P. K. Gupta , Man Mohan Operations research, Sultan Chand & Sons<br>**3.**Hillier Frederick S and Lieberman Gerald J., "Operations Research", McGraw Hill Publication. | | | |
| | Other References | 1. Introductory methods of Numerical Analysis by S. S. Sastry<br>2. Suggested digital plateform:NPTEL/SWAYAM/MOOCs<br>3.Winston Wayne L., "Operations Research: Applications and Algorithms", Cengage Learning, 4 th Edition.<br>**4.**Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd.<br>**5.** Kalavathy S., "Operations Research", S Chand. | | | |

**RSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C213.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **2** | **1** |
| **C213.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **2** | **2** |
| **C213.3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** |
| **C213.4** | **2** | **2** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **1** |
| **C213.5** | **2** | **3** | **2** | **2** | **2** | **2** | **1** | **1** | **2** | **1** |
| **C213.6** | **3** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **1** | **2** |

# Integral Transforms and Special Functions (BHM 309)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** |
| **Program: B. Sc. (H)** | | **Academic Year: 2023-24** |
| **Branch: Mathematics** | | **Semester: VI** |
| 1 | Course Code. | **BHM 309** |
| 2 | Course Title | **Integral Transforms and Special Functions** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 4-0-0 |
| | Course status | Compulsory |
| 5 | Course Objectives | The objective of this course is to introduce the fundamental concepts of Fourier series, Fourier transforms and Laplace transforms and their applications to differential equations and also special functions. |
| 6 | Course Outcomes | CO1: The course outcome is to give foundation knowledge for the students to understand basics of mathematics includingapplied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.<br>CO2: By the time students complete the course they will have wide ranging application of the subject and have the knowledge ofreal valued functions such a Integral transforms and special functions. They will also be able to know about their types..<br>CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying theconcept of transformations he learns to solve a variety of practical problems in science and engineering.<br>CO4: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him welltowards taking more advance level course in mathematics.<br>CO5: Describe and use the concepts of special functions their classification and applications<br>CO6: The student is equipped. With the application of special functions. |
| 7 | Course Description | The course is designed as an introduction to the theory and applications of integral transforms to problems in linear differential equations, to boundary and initial value problems in partial differential equations and continuum mechanics. Many new applications in applied mathematics, physics, chemistry, biology and engineering are included. |

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|---|---|---|---|
| 8 | Outline syllabus: | | CO Mapping |
| | **UNIT 1** | | |
| | A | **Fourier transforms and their applications:** Introduction, Fourier series, Fourier integral formulas. | CO1, CO2 |
| | B | **Fourier transforms and their applications:** Fourier transform of generalized functions, Basic properties of Fourier transform, Applications of Fourier transform. | CO2, CO2 |
| | C | **Hankel Transforms and their applications:** Hankel transforms and examples. | CO3, CO6 |
| | **UNIT 2** | | |
| | A | **Hankel Transforms and their applications:** Operational properties of Hankel transform, Application of Hankel transform to PDE. | CO2 |
| | B | **Mellin Transform and Z-trasnfrom:** Introduction to Mellin transform. | CO3 |

| | | | |
|---|---|---|---|
| | C | **Mellin Transform and Z-trasnfrom:** Operational properties of Mellin transform, Application of Mellin Transforms. | CO3, CO6 |
| | **UNIT 3** | | |
| | A | **Mellin Transform and Z-trasnfrom:** Introduction to Z-transform, basic Operational properties of Z-transform. | CO3 |
| | B | **Mellin Transform and Z-trasnfrom:** Inverse Z-transform and examples. | CO3 |
| | C | **Orthogonal Polynomial:** Simple set of polynomials. | CO4 |
| | **UNIT 4** | | |
| | A | **Orthogonal Polynomial:** Orthogonality, Equivalent condition for orthogonality, Zeros of orthogonal polynomials. | CO4, CO6 |
| | B | **Orthogonal Polynomials:** Recurrence relation, Christoffel-Darboux formula. | CO4 |
| | C | **Legendre's polynomials Laguerre polynomials:**Generating function, Recurrence relations. | CO5, CO6 |
| | **UNIT 5** | | |
| | A | **Legendre's polynomials Laguerre polynomials:** Legendre'sdifferential equation, Rodrigue's formula. | CO5, CO6 |
| | B | **Legendre's polynomials Laguerre polynomials:**Bateman Generatingfunction Introduction,Recurrence relations. | CO5, CO6 |
| | C | **Legendre's polynomials Laguerre polynomials:**Laguerre differential equation, Rodrigue's formula, Orthogonality. | CO5, CO6 |
| | Mode of Examination | Theory | |
| | Weightage distribution | CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks | |
| | Text books | **Suggested Readings**<br>(1) E. D. Rainville, Special Functions, The Macmillan Company, New York, 1960.<br>(2) . L. Debnath,Integral transforms and their Applications, CRC Press, New YorkLondon- Tokyo, 1995.<br>(3) . M. Ya. Antimirov, A.A. Kolyshkin, R. Valliancourt, Applied Integral Transforms, CRM Monograph Series,American Mathematical Society, 2007. | |
| | Other references | (4). A.D Poularikas, The Transforms and Applications Handbook, CRC Press, 1996.<br>(5). Z. X. Wang and D. R. Guo,Special Functions, World Scientific publishing Co., 1989. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C309.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C309.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C309.3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **1** | **2** | **2** |
| **C309.4** | **2** | **2** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **2** |
| **C309.5** | **3** | **2** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **2** |
| **C309.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** |

# Fluid Dynamics (BHM 310)

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|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B. Sc. (H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: VI** | |
| 1 | Course Code | BHM 310 | |
| **2** | **Course Title** | **Fluid Dynamics** | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To introduce the student to widely used techniques in the numerical solution of fluid equations, issues that arise in the solution of such equations, and modern trends in CFD. Emphasis will be on 'learning by doing', as students will work on programming projects for assignments. | |
| 6 | Course Outcomes | CO1: The course provides an introduction to computational fluid dynamics. (K1, K2,K4,K6)<br>CO2: The students will train the numerical solution of model problems by developing and testing own MATLAB programs (K1,K2,K5)<br>CO3:The students will learn to assess the quality of numerical results and the efficiency of numerical methods for basic fluid flow model problems..(K1,K2,K4)<br>CO4: After completion of this course, the student will have knowledge on: - Classification of the basic equations of fluid dynamics (K2,K3,K4)<br>CO5: After completion of this course, the student will have skills on: - Practical use and programming of numerical methods in fluid dynamics. (K2,K4,K6)<br>CO6: After successfulcompletion of this course, the student will have general competence on: - Numerical solution of model problems in fluid dynamics. - Checking and assessing basic numerical methods for fluid flow problems..(K3,K4,K6) | |
| 7 | Course Description | This course aims to introduce numerical modelling and its role in automotive field; it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the automotive field with the knowledge of Heat transfer and fluid dynamics. Further students can able to develop finite difference and finite volume discretized forms of the CFD equations and to formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |
| | A | Introduction and Basic Concepts: Introduction of CFD, Types of fluids and basic equations of flow, Mass Conservation, Newton's second law of motion. | CO1 |
| | B | Fluid flow governing equations, Navier– stokes equation, Boundary layer equations, Expanded form of Navier-stokes equations, Conservation of | CO1 |

| | | | |
|---|---|---|---|
| | | energy principle, Special form of energy equation. | |
| | C | Classification of second order partial differential equations, Initial and Boundary conditions, Governing equations in generalized coordinates, Review of essentials of fluid dynamics. | CO2 |
| | **Unit 2** | | |
| | A | Elementary Finite Difference Equations, Basic aspects of finite difference equations, errors and stability analysis, discretization. | CO3 |
| | B | Taylor's series expansion, difference equation: explicit and implicit. . | CO3 |
| | C | Application to heat conduction and convection, problems on one dimension steady state and unsteady state conduction. | CO3 |
| | **Unit 3** | | |
| | A | Grid Transformation Introduction, general transformation equations. | CO4 |
| | B | matrices and Jacobean, transformed version of governing equation particularly suited for CFD. | CO4 |
| | C | Compressed grids, elliptic grid generation, adaptive grids. | CO4 |
| | **Unit 4** | | |
| | A | Introduction to finite element philosophy, Basics of finite element method. | CO5 |
| | B | Stiffness matrix, Isoperimatric elements. | CO5 |
| | C | Formulation of finite elements for flow and heat transfer problems. | CO5 |
| | **Unit 5** | | |
| | A | Introduction to finite volume philosophy Integral approach. | CO6 |
| | B | Discretization and higher order schemes. | CO6 |
| | C | Application to complex geometry. | CO6 |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA \| MTE \| ETE | |
| | | 25 Marks \| 25 Marks \| 50 Marks | |
| | Text book/s* | 1. Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.<br>2. An Introduction toComputational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd. | |

| | | | |
|---|---|---|---|
| | | 3. Introduction to Computational Fluid Dynamics, Anil W Date, Cambridge University Press.<br>4. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.<br>5. Computational Fluid Dynamics: A Practical Approach, JiyuanTu, Guan HengYeoh, Chaoqun Liu, Elsevier. | |
| | Other References | 1. Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition<br>2. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.<br>3. Introduction to Fluid Mechanics, Edward J Shaughnessy,Jr., Ira M Katz, Oxford University pres. s | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C310.1 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 |
| C310.2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| C310.3 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 |
| C310.4 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| C310.5 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |
| C310.6 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 |

# LAB COURSES
# (Semester- I)

## Mathematics Lab - 1 (BHM 151)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2021- 24** |
| **Program: B.Sc.(H).** | | **Academic Year: 2021- 22** |
| **Branch: Mathematics** | | **Semester: I** |
| **1** | **Course Code** | **BHM 151** |
| **2** | **Course Title** | **Mathematics Lab - 1** |
| **3** | **Credits** | **2** |
| **4** | **Contact Hours (L-T-P)** | **0-0-4** |
| | **Course Status** | **Compulsory** |
| 5 | Course Objective | |
| 6 | Course | **CO1:** The main objective of the course is to equip the student to plot the different graph |

| | | | |
|---|---|---|---|
| | Outcomes | and solve the different types of equations by plotting the graph using<br>different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc. (K1,K2,K3)<br>**CO2.** After completion of this course student would be able to know the convergence of sequences through plotting, verify Bolzano-Weierstrass theorem<br>through plotting the sequence, Cauchy's root test by plotting *n th* roots and Ratio test by plotting the ratio of *n th* and (*n* + 1)th term. (K2,K3)<br>**CO3.** Student would be able to plot Complex numbers and their representations, Operations like addition, substraction, Multiplication, Division, Modulus and<br>Graphical representation of polar form. (K2,K3,K4)<br>**CO4**: Student would be able to perform following task of matrix as Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors,<br>Eigenvalues, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations. (K2,K3,K4)<br>**CO5**: Develop program scripts and functions using the Mathematica /MATLAB /Maple /Scilab/Maxima development environment. (K3,K4,K5)<br>**CO6**: Write the program for evaluates linear system of equations, ordinary differential equations in Mathematica /MATLAB /Maple /Scilab/Maxima.<br>(K4,K5,K6). | |
| 7 | Course Description | | |
| 8 | Outline syllabus | | CO Mapping |
| | Unit 1 | **List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.** | |
| | a, b, c | 1. Plotting the graphs of the following functions:<br>(i) ax<br>(ii) [x] (greatest integer function)<br>(iii) x 2n ; n ∈ N<br>(iv) x 2n−1 ; n ∈ N<br>(v) 1 ;n ∈ N<br>X 2n−1<br>(vi) 1 ;n ∈ N X 2n | CO1, CO6 |
| | Unit 2 | **List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.** | |
| | a, b, c | (vii) √ax + b, \|ax + b\|, c ± \|ax + b\|<br>(ix) \|X\|, sin (1 , x sin 1 , eX, e−X for x ≠ 0. ) ( ) X X X<br>(x) e ax+b, log(ax + b) , 1 , sin(ax + b), cos(ax + b) ,<br>\|sin(ax+b)\|,\|cos(ax + b)\|. ax+b<br>Observe and discuss the effect of changes in the real constants a and b on the graphs. | CO1, CO2 |
| | Unit 3 | **List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.** | |
| | a, b, c | 2. By plotting the graph find the solution of the equation<br>x = ex, x2 + 1 = ex, 1 − x2 = ex, x = log10(x) , cos(etc ) | CO1, CO2, CO6 |
| | Unit 4 | **List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.** | |
| | a, b, c | 3. Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives. | CO2, CO3, CO4 |
| | Unit 5 | **List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.** | |
| | a, b, c | 4. Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc.<br>5. Tracing of conic in Cartesian coordinates.<br>6. Graph of circular and hyperbolic functions.<br>7. Obtaining surface of revolution of curves | CO4, CO5, CO6 |

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| | Mode of examination | Jury+Practical+Viva | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | **MAT LAB Differential and Integral Calculus,** Apress901 Grayson Street Suite 204 Berkely, CAUnited States | | | |
| | Other References | SOLVING APPLIED MATHEMATICAL PROBLEMS WITH MATLAB, CRC Press. | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C151.1 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| C151.2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 2 |
| C151.3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 |
| C151.4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| C151.5 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| C151.6 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 |

## Statistics Lab- I (BDA151)

| **School: SBSR** | | **Batch: 2021-2024** |
|---|---|---|
| **Program: BSc. (H)** | | **Academic Year: 2021-22** |
| **Branch: Mathematics** | | **Semester: 1** |
| 1 | Course number | **BDA-151** |
| 2 | Course Title | **Statistics Lab - 1** |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-4 |
| | Course Status | Compulsory |
| 5 | Course Objective | To familiarize the student in introducing and exploring MS excel.<br>To enable the student on how to approach for solving statistical problems using excel tools.<br>To prepare the students to use excel in their project works.<br>To provide a foundation in use of this MS office for real time applications. |
| 6 | Course Outcomes | CO1: Understand the procedures,Analyzing and Visualizing Data with Excel. (K2)<br>CO2: Discuss and develop the basic understanding of creating formulas and how cells are referenced by rows and columns within Excel. (K2, K5, K6) |

| | | | | | |
|---|---|---|---|---|---|
| | | CO3: Discuss and construct table and graph of data with excel. (K2, K5, K6)<br>CO4: Discuss and calculate basic statistical parameters (mean, measures of dispersion, correlation coefficient, indexes). (K2, K5, K6)<br>CO5: Discuss and calculate /computeconditional Bayes Theorem .. (K2, K5, K6)<br>CO6: Discuss, predict and estimate the variable by regression analysis with excel. (K2, K5, K6) | | | |
| 7 | Course Description | Enable students for using the computer program MS Excel, apply basic statistical techniques and methods for grouping, tabular and graphical display, analysis and interpretation of Statistical data. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | **Lab. Experiment 1:** | | | |
| | | Exploring Data in Excel | | | CO1, CO2 |
| | **Unit 2** | **Lab. Experiment 2:** | | | |
| | | Create Charts | | | CO1, CO3 |
| | **Unit 3** | **Lab. Experiment 3:** | | | |
| | | Calculate Descriptive Statistics | | | CO1, CO4 |
| | **Unit 4** | **Lab. Experiment 4:** | | | |
| | | Problems based on calculation of Moments, Measures of Skewness andKurtosis. | | | CO1,CO5 |
| | **Unit 5** | **Lab. Experiment 5:** | | | |
| | | Computation of conditional probabilities based on Bayestheorem. | | | CO1, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. (1984). Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics.<br>2. Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics, World Press. | | | |
| | Other References | 1. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.<br>2. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.3. Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern. | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C151.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C151.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C151.3** | **2** | **3** | **2** | **2** | **3** | **2** | **3** | **2** | **2** | **3** |
| **C151.4** | **2** | **3** | **2** | **3** | **2** | **2** | **2** | **2** | **3** | **2** |
| **C151.5** | **3** | **3** | **2** | **3** | **2** | **2** | **2** | **2** | **2** | **3** |
| **C151.6** | **3** | **3** | **2** | **2** | **3** | **2** | **2** | **2** | **3** | **3** |

## Statistics Lab- II (BDA 152)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** | |
| **Program: B.Sc.(H)** | | **Academic Year: 2021-22** | |
| **Branch: Mathematics** | | **Semester: II** | |
| 1 | Course Code | **BDA 152** | |
| 2 | Course Title | **Statistics Lab II** | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 0-0-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | Introduce basic statistical concepts, logics and analytical tools MS excel.<br>Provide students with a general understanding of descriptive and inferential statistics and the opportunity to apply them to examine business and economic data.<br>Equip students with the skills to apply statistical concepts and analytical tools to analyze and handle real-world business issues.<br>Train students for presenting and exchanging statistical findings and views. | |
| 6 | Course Outcomes | CO1: Understand the procedures,Analyzing and Visualizing Data with Excel. (K2)<br>CO2: Discuss and develop the basic understanding of SRSWOR, estimate mean, standard error, the sample size. (K2, K5, K6)<br>CO3: Discuss and calculate Ratio and Regression estimation. (K2,K5, K6)<br>CO4: Discuss and calculate systematic with stratified sampling and SRS in the presence of a linear trend. (K2, K5, K6)CO5: Discuss and calculate correlationbetween two variables with excel. (K2, K5, K6)<br>CO6: Discuss, predict and estimate the variable by regression analysis with excel. (K2, K5, K6) | |
| 7 | Course Description | This course provides students with basic statistical concepts and analytical tools, and the opportunity to apply them to analyze real-world problem data. Main topics include sampling methods, descriptive statistics, probability & probability distributions, sampling distributions andconfidence interval estimation, hypothesis testing, simple linear regression and correlation, time series analysis and applications in quality and production management. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Lab. Experiment 1:** | |
| | | To select a SRS with and without replacement. For a population of size 5, estimate population mean, population mean square and population variance. | CO1 |
| | **Unit 2** | **Lab. Experiment 2:** | |
| | | Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS. | CO1 |
| | **Unit 3** | **Lab. Experiment 3:** | |
| | | For SRSWOR, estimate mean, standard error, the sample size. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods. Compare the efficiencies of above two methods relative toSRS. | CO2 |
| | **Unit 4** | **Lab. Experiment 4:** | |
| | | Estimation of gain in precision in stratified sampling.<br>Comparison of systematic with stratified sampling and SRS in the presence of a linear trend. Ratio and Regression estimation: Calculate the population mean or total of the population. | CO2 |
| | **Unit 5** | **Lab. Experiment 5:** | |

| | | | | | |
|---|---|---|---|---|---|
| | | Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.<br>Cluster sampling: estimation of mean or total,<br>variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.<br>Practical based on two stage sampling.<br>Practical based on multistage sampling | | | CO1, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. (1984). Sampling Theories of Survey with Application, IOWA State University Press and<br>Indian Society of Agricultural Statistics.<br>2. Goon A.M., Gupta M.K. and Dasgupta B. (2008):<br>Fundamentals of Statistics, World Press. | | | |
| | Other References | 1. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.<br>2. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.3. Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern. | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C152.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C152.2 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 2 |
| C152.3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| C152.4 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 |
| C152.5 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 |
| C152.6 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 |

## Mathematics Lab- 2 (BHM 251)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2022-23** |
| **Branch: Mathematics** | | **Semester: III** |
| 1 | Course Code | BHM 251 |
| 2 | Course Title | Mathematics Lab II |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-4 |

| | | | | | |
|---|---|---|---|---|---|
| | Course Status | Compulsory | | | |
| 5 | Course Objective | 1. To Learn simple data types, and expressions.<br>2. To learn the control structures of Python programming.<br>3. To know the scope of the variables used in functions.<br>4. To Write simple programs in Python.<br>5. To learn objects, classes, and other object-oriented features<br>6. To Solve ODE and equation with Python | | | |
| 6 | Course Outcomes | The students will be able to :<br>1. Identify the concept of python and visualization of data types different types of data.<br>2. write loops and decision statements in Python.<br>3. explore Python code structure, including the use of functions.<br>4. Implement lists, tuples, and dictionaries in Python programs<br>5. design object- oriented programs with Python classes.<br>6. Use of Python as a tool to Solve equations and \ODE | | | |
| 7 | Course Description | This course teaches computer programming to those with little to no previous experience. It uses the programming system and language called Python to do so because it is easy to learn, versatile and very useful for engineers and other professionals. Python is a special-purpose language that is an excellent choice for writing moderate-size programs that solve problems involving the manipulation of numbers. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | **MODULE I INTRODUCTION TO PYTHON** | | | |
| | | Writing simple programmes using Object, Expressions and Variables. Use of Python as calculator Branching Programs – Looping Programs. | | | CO1, CO2 |
| | **Unit 2** | **MODULE I INTRODUCTION TO PYTHON** | | | |
| | | Defining Functions in Python Program and Scoping Function Definitions – Keyword Arguments and Default Program involving values – Scoping – Specifications – Recursion–Global Variables – Modules –Tuples – Lists – Dictionaries. | | | CO1, CO3 |
| | **Unit 3** | **CLASSES AND OBJECTS** | | | |
| | | Use of Abstract Data Types –Classes – Inheritance –Multiple level of Inheritance –Substitution Principles – Encapsulation and Information Hiding. In Python programmes. | | | CO1, CO4 |
| | **Unit 4** | **Application of Python In Data Science** | | | |
| | | Programs involving problems related to Data Science –Essential Python Libraries – Installation and setup – Dataset Retrieval | | | CO1,CO5 |
| | **Unit 5** | **Application of Python In Mathematical Modelling** | | | |
| | | Write Programs in Python for Solving equations and Ordinary differential equations using Python, Plotting graphs | | | CO1, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | Amos Gilot | | | |
| | Other References | | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | |
| C251.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C251.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |
| **C251.3** | **2** | **3** | **2** | **3** | **2** | **2** | **3** | **2** | **2** | **2** |
| **C251.4** | **2** | **3** | **2** | **3** | **2** | **2** | **2** | **2** | **3** | **2** |
| **C251.5** | **3** | **3** | **2** | **3** | **2** | **3** | **3** | **2** | **2** | **2** |
| **C251.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** |

## Mathematics Lab-3 (BHM 253)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2021- 2024** | |
| **Program: B.Sc.(H)** | | **Academic Year: 2022-23** | |
| **Branch: Mathematics** | | **Semester: IV** | |
| 1 | Course Code | BHM 253 | |
| 2 | Course Title | Mathematics Lab III | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 0-0-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. Understanding the MATLAB environment.<br>2. Being able to do simple calculations using MATLAB.<br>3. Being able to carry out simple numerical computations and analyses using MATLAB. | |
| 6 | Course Outcomes | The students will be able to :<br>CO1: To understand the matrix generation basic notation in MATLAB.<br>CO2: To Understand the concept of Array Operators.<br>CO3: Understand the applications of basic Commands of MATLAB<br>CO4: To Understand Plotting Commands<br>CO 5: To Understand the procedure of solving equations, ODE PDE etc.<br>CO 6: To understand real-life problems with help of MATLAB. | |
| 7 | Course Description | | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **MODULE I INTRODUCTION TO MATLAB** | |
| | | MATLAB installation program code of Vector and Matrix generation, Array operations, Use of Inbuilt functions. | CO1, CO2 |
| | **Unit 2** | **Relational and Logical Operators** | |
| | | Programs conditional statements and loops including If-end statement, if else end statement. Nested If-else end statement, For-end and While-end loops with break commands. | CO3 |
| | **Unit 3** | **m-files** | |
| | | Writing code in script files and saving ,editing programmes using inbuilt functions. | CO3, CO4 |
| | **Unit 4** | **Plotting graphs** | |
| | | Basic Plots, Changes in axis and annotation in a figure, multiple plots in a figure, saving and printing figures, Curve fitting with polynomials using in built functions (i.e. poly fit), | CO5 |
| | **Unit 5** | **Application of MATLAB** | |
| | | Generating MATLAB code for Solving system of equations(linear, One variable etc), Solving ordinary differential equation using in built functions. | CO5, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | | | | |
| | Other References | MATLAB An Introduction with Applications By: Amos Gilat, Wiley | | | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C253.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C253.2 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 2 |
| C253.3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| C253.4 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 |
| C253.5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| C253.6 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |

# Mathematics Lab- 4 (BHM 351)

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| **School: SBSR** | | **Batch: 2021- 2024** |
| **Program: B.Sc.(H)** | | **Academic Year: 2023-24** |
| **Branch: Mathematics** | | **Semester: V** |
| 1 | Course Code | BHM 351 |
| 2 | Course Title | Mathematics Lab- 4 |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-4 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1.To understand SPSS/R and its roles in problem solving. 2. To understand data handling and its analysis.<br>3. Learning the basic statistical software will help students to easily switch over to any other statistical software in future. |
| 6 | Course Outcomes | 1.To Understand the basic workings of SPSS/R, and perform basic statistical analyses.<br>2.To perform descriptive statistics and graphics<br>3.To perform and basic inferential statistics for comparisons and correlations using SPSS/R.<br>4.Importing data, Code editing in SPSS/R.<br>5. Enhance data analysis skills using software.<br>6. Analyze the graphical interpretation would be done using software skills. |
| 7 | Course Description | This course will review topics in probability and statistics studied in core for data analysis. Introduction to SPSS/R for statistical computing, analysis and graphical |

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| | | interpretation would be done using software skills. The following problems can be done on any one of the statistical software to enhance data analysis skills using software. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | **Lab. Experiment 1:** | | | |
| | | | | | CO1, CO2 |
| | | Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists. | | | |
| | **Unit 2** | | | | |
| | | Data inputs: Entering data from the keyboard, Importing Data from Excel, SPSS. SAS, STATA | | | CO3 |
| | **Unit 3** | | | | |
| | | Using R: Analysis of Variance (Oneway & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression. | | | CO4 |
| | **Unit 4** | | | | |
| | | Graphs using SPSS, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean. | | | CO5 |
| | **Unit 5** | | | | |
| | | Using SPSS: Non-parametric tests, Analysis of Variance (One-way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression. | | | CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 | 25 | 50 | |
| | Text book/s* | 1. Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer.<br>2. Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.<br>3. Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc. Eckhouse,<br>4. R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall. Margan G A: SPSS for Introductory Statistics; Uses and Interpretation. | | | |
| | Other References | | | | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C351.1** | **3** | **3** | **2** | **2** | **2** | **3** | **2** | **2** | **1** | **1** |
| **C351.2** | **2** | **3** | **3** | **3** | **3** | **2** | **1** | **2** | **1** | **2** |

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| **C351.3** | **2** | **2** | **2** | **3** | **2** | **2** | **3** | **2** | **2** | **2** |
| **C351.4** | **2** | **3** | **2** | **3** | **2** | **2** | **2** | **2** | **3** | **2** |
| **C351.5** | **3** | **3** | **2** | **3** | **2** | **3** | **3** | **2** | **2** | **2** |
| **C351.6** | **3** | **3** | **2** | **2** | **3** | **3** | **2** | **2** | **2** | **2** |

# Mathematics Lab- 5 (BHM 353)

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|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B.Sc. (H)** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: VI** | |
| 1 | Course Code | BHM 353 | |
| 2 | Course Title | **Mathematics Lab- 5** | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 0-0-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. 2.To improve the student's skills in numerical methods by using the MATLAB. 3. To provide the students are able to formulate a real-world problem as a mathematical programming model, understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand, relationship between a linear program and its dual, including strong duality and complementary slackness and solve specialized linear programming problems like the transportation and assignment problems. | |
| 6 | Course Outcomes | CO1: Understand the procedures, algorithms, and concepts require to solve specific problems. (K2)<br>CO2: Discuss and develop the algorithms to solve system of linear equations and measure the accuracy. (K2, K5, K6)<br>CO3: Discuss and develop the algorithms to solve finite differences and interpolation and measure the accuracy. (K2, K5, K6)<br>CO4: Discuss and develop the algorithms to solve system of transcendental equations and measure the accuracy. (K2, K5, K6)<br>CO5: Discuss and develop the algorithms to solve divided differences and measure the accuracy. (K2, K5, K6)<br>CO6: Discuss and develop the algorithms to solve numerical differentiation and integration and measure the accuracy. (K2, K5, K6) | |
| 7 | Course Description | This course is an introduction to the numerical analysis. The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems in MATLAB. | |
| 8 | Outline syllabus | | CO Achievement |
| | **Unit 1** | | |
| | | 1. Solution of transcendental and algebraic equations by<br>i) Bisection method<br>ii) Newton Raphson method (Simple root, multiple roots, complex roots). | **CO1** |

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| | | iii) Secant method.<br>iv) Regula Falsi method. | |
| | **Unit 2** | | |
| | | 2. Solution of system of linear equations<br>i) LU decomposition method<br>ii) Gaussian elimination method<br>iii) Gauss-Jacobi method<br>iv) Gauss-Seidel method | **CO1,CO2** |
| | **Unit 3** | | |
| | | 3. Interpolation<br>i) Lagrange Interpolation<br>ii) Newton's forward, backward and divided difference interpolations | **CO2,CO3** |
| | **Unit 4** | | |
| | | 4. Numerical Integration<br>i) Trapezoidal Rule<br>ii) Simpson's one third rule<br>iii) Weddle's Rule<br>iv) Gauss Quadrature<br>(iv) The method of successive approximations (Picard) | **CO3, CO4** |
| | **Unit 5** | | |
| | | 5. Method of finding Eigenvalue by Power method (up to 4 × 4 )<br>6. Fitting a Polynomial Function (up to third degree)<br>7. Solution of ordinary differential equations<br>i) Euler method<br>ii) Modified Euler method<br>iii) Runge Kutta method (order 4) | **CO5,CO6** |
| | Mode of examination | Jury/Practical/Viva | |
| | Weightage Distribution | CA / MTE / ETE<br>60% / 0% / 40% | |
| | Text book/s* | - | |
| | Other References | | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C353.1** | **3** | **3** | **2** | **3** | **2** | **3** | **2** | **3** | **2** | **2** |
| **C353.2** | **2** | **3** | **3** | **3** | **3** | **2** | **3** | **2** | **2** | **2** |
| **C353.3** | **2** | **3** | **2** | **2** | **2** | **2** | **3** | **3** | **2** | **2** |
| **C353.4** | **2** | **3** | **2** | **3** | **2** | **3** | **2** | **2** | **3** | **2** |
| **C353.3** | **2** | **3** | **2** | **2** | **2** | **2** | **3** | **3** | **2** | **2** |

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| **C353.4** | **2** | **3** | **2** | **3** | **2** | **3** | **2** | **2** | **3** | **2** |

## Mathematics Lab- 6 (BHM 354)

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|---|---|---|---|
| **School: SBSR** | | **Batch : 2021- 2024** | |
| **Program: B.Sc.(H).** | | **Academic Year: 2023-24** | |
| **Branch: Mathematics** | | **Semester: VI** | |
| 1 | Course Code | **(BHM 354)** | |
| 2 | Course Title | **Mathematics Lab- 6** | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 0-0-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To introduce the student to widely used techniques in the numerical solution of fluid equations, issues that arise in the solution of such equations, and modern trends in CFD. Emphasis will be on 'learning by doing', as students will work on programming projects for assignments. | |
| 6 | Course Outcomes | CO1: The course provides an introduction to computational fluid dynamics. (K1, K2,K4,K6)<br>CO2: The students will train the numerical solution of model problems by developing and testing own MATLAB programs (K1,K2,K5)<br>CO3:The students will learn to assess the quality of numerical results and the efficiency of numerical methods for basic fluid flow model problems..(K1,K2,K4)<br>CO4: After completion of this course, the student will have knowledge on: - Classification of the basic equations of fluid dynamics (K2,K3,K4)<br>CO5: After completion of this course, the student will have skills on: - Practical use and programming of numerical methods in fluid dynamics. (K2,K4,K6)<br>CO6: After successfulcompletion of this course, the student will have general competence on: - Numerical solution of model problems in fluid dynamics. - Checking and assessing basic numerical methods for fluid flow problems..(K3,K4,K6) | |
| 7 | Course Description | This course aims to introduce numerical modelling and its role in automotive field; it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the automotive field with the knowledge of Heat transfer and fluid dynamics. Further students can able to develop finite difference and finite volume discretized forms of the CFD equations and to formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations. | |
| 8 | Outline syllabus | | CO Achievement |
| | **Unit 1** | Introduction of CFD, Types of fluids and basic equations of flow. Newton's second law of motion. | CO1 |
| | | Fluid flow governing equations, Navier– stokes equation, Boundary layer equations, Expanded form of Navier-stokes equations. | CO1 |
| | | Initial and Boundary conditions, Governing equations in generalized coordinates, Review of essentials of fluid dynamics. | CO2 |
| | | | |
| | **Unit 2** | Basic aspects of finite difference equations, errors and stability analysis, discretization. | CO2, CO3 |
| | | Taylor's series expansion, difference equation: explicit and implicit. . | CO2, CO3 |
| | | Application to heat conduction and convection, problems on one dimension steady state and unsteady state conduction. | CO2, CO3 |

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| | **Unit 3** | general transformation equations. | | | CO3, CO4 |
| | | matrices and Jacobean, transformed version of governing equation particularly suited for CFD. | | | CO3, CO4 |
| | | Compressed grids, elliptic grid generation, adaptive grids. | | | CO3, CO4 |
| | | | | | |
| | **Unit 4** | Basics of finite element method. | | | CO4, CO5 |
| | | Stiffness matrix, Isoperimatric elements. | | | CO4, CO5 |
| | | Formulation of finite elements for flow and heat transfer problems. | | | CO4, CO5 |
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| | **Unit 5** | | | | |
| | | Introduction to finite volume philosophy Integral approach. | | | CO3, CO4 CO6 |
| | | Discretization and higher order schemes. | | | CO3, CO4, CO5, CO6 |
| | | Application to complex geometry. | | | CO4, CO5, CO6 |
| | Mode of examination | Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 60% | 0% | 40% | |
| | Text book/s* | - | | | |
| | Other References | | | | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C362.1** | **3** | **3** | **2** | **3** | **2** | **3** | **2** | **3** | **2** | **2** |
| **C362.2** | **2** | **3** | **3** | **3** | **3** | **2** | **3** | **2** | **2** | **3** |
| **C362.3** | **2** | **3** | **2** | **3** | **2** | **2** | **3** | **3** | **2** | **3** |
| **C362.4** | **2** | **3** | **2** | **3** | **2** | **3** | **2** | **2** | **3** | **2** |

# Vocational Courses

(Semester-I)

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|---|---|---|---|
| 1 | Course Code | BHM 152 | |
| **2** | **Course Title** | **Basic Statistical Analysis Using Excel** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 0-0-5 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | Learn to use Effective and Efficient Statistical Analysis with Microsoft Excel to make Business and Economic decisions. | |
| 6 | Course Outcomes | CO1: Identify the major frameworks of Excel to take large data sets and perform analysis to assist in business decision making. (K1,K2, K3)<br>CO2: Demonstrate the impact of business reporting, take raw data and create descriptive tabular and visual reports to help in business decision making. (K2,K3)<br>CO3: Explain, calculate and apply probability rules to assist in business decision making. (K2. K3, K4)<br>CO4: Take samples and use sampling distributions to help business make decisions. (K2, K3, K4)<br>CO5: Make inferences based on sample data using methods such as interval estimation and hypothesis testing. (K3,K4,K5)<br>CO6: Describe how to perform regression analysis on x and y data sets to assist in business decision making. (K5,K6) | |
| 7 | Course Description | The objective of the class is to have the student leave the class with an introductory knowledge of statistics and how to use the tool Excel to take the raw data they are given and convert it into useful information to help make decisions. At its essence, this class teaches how to do Data Analysis (convert raw data into useful information) using Statistical Methods and Excel. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |
| | A | Formulas & Functions, Cell References, Number Format as Façade | CO1, CO6 |
| | B | Effective and efficient spreadsheet design, including Excel's Golden Rule. | CO1, CO6 |
| | C | Data Analysis features, such as PivotTables, Sorting, Filtering and Importing Data. Charting in Excel. | CO1, CO6 |

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| | **Unit 2** | | | | |
| | A | What is Statistics (Descriptive and Inferential). | | | CO2, CO6 |
| | B | Descriptive Statistics: Tabular & Graphical Presentation. | | | CO2, CO6 |
| | C | Descriptive Statistics: Numerical Measures. | | | CO2, CO6 |
| | **Unit 3** | | | | |
| | A | Introduction to Probability. | | | CO3, CO6 |
| | B | Discrete Probability Distributions. | | | CO3, CO6 |
| | C | Continuous Probability Distributions. | | | CO3, CO6 |
| | **Unit 4** | | | | |
| | A | Sampling and Sampling Distributions. | | | CO4, CO6 |
| | B | Interval Estimation. | | | CO4, CO6 |
| | C | Hypothesis Testing (1 and 2 means, 1 and 2 proportions). | | | CO4, CO6 |
| | **Unit 5** | | | | |
| | A | ANOVA. | | | CO5, CO6 |
| | B | Test of Independence. | | | CO5, CO6 |
| | C | Simple Linear Regression. | | | CO5, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1. Gupta. S.C. & Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics , Sultan Chand & Sons Pvt. Ltd. New Delhi. | | | |

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|---|---|---|---|
| | Other References | 1. Goon A.M. Gupta. A.K. & Das Gupta, B (1987). Fundamentals of Statistics, Vol.2, World Press Pvt. Ltd., Calcutta.<br>2. Hogg, R.V. and Craig, A.T. (2002). Introduction to Mathematical Statistics. Pearson Education India.<br>3. Statistical Analysis with Excel for Dummies, 4th Edition 4th Edition by Joseph Schmuller. | |

**COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C152.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C152.2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| C152.3 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 |
| C152.4 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| C152.5 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **C152.6** | **3** | **3** | **2** | **3** | **2** | **2** | **1** | **2** | **2** | **1** |

# Statistical Thinking with R/Python/SPSS ( BHM 153)

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|---|---|---|
| 1 | Course Code | **BHM 153** |
| **2** | **Course Title** | **Statistical Thinking with R/Python/SPSS** |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-5 |
| | Course Status | Compulsory |
| 5 | Course Objective | Objective of this course to introduces how to present, analyze and interpret data using the statistical analysis software package SPSS /R/Python. |
| 6 | Course Outcomes | CO1: Identify the major frameworks of **R/Python/SPSS** to take large data sets and perform analysis to assist in business decision making. (K1,K2,K3)<br>CO2: Demonstrate the impact of business reporting, take raw data and create descriptive tabular and visual reports to help in business decision making. (K1,K2,K3)<br>CO3: Explain, calculate and apply probability rules to assist in business decision making. (K2,K3,K4)<br>CO4: Take samples and use sampling distributions to help business make decisions. (K2,K3,K4)<br>CO5: Make inferences based on sample data using methods such as interval estimation and hypothesis testing. (K3,K4,K5)<br>CO6: Describe how to perform regression analysis on x and y data sets to assist in business decision making. (K2,K3,K6) |

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| 7 | Course Description | This course introduces how to present, analyze and interpret data using the statistical analysis software package SPSS /R/Python. This course will help you develop those skills using SPSS, which is a statistical package widely used in business, industry, government, commerce and the education and health sectors. | | | |
| 8 | Outline syllabus : | | | | CO Mapping |
| | **Unit 1** | | | | |
| | A | Introduction to with R/Python/SPSS. | | | CO1, CO6 |
| | B | **Entering and Editing Data** with R/Python/SPSS. | | | CO1, CO6 |
| | C | Data Analysis features, such as PivotTables, Sorting, Filtering and Importing Data with R/Python/SPSS. | | | CO1, CO6 |
| | **Unit 2** | | | | |
| | A | What is Statistics (Descriptive and Inferential) with R/Python/SPSS. | | | CO2, CO6 |
| | B | Descriptive Statistics: Tabular & Graphical Presentation with R/Python/SPSS. | | | CO2, CO6 |
| | C | Descriptive Statistics: Numerical Measures with R/Python/SPSS. | | | CO2, CO6 |
| | **Unit 3** | | | | |
| | A | Introduction to Probability with R/Python/SPSS. | | | CO3, CO6 |
| | B | Discrete Probability Distributions with R/Python/SPSS. | | | CO3, CO6 |
| | C | Continuous Probability Distributions with R/Python/SPSS. | | | CO3, CO6 |
| | **Unit 4** | | | | |
| | A | Sampling and Sampling Distributions with R/Python/SPSS. | | | CO4, CO6 |
| | B | Interval Estimation with R/Python/SPSS. | | | CO4, CO6 |
| | C | Hypothesis Testing (1 and 2 means, 1 and 2 proportions) with R/Python/SPSS. | | | CO4, CO6 |
| | **Unit 5** | | | | |
| | A | ANOVA with R/Python/SPSS. | | | CO5, CO6 |
| | B | Test of Independence with R/Python/SPSS. | | | CO5, CO6 |
| | C | Simple Linear Regression with R/Python/SPSS. | | | CO5, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage | CA | Viva | ETE | |

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|---|---|---|---|---|---|
| | Distribution | 25 Marks | 25 Marks | 50 Marks | |
| | Text book/s* | 1. **Gupta. S.C. & Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics , Sultan Chand & Sons Pvt. Ltd. New Delhi.**<br>2. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics. W. N. Venables, D.M. Smith and the R Development Core Team. Version 3.0.1 (2013-05-16).<br>3. Field, A. P. 2009. Discovering Statistics using SPSS (Introducing Statistical Method). Oriental Press, Chennai, India. | | | |
| | Other References | 1. Goon A.M. Gupta. A.K. & Das Gupta, B (1987). Fundamentals of Statistics, Vol.2, World Press Pvt. Ltd., Calcutta.<br>2. Dunlop, Dorothy D., and Ajit C. Tamhane. Statistics and data analysis: from elementary to intermediate. Prentice Hall, 2000.<br>3. McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.". | | | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C153.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 3 |
| C153.2 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 1 |
| C153.3 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 |
| C153.4 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| C153.5 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 |
| C153.6 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |

## Semester- III

## Prediction and Forecasting Management

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|---|---|---|---|
| 1 | Course Code | **BHM 252** | |
| **2** | **Course Title** | **Prediction and Forecasting Management** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 0-0-5 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | After completing this course, students are expected to grasp good qualitative and quantitative skills of developing forecasts using averaging and regression-based models and evaluating the forecasts for accuracy and parsimony. More importantly, students are expected to provide analytical solution to a business forecasting problem using appropriately selected model and data and discover meaningful business knowledge from the solution. | |
| 6 | Course Outcomes | CO1: Describe how to perform regression analysis on x and y data sets to assist in business decision making. (K1,K2,K3)<br>CO2: Understand the fundamental advantage and necessity of forecasting in various situations. (K2,K3)<br>CO3: Know how to choose an appropriate forecasting method in a particular environment. (K2,K3,K4)<br>CO4: Demonstrate knowledge and understanding of index numbers theory and methods and be able to provide practical solutions to general aggregation problems. (K2,K3,K4)<br>CO5: Know how to apply various forecasting methods, which includes obtaining the relevant data and carrying out the necessary computation. (K3,K4,K5)<br>CO6: Improve forecast with better statistical models based on statistical analysis. (K3,K4,K6) | |
| 7 | Course Description | This course presents a set of topics in developing analytical methodologies that make prediction and forecasting about future events of interest to individual business and industry in general. Students are introduced to managerial techniques and analytical models that reveal valuable relationships in economic and business data for supporting short-term and long-term planning. Students will learn how to build the models, how to interpret the predictions and forecasts produced from the models, and how to evaluate the reliability of the model results. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |

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|---|---|---|---|---|---|
| | A | Simple Linear Regression Forecasting Model. | | | CO1, CO6 |
| | B | Multiple Linear Regression Forecasting Model . | | | CO1, CO6 |
| | C | Applications in Business. | | | CO1, CO6 |
| | **Unit 2** | | | | |
| | A | Introduction to Business Forecasting. | | | CO2, CO6 |
| | B | Qualitative vs. Quantitative Methods. | | | CO2, CO6 |
| | C | Characteristics of Time Series Data. | | | CO2, CO6 |
| | **Unit 3** | | | | |
| | A | Moving Averaging Models for Trend Identification. | | | CO3, CO6 |
| | B | Naive Average Forecasting, Moving Average Forecasting Model. | | | CO3, CO6 |
| | C | Smoothing Forecasting Model, Applications in Business. | | | CO3, CO6 |
| | **Unit 4** | | | | |
| | A | Time Series Models for Observation Forecast. | | | CO4, CO6 |
| | B | Auto regressive Forecasting (AR) Model, Auto regressive Moving Average (ARMA) Model. | | | CO4, CO6 |
| | C | Auto regressive Integrated Moving Average (ARIMA) Model, Dealing with periodic fluctuation. | | | CO4, CO6 |
| | **Unit 5** | | | | |
| | A | Introduction, Basic Problems in the construction of Index Numbers. | | | CO5, CO6 |
| | B | Construction of Index Numbers, Uses and Limitations of Index Numbers. | | | CO5, CO6 |
| | C | Chain Index, Base Shifting, Splicing and Deflating, Cost of Living Index. | | | CO5, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage | CA | Viva | ETE | |
| | Distribution | 25 | 25 | 50 | |

| | | | |
|---|---|---|---|
| | Text book/s* | 1. Gupta, S.C., Kapoor, V. K. (2007): Fundamentals of Applied Statistics, 4thEdition, Sultan Chand & Sons.<br>2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press. | |
| | Other References | 1. "Forecasting and Time Series", 4thEdition, by Bowerman and O'Connell, Duxbury.<br>2. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.<br>3. Karmel, P.H. and Polasek, M. (2012): Applied Statistics for Economists, 4th edition. Khosla Publishing House by arrangement with Pitman.<br>4. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P)Ltd.<br>5. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6thEdition, Wiley India Pvt. Ltd. | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C252.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| C252.2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| C252.3 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 |
| C252.4 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| C252.5 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| C252.6 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |

## Semester- IV

## Advanced Statistical Analysis (BHM 254)

| | | | |
|---|---|---|---|
| 1 | Course Code | BHM 254 | |
| **2** | **Course Title** | **Advanced Statistical Analysis** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 0-0-5 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | After completing this course, students are expected to become a specialist to analyze the observed phenomena in advanced statistical level. More importantly, students are expected to provide analytical solution to a problem using appropriately selected model and data and discover meaningful knowledge from the solution. | |
| 6 | Course Outcomes | CO1: Describe how to Differentiate various probability distributions. (K1,K2) | |
| | | CO2: Understand the concept of estimation. (K2,K3) | |
| | | CO3: Know how to recognize the sampling distributions. (K2,K3) | |
| | | CO4: Learn non-parametric test such as the Chi- Square test for Independence as well as Goodness of Fit. (K3,K4) | |
| | | CO5: Know how to apply various statistical and analysis. (K3,K4,K5) | |
| | | CO6: Able to know statistical technique implantation in practical situation. (K3,K4,K5) | |
| 7 | Course Description | This course provides students with statistical foundation of the various problems of real life. Students will learn to recognize the main features of the processes under investigation that could be analyzed in terms of advanced statistical approaches. Grading this course will help the future specialist to analyze the observed phenomena in advanced statistical level. | |
| 8 | Outline syllabus : | | CO Mapping |
| | **Unit 1** | | |
| | A | Use of discrete distribution (Uniform, Binomial and Poisson) in real life problem. | CO1, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | B | Use of continuous distribution (Normal, Exponential and Gamma) in real life problem. | | | CO1, CO6 |
| | C | Its applications in Industrial work. | | | CO1, CO6 |
| | **Unit 2** | | | | |
| | A | Sampling Distributions. | | | CO2, CO6 |
| | B | $\chi 2$ distribution properties and Interrelationships. | | | CO2, CO6 |
| | C | t distribution properties and Interrelationships. | | | CO2, CO6 |
| | **Unit 3** | | | | |
| | A | F distribution properties. | | | CO3, CO6 |
| | B | Interrelationship of $\chi 2$, t, F distributions. | | | CO3, CO6 |
| | C | Point Estimation, Interval estimation for mean, variance of normal population and proportion of binomial population. | | | CO3, CO6 |
| | **Unit 4** | | | | |
| | A | Type I and Type II errors, Critical Region, Size of the test, P value, Power. | | | CO4, CO6 |
| | B | Large Sample test -Z test. | | | CO4, CO6 |
| | C | Large Sample test – Chi-Square test-goodness of fit, test of independence. | | | CO4, CO6 |
| | **Unit 5** | | | | |
| | A | ANOVA, Randomization and randomization-based | | | CO5, CO6 |
| | | analysis. | | | |
| | B | Factor Analysis. | | | CO5, CO6 |
| | C | Cluster and Principal Components Analysis (PCM). | | | CO5, CO6 |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | Viva | ETE | |
| | | 25 | 25 | 50 | |
| | Text book/s* | 1. Gupta. S.C. & Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics , Sultan Chand & Sons Pvt. Ltd. New Delhi.<br>2. Westfall, P., & Henning, K. S. (2013). Understanding advanced statistical methods. CRC Press. | | | |

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|---|---|---|---|
| | Other References | 1. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.<br>2. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P)Ltd.<br>3.Triola, M. M., & Triola, M. F. (2006). Biostatistics for the biological and health sciences (pp. 47-48). Boston: Pearson Addison-Wesley. | |

## COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C254.1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 |
| C254.2 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 2 | 1 |
| C254.3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 |
| C254.4 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| C254.5 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 |
| C254.6 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |

| These courses (Core: Major/ Minor) can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), Commerce(UG), BBA/BCA, B.Sc.(C.S.) and others. | | |
|---|---|---|
| **Suggested Continuous Evaluation Methods:** Max. Marks: 25 | | |
| **SN** | **Assessment Type** | **Max. Marks** |
| **1** | **Class Tests** | **10** |
| **2** | **Online Quizzes/ Objective Tests** | **5** |
| **3** | **Presentation/** Research Orientation assignment | **5** |
| **4** | **Assignment (Indian Ancient Mathematics/ Statistics and Mathematicians/ Statisticians).** | **5** |

**---------- THE END ----------**