

**University of Agricultural Sciences, Bengaluru**



**COURSE CURRICULUM**

for

**B. Tech. (Food Technology)  
Degree Programme**

**as per V Deans' Committee's Recommendations  
(with effect from the academic year 2016-17)**

**College of Agriculture  
Hassan-573 225**

**2018**

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## PREAMBLE

The University of Agricultural Sciences, Bangalore has started B. Tech. (Food Science and Technology) degree program at College of Agriculture, Hassan from the academic year 2007–08 as per the ICAR-IV Deans' Committee recommendations. Upgradation of curriculum from time to time was felt necessary to incorporate the recent developments in the areas of Food Science and Food Processing Technology and inputs from scientists of CFTRI, Mysore. For doing so the University constituted an expert committee which met on 5<sup>th</sup> December 2011 and recommended certain revisions in the syllabus. Later it was discussed and finalized at the Board of Studies meeting held on 19<sup>th</sup> December 2011 and notified *vide* Notification No. R/PS/BTech(FST)/CC/2012-13 dated 1<sup>st</sup> August 2012, for incorporation from the Academic year 2012-13.

In the Year 2016, the ICAR-V Deans' Committee recommended new syllabus for B.Tech. (Food Technology) degree programme (*vide* ICAR-V Deans' Committee's Report for UG 2017-18 dated: 16.01.2017). Subsequently the University of Agricultural Sciences, Bangalore has constituted a separate Board of Studies for each faculty for effective implementation of the new syllabus as per the V Deans' Committee's Recommendations. One such board was **Board of Studies (UG)-Faculty of Food Science & Technology**, which is the first of its kind in the history of UAS(B).

As per the V Deans' Committee recommendations and the recommendation of the ICAR review team, Dept. of Food Science & Technology was bifurcated into 6 sections namely, Section of Basic Engineering, Section of Food Science & Nutrition, Section of Food Processing Technology, Section of Food Safety and Quality, Section of Food Process Engineering and Section of Food Business Management and same was approved in the 183<sup>rd</sup> meeting of the

Academic Council, UAS(B), held at GKVK, Bengaluru on 20/03/2017.

Based on the feedback given by the teachers and graduates from our college who are presently on various positions in food industries, the need was felt for revision and fine tuning of the course curriculum. Changes in the curriculum went through multiple levels of discussion, revision, presentation by all concerned teachers, to bring to its final shape. The present curriculum consists of total 183 credit hours, which includes: Basic Sciences & Humanities (12 credits), Agriculture & Allied Sciences (14 credits), Food Technology Core Courses in the areas of Basic Engineering (15 credits), Food Science & Nutrition (14 credits), Food Processing Technology (28 credits), Food Safety & Quality (21 credits), Food Process Engineering (29 credits) and Food Business Management (8 credits) during the first three years of the degree program. During the 7<sup>th</sup> and 8<sup>th</sup> semesters the students will undergo extensive practical training in the form of Student READY Program (40 credits) which includes Industrial Tour, Experiential Learning, Research Project, Seminar and Internship/In-plant training in various food industries.

The revised course curriculum was finally approved by the Board of Studies-UG, Faculty of Food Science & Technology, UAS(B) in its 1<sup>st</sup> meeting held on 13.01.2017 and further by the Academic Council, UAS(B) in its 183<sup>rd</sup> meeting held on 20.03.2017 *vide* Agenda Part-B: Item-15 and the Board of Management, UAS(B) in its 374<sup>th</sup> Emergent Meeting held on 29.05.2017 *vide* Agenda Part-B: Item-13. The detailed course curriculum of the B.Tech. (Food Technology) degree programme is presented here.

**Course Curriculum  
for  
B. Tech. (Food Technology)**

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| Basic Engineering                           | 17       |
| Food Science and Nutrition                  | 23       |
| Food Processing Technology                  | 29       |
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| Food Process Engineering                    | 47       |
| Food Business Management                    | 61       |
| Food Plant operations/Student READY Courses | 65       |
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|       |   |
|-------|---|
| AGR   | Agronomy  |
| AET   | Agricultural Entomology                                 |
| AEX   | Agricultural Extension                                  |
| AST   | Agricultural Statistics                                 |
| BEN   | Basic Engineering                                       |
| BIO   | Biology   |
| CPH   | Crop Physiology   |
| CSC   | Computer Science  |
| ENG   | English   |
| FBM   | Food Business Management                                |
| FES   | Forestry and Environmental Science                      |
| FPE   | Food Process Engineering                                |
| FPO   | Food Plant Operations                                   |
| FPT   | Food Processing Technology                              |
| FSN   | Food Science and Nutrition                              |
| FSQ   | Food Safety and Quality                                 |
| HRT   | Horticulture  |
| KAN   | Kannada   |
| MAT   | Mathematics   |
| MEB   | Microbial Environmental Biotechnology                   |
| NSS   | National Service Scheme                                 |
| PAT   | Plant Pathology   |
| PED   | Physical Education                                      |
| READY | Rural and Entrepreneurship Awareness Development Yojana |

**ABSTRACT**

|      | Particulars  | Credit Hours     |
|------|--|------------------|
| I.   | BASIC SCIENCES & HUMANITIES                            | 7+8=15           |
| II.  | AGRICULTURE AND ALLIED SCIENCES                        | 10+4=14          |
| III. | FOOD TECHNOLOGY CORE COURSES                           |                  |
|      | 1. Basic Engineering (BEN)                             | 7+5=12           |
|      | 2. Food Science & Nutrition (FSN)                      | 8+6=14           |
|      | 3. Food Processing Technology (FPT)                    | 17+11=28         |
|      | 4. Food Safety and Quality (FSQ)                       | 14+7=21          |
|      | 5. Food Process Engineering (FPE)                      | 19+10=29         |
|      | 6. Food Business Management (FBM)                      | 6+2=8            |
| IV.  | FOOD PLANT OPERATIONS/STUDENT READY COURSES            |                  |
|      | 1. Student READY - Industrial Tour                     | 0+1=1            |
|      | 2. Student READY - Experiential Learning Programme - I | 0+7=7            |
|      | 3. Student READY-Experiential Learning Programme - II  | 0+7=7            |
|      | 4. Student READY - Research Project                    | 0+4=4            |
|      | 5. Student READY - Seminar                             | 0+1=1            |
|      | 6. Student READY - Internship/In-Plant Training        | 0+20=20          |
|      | <b>Total</b>   | <b>88+93=181</b> |
| V.   | REMEDIAL COURSES                                       | 1+1/2+0=2        |
|      | <b>GRAND TOTAL</b>                                     | <b>183</b>       |

**LIST OF COURSES**

**I. BASIC SCIENCES & HUMANITIES**

| Sl. No. | Course No. | Course Title                                      | Credit Hrs. | Page No. |
|---------|------------|---|-------------|----------|
| 1       | ENG 111    | Comprehension and Communication Skills in English | 1+1         | 1        |
| 2       | MAT 112    | Engineering Mathematics for Food Technology-I     | 2+0         | 1        |
| 3       | MAT 122    | Engineering Mathematics for Food Technology -II   | 2+0         | 2        |
| 4       | AST 223    | Statistical Methods & Numerical Analysis          | 1+1         | 3        |
| 5       | CSC 311    | Computer Programming & Data Structures            | 1+2         | 4        |
| 6       | KAN 111    | Kannada -I* /112                                  | 0+1         | 5        |
| 7       | KAN 121    | Kannada -II* /122                                 | 0+1         | 6        |
| 8       | NSS 111    | National Service Scheme*                          | 0+1         | 7        |
| 9       | PED 111    | Physical Education and Yoga Practices*            | 0+1         | 7        |
|         |            | <b>Total</b>                                      | <b>7+8</b>  |          |

\* Non-gradual course

**NSS** to be spread over in first four semesters;

**PED** to be spread over in first two semesters

## II. AGRICULTURE AND ALLIED SCIENCES

| Sl. No.      | Course No. | Course Title  | Credit Hrs. | Page No. |
|--------------|------------|---|-------------|----------|
| 1            | AGR 123    | Agronomy of Field Crops                                 | 1+1         | 10       |
| 2            | HRT 111    | Production Technology of Fruits and Vegetables          | 1+1         | 10       |
| 3            | CPH 212    | Post Harvest Physiology                                 | 1+0         | 11       |
| 4            | AET 222    | Post Harvest Pest Management                            | 1+0         | 11       |
| 5            | PAT 121    | Introductory Plant Pathology and Storage Diseases       | 1+0         | 12       |
| 6            | FES 221    | Environmental Studies & Disaster Management             | 2+0         | 13       |
| 7            | MEB 222    | Introduction to Food Biotechnology                      | 2+1         | 14       |
| 8            | AEX 321    | Entrepreneurship Development and Business Communication | 1+1         | 15       |
| <b>Total</b> |            |   | <b>10+4</b> |          |

## III. FOOD TECHNOLOGY CORE COURSES

### 1. SECTION OF BASIC ENGINEERING

| Sl. No.      | Course No. | Course Title                   | Credit Hrs. | Page No. |
|--------------|------------|--------------------------------|-------------|----------|
| 1.           | BEN 111    | Engineering Drawing & Graphics | 1+1         | 17       |
| 2.           | BEN 112    | Electrical Engineering         | 1+1         | 18       |
| 3.           | BEN 113    | Workshop Technology            | 1+1         | 19       |
| 4.           | BEN 121    | Electronics & Instrumentation  | 2+1         | 20       |
| 5.           | BEN 122    | Fluid Mechanics                | 2+1         | 21       |
| <b>Total</b> |            |                                | <b>7+5</b>  |          |

## 2. SECTION OF FOOD SCIENCE AND NUTRITION

| Sl. No.      | Course No. | Course Title                        | Credit Hrs. | Page No. |
|--------------|------------|-------------------------------------|-------------|----------|
| 1            | FSN 121    | Introduction to Food Science        | 1+1         | 23       |
| 2            | FSN 122    | Food Biochemistry & Nutrition       | 2+1         | 24       |
| 3            | FSN 211    | Principles of Food Preservation     | 1+1         | 25       |
| 4            | FSN 311    | Food Additives & Preservatives      | 1+1         | 26       |
| 5            | FSN 312    | Speciality & Functional Foods       | 1+1         | 27       |
| 6            | FSN 321    | Sensory Evaluation of Food Products | 2+1         | 28       |
| <b>Total</b> |            |                                     | <b>8+6</b>  |          |

## 3. SECTION OF FOOD PROCESSING TECHNOLOGY

| Sl. No.      | Course No. | Course Title                                 | Credit Hrs.  | Page No. |
|--------------|------------|--|--------------|----------|
| 1            | FPT 121    | Processing Technology of Liquid Milk         | 1+1          | 29       |
| 2            | FPT 211    | Processing Technology of Dairy Products      | 1+1          | 29       |
| 3            | FPT 212    | Processing Technology of Cereals             | 2+1          | 30       |
| 4            | FPT 221    | Processing Technology of Beverages           | 1+1          | 31       |
| 5            | FPT 222    | Processing Technology of Legumes & Oilseeds  | 2+1          | 32       |
| 6            | FPT 311    | Processing Technology of Fruits & Vegetables | 2+1          | 33       |
| 7            | FPT 312    | Processing of Meat & Poultry Products        | 1+1          | 34       |
| 8            | FPT 313    | Food Packaging Technology & Equipment        | 2+1          | 34       |
| 9            | FPT 314    | Processing of Spices & Plantation Crops      | 2+1          | 35       |
| 10           | FPT 321    | Bakery, Confectionery & Snack Products       | 2+1          | 36       |
| 11           | FPT 322    | Processing of Fish & Marine Products         | 1+1          | 37       |
| <b>Total</b> |            |  | <b>17+11</b> |          |

#### 4. SECTION OF FOOD SAFETY & QUALITY

| Sl. No.      | Course No. | Course Title                                   | Credit Hrs. | Page No. |
|--------------|------------|--|-------------|----------|
| 1            | FSQ 111    | General Microbiology                           | 2+1         | 38       |
| 2            | FSQ 211    | Food Microbiology                              | 2+1         | 39       |
| 3            | FSQ 212    | Food Chemistry of Macronutrients               | 2+1         | 40       |
| 4            | FSQ 221    | Food Chemistry of Micronutrients               | 1+1         | 41       |
| 5            | FSQ 222    | Industrial Microbiology                        | 2+1         | 42       |
| 6            | FSQ 311    | Instrumental Techniques in Food Analysis       | 2+1         | 42       |
| 7            | FSQ 321    | Food Plant Sanitation                          | 1+1         | 44       |
| 8            | FSQ 322    | Food Quality, Safety Standards & Certification | 2+0         | 45       |
| <b>Total</b> |            |  | <b>14+7</b> |          |

#### 5. SECTION OF FOOD PROCESS ENGINEERING

| Sl. No.      | Course No. | Course Title                                       | Credit Hrs.  | Page No. |
|--------------|------------|--|--------------|----------|
| 1            | FPE 111    | Food Thermodynamics                                | 2+1          | 47       |
| 2            | FPE 121    | Post Harvest Engineering                           | 2+1          | 48       |
| 3            | FPE 211    | Food Refrigeration & Cold Chain                    | 2+1          | 49       |
| 4            | FPE 212    | Heat & Mass Transfer in Food Processing            | 2+1          | 51       |
| 5            | FPE 213    | Unit Operations of Food Processing-I               | 2+1          | 52       |
| 6            | FPE 221    | Unit Operations of Food Processing-II              | 2+1          | 54       |
| 7            | FPE 222    | Food Storage Engineering                           | 2+1          | 55       |
| 8            | FPE 321    | ICT Applications in Food Industry                  | 1+1          | 56       |
| 9            | FPE 322    | Food Process Equipment Design                      | 2+1          | 58       |
| 10           | FPE 323    | Instrumentation & Process Control in Food Industry | 2+0          | 59       |
| <b>Total</b> |            |  | <b>19+10</b> |          |

#### 6. SECTION OF FOOD BUSINESS MANAGEMENT

| Sl. No.      | Course No. | Course Title  | Credit Hrs. | Page No. |
|--------------|------------|---|-------------|----------|
| 1            | FBM 121    | Introduction to Economics & Business Management         | 2+0         | 61       |
| 2            | FBM 311    | Marketing Management & International Trade              | 2+0         | 61       |
| 3            | FBM 321    | Project Preparation & Management                        | 1+1         | 62       |
| 4            | FBM 411    | Personality Development & Soft Skills for Food Industry | 1+1         | 64       |
| <b>Total</b> |            |   | <b>6+2</b>  |          |

#### IV. FOOD PLANT OPERATIONS/(STUDENT READY) COURSES

| Sl. No.      | Course No. | Course Title                                       | Credit Hrs. | Page No. |
|--------------|------------|--|-------------|----------|
| 1            | FPO 311    | Student READY-Industrial Tour*                     | 0+1         | 65       |
| 2            | FPO 411    | Student READY-Experiential Learning Programme - I  | 0+7         | 65       |
| 3            | FPO 412    | Student READY-Experiential Learning Programme - II | 0+7         | 65       |
| 4            | FPO 413    | Student READY-Research Project                     | 0+4         | 66       |
| 5            | FPO 414    | Student READY-Seminar                              | 0+1         | 66       |
| 6            | FPO 421    | Student READY-Internship/In-Plant Training         | 0+20        | 66       |
| <b>Total</b> |            |  | <b>0+40</b> |          |

#### V. REMEDIAL COURSES

| Sl. No.      | Course No. | Course Title             | Credit Hrs.         | Page No. |
|--------------|------------|--------------------------|---------------------|----------|
| 1            | BIO 111    | Introductory Biology     | 1+1                 | 67       |
| 2            | MAT 111    | Introductory Mathematics | 2+0                 | 67       |
| <b>Total</b> |            |                          | <b>1+1/<br/>2+0</b> |          |

**SEMESTERWISE DISTRIBUTION OF COURSES**

**I YEAR I-SEMESTER**

| Course No.      | Course Title                                    | Credit Hrs. | Page No. |
|-----------------|---|-------------|----------|
| BEN 111         | Engineering Drawing and Graphics                | 1+1         | 17       |
| BEN 112         | Electrical Engineering                          | 1+1         | 18       |
| BEN 113         | Workshop Technology                             | 1+1         | 19       |
| ENG 111         | Comprehensive & Communication Skills in English | 1+1         | 1        |
| FPE 111         | Food Thermodynamics                             | 2+1         | 47       |
| FSQ 111         | General Microbiology                            | 2+1         | 38       |
| HRT 111         | Production Technology of Fruits and Vegetables  | 1+1         | 10       |
| MAT 113         | Engineering Mathematics for Food Technology-I   | 2+0         | 1        |
| KAN 111/<br>112 | Kannada-I*                                      | 0+1         | 5        |
| NSS 111         | National Service Scheme*                        | 0+1         | 7        |
| PED 111         | Physical Education and Yoga Practices*          | 0+1         | 7        |
| BIO 111         | Introductory Biology <sup>#</sup>               | 1+1         | 67       |
| MAT 111         | Introductory Mathematics <sup>#</sup>           | 2+0         | 67       |
|                 | <b>Total</b>                                    | <b>11+7</b> |          |

\* Non-gradual course; # Remedial course

**I YEAR II-SEMESTER**

| Course No.     | Course Title                                      | Credit Hrs. | Page No. |
|----------------|---|-------------|----------|
| AGR 123        | Agronomy of Field Crops                           | 1+1         | 10       |
| BEN 121        | Electronics and Instrumentation                   | 2+1         | 20       |
| BEN 122        | Fluid Mechanics                                   | 2+1         | 21       |
| FBM 121        | Introduction to Economics and Business Management | 2+0         | 61       |
| FPE 121        | Post Harvest Engineering                          | 2+1         | 48       |
| FPT 121        | Processing Technology of Liquid Milk              | 1+1         | 29       |
| FSN 121        | Introduction to Food Science                      | 1+1         | 23       |
| FSN 122        | Food Biochemistry and Nutrition                   | 2+1         | 24       |
| MAT 122        | Engineering Mathematics for Food Technology-II    | 2+0         | 2        |
| PAT 121        | Introductory Plant Pathology and Storage Diseases | 1+0         | 12       |
| KAN121/<br>122 | Kannada-II*                                       | 0+1         | 6        |
| NSS            | National Service Scheme*                          | 0+1         | 7        |
| PED            | Physical Education & Yoga Practices*              | 0+1         | 7        |
|                | <b>Total</b>                                      | <b>16+7</b> |          |

\* Non-gradual course

## II YEAR I-SEMESTER

| Course No. | Course Title                              | Credit Hrs. | Page No. |
|------------|---|-------------|----------|
| CPH 212    | Post Harvest Physiology                   | 1+0         | 11       |
| FPE 211    | Food Refrigeration and Cold Chain         | 2+1         | 49       |
| FPE 212    | Heat and Mass Transfer in Food Processing | 2+1         | 51       |
| FPE 213    | Unit Operations in Food Processing – I    | 2+1         | 52       |
| FPT 211    | Processing Technology of Dairy Products   | 1+1         | 29       |
| FPT 212    | Processing Technology of Cereals          | 2+1         | 30       |
| FSN 211    | Principles of Food Preservation           | 1+1         | 25       |
| FSQ 211    | Food Microbiology                         | 2+1         | 39       |
| FSQ 212    | Food Chemistry of Macronutrients          | 2+1         | 40       |
| NSS        | National Service Scheme*                  | 0+1         | 7        |
|            | <b>Total</b>                              | <b>15+8</b> |          |

## II YEAR II-SEMESTER

| Course No. | Course Title                                  | Credit Hrs. | Page No. |
|------------|---|-------------|----------|
| AET 222    | Post Harvest Pest Management                  | 1+0         | 11       |
| AST 223    | Statistical Methods and Numerical Analysis    | 1+1         | 3        |
| FES 221    | Environmental Studies & Disaster Management   | 2+0         | 13       |
| FPE 221    | Unit Operations in Food Processing-II         | 2+1         | 54       |
| FPE 222    | Food Storage Engineering                      | 2+1         | 55       |
| FPT 221    | Processing Technology of Beverages            | 1+1         | 31       |
| FPT 222    | Processing Technology of Legumes and Oilseeds | 2+1         | 32       |
| FSQ 221    | Food Chemistry of Micronutrients              | 1+1         | 41       |
| FSQ 222    | Industrial Microbiology                       | 2+1         | 42       |
| MEB 222    | Introduction to Food Biotechnology            | 2+1         | 14       |
| NSS        | National Service Scheme*                      | 0+1         | 7        |
|            | <b>Total</b>                                  | <b>16+8</b> |          |

\* Non-gradual course

## III YEAR I-SEMESTER

| Course No. | Course Title                                   | Credit Hrs. | Page No. |
|------------|--|-------------|----------|
| CSC 311    | Computer Programming and Data structures       | 1+2         | 4        |
| FBM 311    | Marketing Management and International Trade   | 2+0         | 61       |
| FPT 311    | Processing Technology of Fruits and vegetables | 2+1         | 33       |
| FPT 312    | Processing of Meat and Poultry Products        | 1+1         | 34       |
| FPT 313    | Food Packaging Technology and Equipment        | 2+1         | 34       |
| FPT 314    | Processing of Spices and Plantation Crops      | 2+1         | 35       |
| FSN 311    | Food Additives and Preservatives               | 1+1         | 26       |
| FSN 312    | Specialty and Functional Foods                 | 1+1         | 27       |
| FSQ 311    | Instrumental Techniques in Food Analysis       | 2+1         | 42       |
| FPO 311    | Student READY – Industrial Tour*               | 0+1         | 65       |
|            | <b>Total</b>                                   | <b>14+9</b> |          |

## III YEAR II-SEMESTER

| Course No. | Course Title  | Credit Hrs. | Page No. |
|------------|---|-------------|----------|
| AEX 321    | Entrepreneurship Development and Business Communication | 1+1         | 15       |
| FBM 321    | Project Preparation and Management                      | 1+1         | 62       |
| FPE 321    | ICT Applications in Food Industry                       | 1+1         | 56       |
| FPE 322    | Food Process Equipment Design                           | 2+1         | 58       |
| FPE 323    | Instrumentation and Process Control in Food Industry    | 2+1         | 59       |
| FPT 321    | Bakery, Confectionery and Snack Products                | 2+1         | 36       |
| FPT 322    | Processing of Fish and Marine Products                  | 1+1         | 37       |
| FSN 321    | Sensory Evaluation of Food Products                     | 2+1         | 28       |
| FSQ 321    | Food Plant Sanitation                                   | 1+1         | 44       |
| FSQ 322    | Food Quality, Safety Standards and Certification        | 2+0         | 35       |
|            | <b>Total</b>  | <b>15+9</b> |          |

\* Non-gradual course

**IV YEAR I-SEMESTER**

| Course No. | Course Title  | Credit Hrs. | Page No. |
|------------|---|-------------|----------|
| FBM 411    | Personality Development and Soft Skills for Food Industry | 1+1         | 64       |
| FPO 411    | Student READY –Experiential Learning Programme-I          | 0+7         | 65       |
| FPO 412    | Student READY –Experiential Learning Programme-II         | 0+7         | 65       |
| FPO 413    | Student READY – Research Project                          | 0+4         | 66       |
| FPO 414    | Student READY – Seminar                                   | 0+1         | 66       |
|            | <b>Total</b>  | <b>1+20</b> |          |

**IV YEAR II-SEMESTER**

| Course No. | Course Title                                  | Credit Hrs. | Page No. |
|------------|---|-------------|----------|
| FPO 421    | Student READY- Internship / In-Plant Training | 0+20        | 66       |
|            | <b>Total</b>                                  | <b>0+20</b> |          |

**SEMESTERWISE DISTRIBUTION OF CREDIT HOURS**

| Semester                     | Total Credit Hours           |
|------------------------------|------------------------------|
| I Year I Semester            | 11+7=18                      |
| I Year II Semester           | 16+7= 23                     |
| II Year I Semester           | 15+8= 23                     |
| II Year II Semester          | 16+8= 24                     |
| III Year I Semester          | 14+9= 23                     |
| III Year II Semester         | 15+9= 24                     |
| IV Year I Semester           | 1+20= 21                     |
| IV Year II Semester          | 0+20= 20                     |
| <b>Total Gradial Courses</b> | <b>88+88=176</b>             |
| Total Non-gradial Courses    | 0+5=5                        |
| <b>Total Credit Hours</b>    | <b>88+93=181</b>             |
| Remedial courses             | 1+1/2+0=2                    |
| <b>Grand Total</b>           | <b>89+94=183 / 90+93=183</b> |



**AST223 Statistical Methods and Numerical Analysis 1+1**

**Theory:** Concepts of data, collection and classification, functions and limitations of statistics, interpretation of numerical data; Z-test, t-test, F-test, Chi-square test; Measures of central tendency: mean, median, mode, geometric mean, (harmonic mean) and properties; Measures of dispersion: range, quartile deviation, mean deviation, standard deviation and properties, coefficient of variance; Skewness and Kurtosis: moments, measures of skewness and kurtosis, construction of discrete and continuous frequency distribution; Correlation: Karlpearsons correlation coefficient and its properties; Spearman's rank correlation, Regression: definition and properties of regression, calculation of regression coefficient, regression equations and multiple linear regression; Analysis of Variance: Probability Distribution: meaning of variance (ANOVA), nature of variance, one way and two way analysis; Numerical analysis: Finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, numerical integration, numerical integration by Trapezoidal, Simpson's and Weddle's rules; Numerical solution of ordinary differential equations by Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method; Laplace transforms: Definition of Laplace transform, Laplace transforms of elementary functions, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals; Experimental designs: Basic designs, completely randomized design (CRD) - Layout and analysis with equal and unequal number of observations, randomized block design (RBD) - Layout and analysis, Latin square design (LSD) - Layout and analysis; Response surface methodology.

**Practicals:** Problems: Construction of frequency distribution table discrete and continuous, construction of frequency graphs & diagrams, simple bar diagram, component multiple bar diagram,

measures of central tendency arithmetic mean, median, mode, Geometric mean and Harmonic mean and their properties, calculation of arithmetic mean, median, mode for ungrouped and grouped data, F-test; Calculation of correlation coefficient and its testing; Fitting of simple linear regressions; Fitting of multiple regression equations; probability distribution, ANOVA: One way/two way; Problems on Newton forward interpolation formula for equal intervals, Newton backward interpolation formula for equal intervals, Problems on Trapezoidal rule, Simpson's 1/3 & 3/8 rule, Problems on Solution of O.D.E of first order & second order by Runge-kutta method, Problems on Euler's method, Problems on Laplace transform, Inverse transform, Problems on solution of first order differential equations, Problems on Response surface methodology.

**CSC 311 Computer Programming and Data Structures 1+2**

**Theory:** Introduction and historical background: Review of computer technology; Processor, memory, secondary storage, display devices and other peripheral devices; Basic computer organization, future trends; Brief review of present day applications, programming; Introduction to systems software, applications software and programming language; Algorithms and flow charts: Input processing output model of a computer program; Role of the compiler and the integrated development environment; Introduction to C: Structure of a C program, simple data types, declarations, operators and expressions; The assignment statement; Library functions; Control Structures: Conditional and iterative execution of statements; Importance of documentation; Nesting of control structures and the use of indentation to indicate nesting levels; Labels and the "go to" statement; Arrays; Single and multi dimensional arrays: Character strings and string functions; Functions: Scope rules; Argument passing by reference and by value; Storage classes; Use of function prototypes; Structures, unions and user defined types; Operations on files: Concept of standard input and output files; Formatting of data on input and

output; Use of include files; Introduction to high level languages; Primary data types and user defined data types, variables, typecasting, operators, building and evaluating expressions, standard library functions, managing input and output, decision making, branching, looping, arrays, user defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, string functions, structures and union, pointers, stacks, push/pop operations, queues, insertion and deletion operations, linked lists.

**Practicals:** Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global and external variables; Using pointers; Implementing stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/deletion in data structures.

## ಕನ್ನಡ ಪಠ್ಯಕ್ರಮ

### I. ಕನ್ನಡ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ/ For Kannada Students

**KAN 111** **Kannada-I** **0+1**

ಅ. ಕಾವ್ಯ-ಕಥೆ: ಜನಪದ ಗೀತೆಗಳು-ಜನಪದರು; ಶರಣರ ವಚನಗಳು-ಜೇಡರದಾಸಿಮಯ್ಯ, ಬಸವಣ್ಣ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ; ಹೊಸ ಬಾಳಿನ ಗೀತೆ- ಕುವೆಂಪು; ತಿಳಿದವರೇ ಹೇಳಿ-ವೈದೇಹಿ; ಜೀತ-ಡಾ|| ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ; ಒಂದು ಖಾಸಗಿ ಪತ್ರ-ವಿನಯಾ ಒಕ್ಕಂದ.

ಆ. ಕೃಷಿ ಬರಹ: ಆಧುನಿಕ ಪೂರ್ವ ಕನ್ನಡ ಕೃಷಿ ಸಾಹಿತ್ಯ ಪರಿಚಯ - ಡಾ|| ಜಿ. ವೀರಭದ್ರಗೌಡ, ಕನ್ನಡದಲ್ಲಿ ಕೃಷಿವಿಜ್ಞಾನ ಸಾಹಿತ್ಯದ ಉಗಮ ಮತ್ತು

ವಿಕಾಸ- ಡಾ|| ಜಿ. ಬಾಲಕೃಷ್ಣ, ಎಲ್ ಫಾರ್ ಲೈನ್ ಅಲ್ಲ: ಲಕ್ಷ್ಮಣಯ್ಯ-ಡಾ|| ಟಿ.ಎಸ್. ಚನ್ನೇಶ್, ಅಹಾರವೆಂಬ ಆಯುಧ-ನಾಗೇಶ ಹೆಗಡೆ.

ಇ. ಪ್ರಾಯೋಗಿಕ: ಅನುವಾದ, ಪಾರಿಭಾಷಿಕ ಪದರಚನೆಯ ವಿಧಾನಗಳು.

**KAN 121** **Kannada-II** **0+1**

ಅ. ಕಾವ್ಯ-ಕಥೆ-ಜನಪದ-ಸಂಸ್ಕೃತಿ ಮತ್ತು ಕನ್ನಡ ಪ್ರಜ್ಞೆ-ಸಂಕೀರ್ಣ ಬೇವಿನಹಟ್ಟಿ ಕಾಳಮ್ಮನ ಸಾಲು-ಜನಪದ, ಗೋವಿನ ಹಾಡು- ಜನಪದ, ಕರ್ನಾಟಕ ಜಾನಪದ ಲೋಕದೃಷ್ಟಿ-ಪುರುಷೋತ್ತಮ ಬಿಳಿಮಲೆ, ಕೆರೆಗೆ ಹಾರ-ಜನಪದ, ನೇರಂಬ ಜೀವ ದ್ರವ-ಜಿ. ಬಾಲಕೃಷ್ಣ, ಸೂಫಿ ಕತೆಗಳು, ಕನ್ನಡದ ಶುದ್ಧತೆ-ಕೆ.ವಿ. ನಾರಾಯಣ, ವಚನಕಾರರು ಮತ್ತು ಭಾಷೆ, ಕದಂಬರ ಕನ್ನಡ ಲಿಪಿ-ಷ. ಶೆಟ್ಟರ್, ಅವನತಿ-ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ, ಇಲ್ಲಿ ಯಾರೂ ಮುಖ್ಯರಲ್ಲ, ಯಾರೂ ಅಮುಖ್ಯರಲ್ಲ-ಕೃಪಾಕರ ಸೇನಾನ, ಕೃಷಿ ಗಾದೆಗಳು-ಜನಪದ, ಕೃಷಿ ಗಾದೆಗಳ ಅವಲೋಕನ-ಜಿ. ವೀರಭದ್ರಗೌಡ.

ಆ. ಪ್ರಾಯೋಗಿಕ: ಕನ್ನಡದಲ್ಲಿ ಕೃಷಿ ಸಾಹಿತ್ಯ ಪ್ರಕಾರಗಳು ಮತ್ತು ಅವುಗಳ ರಚನಾ ಸ್ವರೂಪ; ವ್ಯವಹಾರ ಕನ್ನಡ-ಪತ್ರಲೇಖ.

### II. ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ/ For Non Kannada Speaking Students

**KAN 112** **Kannada-I** **0+1**

Development of listening and speaking skills with Kannada structure pattern - Introducing each other - Conversation between friends - Enquiring about family - Plan to go for a movie - Routine activities of a student - In a book shop - Introducing College/University - Conversation between a farmer and a Scientist - Data collection in a village - Conversation on going on a tour. Development of writing and reading skills with Kannada structure pattern - Kannada Script practice and reading.

**KAN 122** **Kannada-II** **0+1**

Development of listening and speaking skills with Kannada structure pattern - Conversation between a Doctor and a Patient; About Children's Education; Halebid-Belur; Discussing about Examination and Future Plan. Development of writing and reading skills with

Kannada structure pattern : Translation of simple sentences English into Kannada, Selected lesson for reading (Nada Geete, Kannada Habbagalu, Prekshaniya Sthalagalu, Kannada Kavi, Kannada Vignani).

**PED 111 Physical Education and Yoga 0+1  
Practices-I**

**PART I**

Physical Education–Definition, Meaning, Scope and importance; Types of tournaments; Construction and laying out of the track and field. Teaching skills and rules, demonstration and practice of Football, Basketball, Kabaddi, Ball Badminton and Table Tennis. Teaching of some of the Asanas.

**PART-II**

Teaching skills and rules demonstration and practice of Hockey, Kho-Kho, Track events and field events. Teaching of weight training, circuit training and calisthenics. Teaching of some of the Asanas.

**Note:** 1) Compulsory Uniform: Half pants, Tee Shirts, Shoes and socks all white (Girls will have white Tee Shirt and Track pants)

2) The games mentioned in the practical may be inter changed depending on the season and facilities.

**NSS 111 National Service Scheme (NSS)-I 0+1**

**PART I:** Introduction and basic components of NSS: Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health. NSS programmes and activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme / schemes of GOI, coordination with different agencies and maintenance of diary; Understanding youth:Definition, profile, profile, categories, issues and challenges of youth; and

opportunities for youth who is agent of the social change; Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership; Social harmony and national integration: Indian history and culture, role of youth in nation building, conflict resolution and peace-building; Volunteerism and shramdan: Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism; Citizenship, constitution, human rights, human values and ethics: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information, human values and ethics; Family and society:Concept of family, community (PRIs and other community based organisations) and society.

**PART II:** Importance and role of youth leadership: Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership; Life competencies: Definition and importance of life competencies, problem-solving and decision-making, inter personal communication; Youth development programmes: Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organstions; Health, hygiene and sanitation: Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health; Youth health, lifestyle, HIV AIDS and first aid:Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid; Youth and yoga:History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

**PART III:** Vocational skill development: To enhance the employment potential and to set up small business enterprises skills

of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list. Issues related environment: Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management. Disaster management: Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management. Entrepreneurship development: Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution. Formulation of production oriented project: Planning, implementation, management and impact assessment of project. Documentation and data reporting: Collection and analysis of data, documentation and dissemination of project reports.

**PART IV:** Youth and crime: Sociological and psychological factors influencing youth crime, cyber crime, peer mentoring in preventing crime and awareness for juvenile justice. Civil/self defence: Civil defence services, aims and objectives of civil defence; needs and training of self defence. Resource mobilization: Writing a project proposal of self fund units (SFUs) and its establishment. Additional life skills: Positive thinking, self-confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

## II AGRICULTURE AND ALLIED SCIENCES

### AGR 123      **Agronomy of Field Crops**      **1+1**

**Theory:** Classification of crops; Principles of tillage; crop rotation, cropping systems, relay cropping and mixed cropping; Crop production technology for major cereal crops viz., paddy, wheat, maize, pearl millet, sorghum, finger millet. Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, yield potential, Crop production technology for major oilseed crops viz., groundnut, sesame, rapeseed, mustard; Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, yield potential, Crop production technology for major pulses and commercial crops viz., pigeon pea, cowpea, gram, green gram, black gram, sugarcane and cotton.

**Practicals:** Identification of seed of different crops and their varieties; Establishments of cereals pulses oilseeds crops in crop museum, Preparation of nursery for paddy. Study of morphological characteristics of different crops. Study of different crops and their nutritional values. Use of bio fertilizer in pulses and oilseeds. Quality parameters in sugarcane and cotton; Fertilizer application methods.

### HRT 111      **Production Technology of**      **1+1** **Fruits and Vegetables**

**Theory:** Origin, distribution, uses, area and production, soil and climatic requirements, commercial varieties/ hybrids, planting methods, nutrition, irrigation, weed management, inter and mixed cropping, harvesting and yield of Mango, Banana, Citrus, Grapes, Guava, Papaya, Sapota, Pineapple, Pomegranate, Jackfruit, Potato, Tomato, Chilli, Onion, Carrot, Palak and Amaranthus.

**Practicals:** Identification of fruits and vegetables; Lay out and planting of orchard; Propagation techniques, pruning, training and physiological disorders in above fruits and vegetables.

**CPH 212 Post Harvest Physiology 1+0**

Plant physiology, Post harvest physiology, scope and importance in food production. Plant growth and development: measurement of growth and yield parameters. Transpiration: Transpiration in harvested produce and reduce transpiration and increase shelf life of harvested produce. Respiration: Post harvested produce. Concept of physiological maturity: Different methods to determine maturity. Maturity indices for different cereals, pulses, oil seeds, fruits and vegetables. Ripening: Process of ripening, changes during ripening of fruits and difference between climacteric and non-climacteric fruits. Regulation of fruit ripening Ethylene: biosynthesis, post harvest uses, treatment of ethylene and sources of ethylene, undesirable effects and ethylene inhibitors. Senescence: Physiological changes during senescence control of senescence and significance. Abscission: process of abscission, Factors affecting senescence and abscission of plant parts. Use of growth regulators to promote senescence or increase shelf life of fruits. Role of plant growth regulators in post harvest physiology: commercial application of plant hormones to reduce the senescence and increase the shelf life of harvested produce. Pre-harvest factors affecting post harvest life of crop produce. Harvesting and post harvest biology of fresh produce. Post harvest handling of fruits and vegetables: Physiological and biochemical changes after harvest of vegetables, nature and causes of losses and control. Physiological disorders in fruits and vegetables: Types, symptoms, control measures, factors affecting physiological disorders and importance of nutrients to reduce physiological disorders in fruits and vegetables.

**AET 222 Post Harvest Pest Management 1+0**

Classification of insects based on economic importance, Storage losses (Seed and food) due to insects, mites, rodents and birds. Ecosystem approach to study the association of insects with fungi, mites, birds and rodents. Sources of infestation. Nature of damage

and biology of major stored grains pest. Significance of temperature and moisture migration in the development of moulds and insects population. Biochemical changes in stored commodities due to pest infestation. Chemical, non chemical and integrated approaches to management and safe use of pesticides in stored commodities. Visit to central warehouse, FCI godowns and CFTRI, Mysore.

**PAT 121 Introductory Plant Pathology and Storage Diseases 1+0**

Historical developments and economic significance of storage diseases/pathogens – Introduction, scope and objectives of plant pathology, definition of plant pathology. Importance of plant pathology, significance of major plant diseases. History and development of plant pathology, concept and definitions of plant diseases. Definition and concepts of plant diseases: Classification of plant diseases based on type of pathogen, mode of spread, mode of inoculum, plant parts affected, number of generation of infection. Symptoms of plant diseases: General symptoms of plant diseases viz., fungi, bacteria, viruses and nematodes. General characters of plant pathogens: viz., fungi, bacteria, viruses and nematodes. General characters of plant pathogenic fungi: Major characteristics, habitats of fungi, definition of fungi, vegetative structure of fungi, specialized structures of fungi. Reproduction in fungi: sexual and asexual methods of reproduction and their fruiting bodies. Sexual and asexual spores of fungi. General characters of plant pathogenic bacteria: structure and morphology of bacteria. General characters of plant pathogenic Viruses: introduction, biological status of viruses, definition of viruses, significance, general composition, shapes and sizes of viruses. General characters of plant pathogenic Nematodes: definition, significance, anatomy, sensory organs of nematodes. Study of important market and storage diseases of cereals, pulses, commercial, oilseeds, vegetables, fruits and their management: Mycotoxins: Mycotoxins produced by pathogens and their effect on human and animal health



technology: Restriction enzymes, cloning vectors, cloning procedure, cloning of specific gene and their identification (colony hybridization, C-DNA, southern blotting, polymerase chain reaction); Biosensors: Classification, application in food industry; Application of biotechnology in quality improvement of functional foods from plant sources–Vitamin, carotene, anthocyanin, proteins, Starch and oil content, Enzymes for food processing such as beta-galactosidase, chymosin, glucose isomerase and  $\alpha$ -amylase. Application of biotechnology in food: Immobilization of enzymes: Arresting of cell in insoluble matrix, immobilized cell systems, cell attachment in a surface, aggregation, entrapment, containment, physical adsorption, covalent bonding, cross linking, entrapment into polymeric films, microencapsulation, large scale cell immobilization, uses and applications in industries; Ethical issues concerning GM foods: Testing for GMOs, current guidelines for production, release and movement of GMOs, labeling and traceability, trade related aspects, bio-safety, risk assessment, risk management, public perception of GM foods, IPR, GMO Act 2004;

**Practicals:** Study of auxotroph; Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*; Transformation, plasmid DNA isolation, Restriction digestion and Agarose Gel Electrophoresis; Isolation of genomic DNA from plants; Polymerase Chain Reaction for detection of GMO/Food pathogen; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA.

### **AEX 321 Entrepreneurship Development and Business Communication 1+1**

**Theory:** Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur, creativity; role of entrepreneurship, ethics and social responsibilities; Entrepreneurship development: Overview of Indian social, political and economic

systems and their implications for decision making by individual entrepreneurs; Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, generation, incubation and commercialization of ideas and innovations; Women entrepreneurship: Role and importance, problems; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation; Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs)/SSIs; Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships; Overview of food industry inputs; Characteristics of Indian food processing industries and export; Social responsibility of business.

**Practicals:** Visit to public enterprises, private enterprises and agro-processing/food business centres; SWOT analysis of public enterprises and private enterprises; Project proposals as entrepreneur – individual and group; Presentation of project proposals in the class.

### III FOOD TECHNOLOGY CORE COURSES

#### 1. SECTION OF BASIC ENGINEERING

##### **BEN 111      Engineering Drawing and Graphics      1+1**

**Theory:** First and third angle methods of projection; Preparation of working drawing from models and isometric views; Drawing of missing views; Different methods of dimensioning; Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints; Processes for producing leak proof joints. Symbols for different types of welded joints; Nomenclature, thread profiles, multi-start threads, left and right hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

**Practicals:** Introduction of drawing scales; Principles of orthographic projections; Reference planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and

drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

##### **BEN 112      Electrical Engineering      1+1**

**Theory:** AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, reluctance etc, laws of magnetic circuits, Phase relations and vector representation, AC through resistance, inductance and capacitance, A.C. series and parallel circuits, Simple R-L, R-C and R-L-C circuits, 3 Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement. Transformer : Principle of working, construction of single phase transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors. Poly-phase induction motor: Construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics, D.C. Motors, their starting, speed controls and characteristics. Electric Power Economics, Maximum demand charge, Load factor, power factor and power factor improvement, Measuring Equipment's: Classification, Characteristics of different electrical measuring systems and equipment's, Electrical Wiring, system of wiring, domestic wiring installation, industrial electrification, protection devices, Earthing, use of Multimeter, Circuit protection devices, fuses, MCB, ELCB & relays.

**Practicals:** Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, Starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Problems on Industrial Electrification. Study of various circuit protection devices. Study of various measuring instruments.

**BEN 113                      Workshop Technology                      1+1**

**Theory:** Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Indian Factory Acts on safety; and Heat treatment processes. Types of Heat treatment process-hardening, tempering, annealing, normalizing and quenching. Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipments; Gas welding and gas cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost; Smithing and forging: Different forging operations, defects of forging; Brief ideas about power hacksaw, Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, Machinery: Introduction to various workshop

machines (1) Lathe, (2) Milling machine, (3) Shaper and planner, (4) Drilling and boring machine, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for casting, shaping, slotting and planning operations, work holding and tool holding devices; Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

**Practicals:** Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipments, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs

**BEN 121                      Electronics and Instrumentation                      2+1**

**Theory:** Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, filter circuits; Diode circuits for OR and AND (both positive and negative logic). Bipolar Junction Transistor (BJT): Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Coupling of amplifiers, h-parameter model of a transistor, analysis of small signal,

CE amplifier, phase shift oscillator, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiting, OP-AMP voltage regulators; Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map, binary adder, D/A converter and generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples.

**Practicals:** Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as a active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

**BEN 122                      Fluid Mechanics                      2+1**

**Theory:** Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Compressible and non-compressible fluids; Surface tension, capillarity; Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedis principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Laminar flow between two straight parallel boundaries; Flow past through the immersed solids, packed and fluidized beds; Flow through pipes: Loss of head, determination of pipe diameter;

Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Turbines and pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, working principle of Submersible pumps; Reciprocating pumps: Working of reciprocating pump, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps; Open channel hydraulics: Classification of open channel and definitions, most economical sections of regular cross-sections; Specific energy concept-critical depth, energy diagrams; Velocity and pressure profiles in open channels; Hydraulic jumps-types.

**Practicals:** Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes.

## 2. SECTION OF FOOD SCIENCE AND NUTRITION

### FSN 121 Introduction to Food Science 1+1

**Theory:** Functions of foods - energy giving, body building, protecting and regulating. Cooking methods - types, merits and demerits. Cereals and millets - structure, composition, processing techniques, effect of heat and acid and functions of starch in cookery. Legumes, nuts and oil seeds - composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - types, composition, pigments, changes caused by heat, acid and alkali. Egg - structure, composition, grading of egg, functions and changes during cooking. Meat, poultry and fish - kind, structure, composition, pigments, factors affecting tenderness, postmortem changes and changes during cooking. Sugars - types, composition, manufacturing process, effect of heat and acid, functions in cookery. Honey - classification, composition, physical and chemical properties, purity standards, food and nutritional value, handling, processing, testing and storage. Royal jelly - production, composition, food and nutritional value. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques and rancidity of fats. Brief overview of beverages. Condiments and spices - importance in daily life. Introduction to processed and convenience foods - precooked, ready to eat, frozen, dehydrated foods and instant food mixes.

**Practicals:** Kitchen equipment and their uses. Weighing and measuring food items. Cooking methods. Cereal cookery - preparations showing dextrinization and gelatinization, functions of starch in cereals, gluten formation and factors affecting it. Identification of the food grains. Legumes, nuts and oils seeds - ways of using and making complete protein. Vegetable cookery - effect of heat and alkali on pigments and use of vegetables with other foods. Preparation of soups, salads and beverages. Milk and milk products - effect of heat, acid and alkali, uses of milk and milk products in various preparations. Egg cookery - preparations showing functions of egg, various ways

of using egg. Meat cookery – preparations involving various methods of cooking. Sugars – preparations showing functions of sugar in cookery.

### FSN 122 Food Biochemistry and Nutrition 2+1

**Theory:** Biochemistry and its scope, cellular biochemistry; Carbohydrates: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism; Proteins: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism; Lipids: Occurrence, classification and structure, physicochemical and metabolic functions, metabolism; Nucleic acids: Properties, structure and metabolism; Vitamins and minerals: Chemistry and metabolic functions; Enzymes: Chemical nature and nomenclature, classification, sources and properties, mechanism of action, coenzyme and prosthetic groups; Concepts and content of nutrition: metabolic function of nutrients; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Functions of food; Basic food groups; nutrients supplied by food; Mechanism of enzyme action: Introduction to enzymes, coenzymes, regulation of enzymatic activity, enzyme kinetics, inhibition effects of pH, allosteric enzymes, derivation of Michaelis Menten equation; Nucleic acids; Nutrients: Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings; Metabolism of carbohydrates: Biological role of carbohydrates, glycolysis and respiration, production of ATP, brief description of electron transport chain, oxidative and substrate phosphorylation; Metabolism of lipids: Biological role of lipids, breakdown of triglycerides and phospholipids, oxidation of long chain fatty acids, ketosis, biosynthesis of fatty acids, triglycerides and phospholipids; Metabolism of proteins: Breakdown of proteins, transamination,

deamination, decarboxylation, nitrogen fixation, urea cycle; Changes during food processing treatment of drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods.

**Practicals:** Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates, amino acids, proteins and lipids; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pKa of acids; Determination of pI for casein.

### **FSN 211 Principles of Food Preservation 1+1**

**Theory:** Sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle and equipment for blanching, canning, pasteurization, sterilization; Preservation by use of low temperature: Principle, methods, equipment; Preservation by drying, dehydration and concentration: Principle, methods, equipment; Preservation by irradiation: Principle, methods, equipment; Preservation by chemicals-antioxidants, mould inhibitors, antibiotics, acidulants, etc.; Preservation by fermentation: Principles, methods, equipment; Non thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, sonication, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing; Quality tests and shelf-life of preserved foods.

**Practicals:** Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives;

Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze-drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

### **FSN 311 Food Additives and Preservatives 1+1**

**Theory:** Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food colors (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

**Practicals:** Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic); Identification of food colour by TLC (organic and inorganic); Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in frozen fish; Role of leaving agent in baked food product; Preservation of coconut shreds using humectants.

## **FSN 312 Speciality and Functional Foods 1+1**

**Theory:** Need and scope of specialty foods, convenience foods, functional foods, health foods and low cost foods. Specialty foods based on sources - cereals and millets, legumes and pulses, spices and herbs, animal food sources and their byproducts. Specialty foods based on - innovative process technology, bioactive components/ novel nutraceuticals, fast foods. Specialty foods based on genetically modified foods and transgenic foods. Proprietary foods. Supplementary foods. Specific consumer oriented foods - defense persons, space/astronauts, high altitude mountain climbers, sports person and industrial workers. Specialty foods based on growing condition - organic and inorganic farming. Study of various rules, regulations and acts governing specialty foods. Maternal nutrition-physiological changes and nutritional requirements during pregnancy and lactation. Importance of meal planning and use of food groups while planning meals.

**Practicals:** Market survey of available processed products in view of cost, health claim and quality assurance. Preparation of specialty foods based on low cost and nutrient supplementation, convenience and functionality. New product development for infant (weaning foods), geriatric, physiological status and athletes. Preparation of specialty food using locally available food crops, fruits, vegetables and their byproducts. Assessment of byproduct for preparation of value added specialty food. Isolation of phytochemical/ bioreactive agent of plant sources and their utilization in proprietary foods. Formulation of new products based on corporate decision like protein/energy rich, low calorie (fat replacer), low sodium content, glycemic index based, cholestromic index based and phyto-chemical based product. Preparation of specialty food for industrial workers as per nature of work and status of worker. Preparation of food cultivated under organic conditions.

## **FSN 321 Sensory Evaluation of Food Products 2+1**

**Theory:** Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects; factors affecting food acceptance. Terminology related to sensory evaluation. Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Discrimination Tests, Procedure: Types of tests – difference tests (Paired comparison, duo-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests. Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Consumer Research – Affective Tests: Objectives. Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations. Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests; Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control.

**Practicals:** Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo-trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

### 3. SECTION OF FOOD PROCESSING TECHNOLOGY

#### FPT 121 Processing Technology of Liquid Milk 1+1

**Theory:** Historical development of dairying in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage; Equipment for milk processing: bulk milk cooler, milk chilling unit, milk reception equipment, filtration unit, clarifier, milk tank/silo, pasteurizer, sterilizer, centrifuge, homogenizer, packaging and filling machines and CIP units; Hygienic design concepts, sanitary pipes and fittings, corrosion process and its control. Adulteration in milk and its detection; Types of milk: reconstituted/rehydrated milk, recombined milk, standardized milk, skim milk, sterilized milk and flavoured milk. Quality defects in milk, causes and prevention. Cream: definition, classification, processing and manufacture of different types; Fermented milk products: Processing, manufacture, storage and packaging of dahi / cultured buttermilk, acidophilus milk and yoghurt; Bio chemical changes occurring during manufacture of fermented milks, factors affecting these changes and effects of these changes on the quality of finished products.

**Practicals:** Platform tests for raw milk (clot on boiling test, alcohol test); Determination of proximate composition; Physical, biochemical and microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Separation of fat from milk; Standardization, homogenization, pasteurization and packaging of milk; Preparation of curd and yogurt; Visit to milk chilling centre and dairy plant.

#### FPT 211 Processing Technology of Dairy Products 1+1

**Theory:** Classification of dairy products; Butter: definition, composition, butter making equipment, processing and production steps, packaging and storage, overrun, quality testing of table butter,

quality defects, causes and prevention; Butter oil and Ghee: definition, composition, processing, equipment, quality tests; Paneer and Cheese: definition, composition, types, flow diagram, equipment, processing steps, packaging and storage, quality defects, causes and prevention; Ice cream and frozen desserts: definition, composition, types, flow diagram, equipment, processing steps, packaging and storage, quality testing, defects, causes and prevention; Condensed and Dried Milks: definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, standards for dried milk, manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, packaging and storage, quality testing, defects, causes and prevention; Traditional Indian Dairy Products – Khoa and khoa-based sweets, Chhana and chhana based sweets: definition, composition, equipment, processing, packaging, storage and quality testing; By-products of dairy industry and their utilization.

**Practicals:** Preparation of butter/ table butter, ghee, paneer, selected types of cheese, ice-cream and selected frozen desserts, condensed milk; milk powder and selected Indian dairy products; Determination of quality parameters of selected dairy products; Visit to dairy plant.

#### FPT 212 Processing Technology of Cereals 2+1

**Theory:** Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets; Chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling, milling operations, milling efficiency; Quality characteristics influencing final milled product; Rice bran stabilization and its methods; Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches; Barley: Malting and milling;

Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

**Practicals:** Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Conditioning and milling of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value added products from millets; Visit to Cereal processing unit.

#### **FPT 221 Processing Technology of Beverages 1+1**

**Theory:** History and importance of beverages; Status of beverage industry; Processing of beverages: packaged drinking water, fruit beverages, juice based beverages, dairy based beverages, tea, coffee, cocoa, spices and plant extracts, alcoholic beverages, speciality beverages, synthetic beverages, still drinks, carbonated, low-calorie and dry beverages, isotonic and sports drinks; FSSAI specifications for beverages; Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water; Sweeteners, colorants, acidulants, clouding, clarifying and flavouring agents for beverages; Carbonation; Quality tests and control in beverages; Miscellaneous beverages: Coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups.

**Practicals:** Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value,

gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages like coconut milk and flavoured syrups.

#### **FPT 222 Processing Technology of Legumes and Oilseeds 2+1**

**Theory:** Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti-nutritional compounds; Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

**Practicals:** Determination of physical properties of legumes and oil seeds; Preconditioning of pulses before milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected



manufacture and types of paper, advantages of corrugated and paper board boxes; Glass–manufacture, advantages, disadvantages; Metal (Aluminium / tin / SS) – manufacture, advantages, disadvantages; Plastic – classification of polymers, properties and uses of plastics; Classification of packages; Lamination; Coating on paper and films; Moulding – injection, blow, extrusion; Aseptic packaging: need, advantages, process, materials used, comparison with conventional packaging; Permeability: theoretical considerations, permeability of gases and vapours, permeability of multilayer materials, permeability in relation to packaging requirement of foods; Transport properties of barrier materials; Simulations of product: package environment interaction; Packaging of specific foods; Mechanical and functional tests on package.

**Practicals:** Classification of various packages based on material and rigidity; Measurement of thickness, basic weight, grammage, water absorption, bursting strength, tear resistance, puncture resistance, grease resistance and tensile strength of paper and paperboards; Determination of gas and water transmission rate of package films; Determination of lacquer integrity test; Drop test and box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; Packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machine, bottle filling machine and form-fill-seal machine.

#### **FPT 314 Processing of Spices and Plantation Crops 2+1**

**Theory:** Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition; processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon; Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint

marjoram. Rosemary, saffron, sage; Savory, thyme, ajwan; Asafoetida, curry leaves; Post harvest technology for Tea, coffee, cocoa; Vanilla and annatto processing; Post harvest technology and processing of areca nut, cashew nut, oil palm; Flavours of minor spices; Flavour of major spices; Spice oil and oleoresins: Extraction techniques; Standard specification of spices; Functional packaging of spices and spice products; By-products of plantation crops and spices.

**Practicals:** Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil, specific gravity, refractive index, acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.

#### **FPT 321 Bakery, Confectionery and Snack Products 2+1**

**Theory:** Bakery products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Product quality characteristics, defects, causes and corrective measures; Snack foods: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings; Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing.

**Practicals:** Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging

and quality evaluation of selected confectionery items; preparation, packaging and quality evaluation of selected chocolates; Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

#### **FPT 322 Processing of Fish and Marine Products 1+1**

**Theory:** Fisheries resources, global and Indian scenario; Types of fish and other marine products; Classification of fish (fresh water and marine), composition of fish, characteristics of fresh fish, spoilage of fish- microbiological, physiological, biochemical; Relationship between chilling and storage life, general aspects of fish freezing, changes in quality during chilled and frozen storage; Principles of canning, effect of heat processing on fish, storage of canned fish, pre-process operations, post-process operations, cannery operations for specific canned products; Fish products: surimi and Fish Mince products; Fish Protein Concentrates (FPC), Fish Protein Extracts (FPE), Fish Protein Hydrolysates (FPH); Novel methods; Low dose irradiation; High pressure treatment, MAP, vacuum packaging, gas packaging; oxygen absorbents and CO<sub>2</sub> generators, ethanol vapour generation, hurdle barrier concept, value added fish products, packaging; Sea food quality assurance, HACCP, EU hygienic regulations and ISO 9000 standards; New kinds of quality and safety problems emerging in sea food processing and preservation.

**Practicals:** Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products - Selection and grading; Quality evaluation of fish; Preparation of sun dried and salt cured fish, Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Preparation of value added sea products: Cutlets, bullets, wafers; Canning methods for marine fishery products; Estimation of TVB and TMA; Visit to fish and prawn processing industry.

#### **4. SECTION OF FOOD SAFETY AND QUALITY**

#### **FSQ 111 General Microbiology 2+1**

**Theory:** Evolution and scope of microbiology; History of microbiology; Microbial classification, nomenclature and identification; Taxonomic groups; General methods of classifying bacteria; Microscopy and microscopes: Smears and staining; Morphology and fine structure of bacteria; Cultivation of bacteria, nutritional requirements; Bacteriological media; Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Growth of bacteria, Stages of growth curve; Generation time; Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus: Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

**Practicals:** Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, Pour plate method; Direct Microscopic count; Factors influencing growth: pH, temperature, growth curves for bacteria.

**FSQ 211****Food Microbiology****2+1**

**Theory:** Significance of microbes in food science; Microbial spoilage of foods Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Factors affecting kinds, numbers, growth and survival of microorganisms in foods; Intrinsic factors; pH, water activity, nutrients etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere; Contamination of foods; Sources of contamination, Genera of bacteria, Maintenance of anaerobic conditions; Asepsis, removal of microorganisms; Intermediate moisture foods; Microbiology of milk and milk products; fruits and vegetables, cereal and cereal products, meat and meat products, fish and other sea foods; poultry and eggs: sugar and sugar products; salts and spices, canned foods, – sources of contamination, spoilage defects and their causative organisms, prevention and control. Shelf life: Calculation of shelf life, Factors influencing shelf life; deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf life simulation for moisture, oxygen, and light sensitive products; Food borne diseases, food infections, food intoxication, and toxico-infection, causes of food borne illness, symptoms Definition of pathogen and indicator organism. Important bacterial pathogens – *E.coli*, *Salmonella*, *Staph. aureus*, *Clostridium* and their toxins. Mycotoxins –Aflatoxin, Ochratoxin, Patulin, Ergot alkaloids, and DON in foods. Food borne viruses: Polio, hepatitis A & E, noroviruses, rota viruses, prion diseases, types of food involved, toxicity and symptoms. Detection of *Salmonella* and *Staph. aureus* from food samples.

**Practicals:** Isolation of bacteria and molds from foods Microbiological examination (total viable count, coliforms and yeast and molds) of cereal and cereal products; vegetable and fruits; meat and meat products; fish and other sea foods; eggs and poultry; milk and milk products; sugar, salts and spices; and canned products;

Determination and enumeration of pathogenic and indicator organisms in foods (*Coliform/Enterococcus*); Thermal death time determination; Detection of coliforms from water by MPN method and MFT technique.

**FSQ 212****Food Chemistry of Macronutrients****2+1**

**Theory:** Nature, scope and development of food chemistry; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulsions); Carbohydrates: Changes of carbohydrates on cooking, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates; Proteins in foods: Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein; Lipids in foods: Role and use of lipids/fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, safety use of oils and fats in food formulation; Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques chemical aspects of lipids and antioxidants.

**Practicals:** Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil.

## **FSQ 221 Food Chemistry of Micronutrients 1+1**

**Theory:** Chemistry of food flavour; Philosophy and definitions of flavour, flavourmatics/flavouring compounds, sensory assessment of flavour, technology for flavour retention; Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs; Food colorants; Regulatory use of regulatory dyes; Colour losses during thermal processing; Vitamins and minerals: Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins and minerals, optimization and retention of vitamins and minerals; Chemistry of anti-nutritional factors. Enzymes in food industry: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients. Minerals: Functions, sources, factors affecting absorption of minerals, absorption promoters, absorption inhibitors, effect of deficiency; Vitamins and hormones: Classification, functions, sources, effects of deficiency, fat soluble vitamins, water soluble vitamin; Relationship between vitamins and hormones in terms of their biological role; Physico-chemical and nutritional changes during processing.

**Practicals:** Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron; Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids); Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables. Assay of Amylases, papsain and lipase.

## **FSQ 222 Industrial Microbiology 2+1**

**Theory:** History of industrial microbiology; Primary and secondary metabolites produced by the microorganisms; Screening of microorganisms; Organizations involved in microbiological work; Fermentation media, Industrial sterilization; Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, Fermentor: Components of a fermentor, parts of fermentors, peripheral parts and accessories, additional accessories and peripherals. Types of fermentors: Types of fermentations; Submerged liquid fermentation and solid state fermentation; Importance of fermentation in food industry, types of food fermentations. Industrially important secondary metabolites; and microorganisms involved; Probiotics: Importance, role in fermented foods, organisms involved, beneficial effects; Bacteriocins; Nisin: Production of microbial enzymes; Downstream processing of enzymes; Cell disruption methods: Mechanical disruption methods and non-mechanical disruption methods; Extraction; Purification; Concentration; Product recovery;

**Practicals:** Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/ Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/proteases/Lipase; Production and assay of nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast; Mushroom production.

## **FSQ 311 Instrumental Techniques in Food Analysis 2+1**

**Theory:** Concepts of food analysis; Rules and regulations of food analysis; Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods; Principles and methodology involved in analytical techniques: ion

selective electrodes, spectroscopy, ultraviolet, visible, fluorescence, infrared spectro-, atomic absorption and emission, mass spectroscopy, nuclear magnetic resonance and electron spin resonance; Chromatography: Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method, gas-liquid, high performance liquid chromatography; Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, isotopic techniques, manometric techniques; Immuno assay techniques in food analysis; Evaluation of analytical data: Accuracy and precision, statistical significance, co-relations regression, result interpretation; Instrumentation and sensors for the food industry; Sensors for food flavour and freshness, electronic noses, tongues and testers; Introduction to flavour assessment, modelling the human nose, electronic nose, electronic tongue, marker chemical approach Food compositional analysis using near infra-red absorption technology: Principles of measurement, instrumentation, applications in the food industry, power of process monitoring and trending, Practical considerations for implementing on-line measurement, Practical aspects of infra-red remote thermometry, radiation thermometers, measurement principles, Practical situations, miscellaneous techniques; In-line and off-line FTIR measurements, food applications, calibration and general aspects of routine use; Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors; Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, ions, gases and volatiles, amperometric, potentiometric and thermometric biosensors; Acoustic sensors, optical immunosensors; Fluorescence sensor systems; Novel sensing receptors, sensor arrays, commercial biosensors.

**Practicals:** Sampling plan; Sample collection and preparation for analysis; Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Analysis of heavy metals using atomic absorption spectrophotometer; Separation of

amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of prolines by ion-exchange chromatography; Molecular weight determination using saphadex-gel; Identification of organic acids by paper electrophoresis; Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLC; Quantitative make-up of water and fat soluble vitamins using HPLC; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Spectrophotometric method of total chlorophyll (A & B).

**FSQ 321 Food Plant Sanitation 1+1**

**Theory:** Definition of Sanitation; Importance of sanitation in the food industry: Sanitation laws and regulations and guidelines, potential risks of food borne bioterrorism, bioterrorism protection measures, role of pest management in bio-security; Relationship of microorganisms to sanitation, allergens, allergen control; Food contamination, protection against contamination;

Health and Personal hygiene of food handlers: Role of FSMS in sanitation, quality assurance for cleaning compounds/detergents,-handling and storage precautions; Sanitizers, sanitizing methods, sanitation equipment, waste product handling, solid waste disposal, liquid waste disposal; Pest control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management; Sanitary design and construction for food processing plants: Site selection, site preparation, building construction considerations, processing and design considerations, pest control design; Low-moisture food manufacturing and storage sanitation: Sanitary construction considerations, receipt and storage of raw materials, cleaning of low-moisture food manufacturing plants; Dairy processing plant sanitation: Role of pathogens, sanitary construction considerations, soil characteristics in dairy plants, sanitation principles, cleaning equipment; Meat and poultry plant sanitation: Role of sanitation, sanitation principles, cleaning compounds for meat



## 5. SECTION OF FOOD PROCESS ENGINEERING

### FPE 111 Food Thermodynamics 2+1

**Theory:** Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat; First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility; Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule; Thermodynamic cycles: Carnot vapour power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle; Psychrometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms, three stages of water, phase diagram for water, vapour pressure temperature curve for water, heat requirement for vaporization, measurement of humidity, Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

**Practicals:** Determination of dryness fraction of steam. Determination of state of air using psychrometric chart and hygrometer; Use of psychrometric chart during drying process/humidification process; Demonstration of equilibrium sorption isotherms; Visit to food plant with steam utilization.

### FPE 121 Post Harvest Engineering 2+1

**Theory:** Overview of post harvest technology: Concept and science, production and post harvest losses, reasons for losses, importance of loss reduction; Post Harvest Handling operations; Cleaning: Scalping, Cleaning and grading of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading; Grading Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance; Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and shelling: Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.; Grain drying theory, grain dryers; Liquid dryers; Parboiling: process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature; Milling: milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials handling: Introduction to different conveying equipments used for handling of grains, fruits and vegetables; Scope and importance of material handling devices; Study of different material handling systems: Classification, principles of operation, conveyor system selection; Belt conveyor: Principle, characteristics, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity,

power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

**Practicals:** Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

### **FPE 211 Food Refrigeration and Cold Chain 2+1**

**Theory:** Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization; Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression

system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure-enthalpy diagram, super heating, sub cooling; Liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling, actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine, Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants-physical, chemical, safety, thermodynamic and economical; Azeotropes; Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture, principles and systems of ice production, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost heave, automated cold stores, Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, refrigerated vans, refrigerated display; Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological

principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling load calculations: Load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration, peak load; etc.

**Practicals:** Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods; Study of spray freezing process for foods; Study of thawing of foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of refrigerated display of foods and estimation of cooling load. Study of freeze dryer and freeze drying process.

**FPE 212                      Heat and Mass Transfer in                      2+1**  
**Food Processing**

**Theory:** Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of

the fins; Introduction to unsteady state heat conduction: Convection: Forced and free convection, Use of dimensional analysis for correlating variables affecting convection heat transfer; Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Introduction to condensing and boiling heat transfer: Film- and drop-wise condensation, effect of non-condensable gases, boiling heat transfer; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

**Practicals:** Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Determination of thermal conductivity of different food products; Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer.

**FPE 213                      Unit Operations in Food Processing-I                      2+1**

**Theory:** Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw

crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping); Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids; Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machines; Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids; Membrane separation: General considerations, materials for membrane construction, ultra-filtration, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and micro filtration.

**Practicals:** Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer; Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of centrifugal separator; Study on osmosis in fruits; Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultra filtration/membrane separation process.

## FPE 221 Unit Operations in Food Processing-II 2+1

**Theory:** Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation; Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of single effect and multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchanges; Recompression heat and mass recovery and vacuum creating devices; Expression and Extraction: liquid-liquid extraction processes, types of equipment and for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations; Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization; Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/differential distillation, fractional distillation, steam distillation, distillation of wines and spirits; Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment; Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, methods of heating, and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger; Sterilization: Principles, process time, T-evaluation, different methods; UHT sterilization, in package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package; Aseptic processing: principles, analysis of thermal resilience, duration

mathematics of conduction heating; Blanching: principle and equipment; Homogenization, Emulsification.

**Practicals:** Study of working principle open pan and vacuum evaporator; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of sterilizer; Design problems on freezers; Numerical problem on thermo bacteriology (D, Z and F); Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar; Study of blancher, pasteurizers, fryers, homogenizers, irradiators; Determination of oil uptake by the food product during frying; Study on qualitative changes in the fried food product; Visit sugar processing industry.

#### **FPE 222                      Food Storage Engineering                      2+1**

**Theory:** Storage: Importance of scientific storage systems, factors responsible and conditions for storage of perishables and semi-perishables. Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control; controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, ZEEC. Storage structures: Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation; Aeration and stored grain management: purposes of aeration, aeration theory, aeration system design, aeration system operation; cold storage, control of temperature and relative humidity inside storage; Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure

distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.

**Practicals:** Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design Drawing & layout of grain godowns for particular capacity and commodity; Visits to cold storage; Design drawing and layout of cold storage for particular capacity and commodity; Visits to CA storage; Design drawing & layout of CA storage for particular capacity and commodity; Visits to evaporative cooling system for storage; Storage study in the MAP and CAP.

#### **FPE 321                      ICT Applications in Food Industry                      1+1**

**Theory:** Importance of computerization in food industry, operating environments and information systems for various types of food industries, Supervisory control and data acquisition (SCADA); SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems; Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems, use of add?ins, use of solver; Web hosting and webpage design; file transfer protocol (FTP), on-line food process control from centralized server system in processing plant; Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system, problem solving methodologies, numeric, cell, arrays, matrix operations, user defined functions, programming using MATLAB; debugging MATLAB programs, applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB, function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to toolboxes useful to food industry,

curve fitting toolbox, fuzzy logic toolbox, neural network toolbox, image processing toolbox, statistical toolbox; Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry; Introduction to CFD software, GAMBIT and FLUENT software; LabVIEW - LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW; LabVIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.

**Practical:** Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add?Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using

FLUENT; Introduction to LabVIEW and NI-DAQ.

## **FPE 322      Food Process Equipment Design      2+1**

**Theory:** Engineering properties of agricultural smaterials: physical, mechanical, aero-hydrodynamic, rheological, thermal properties, Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes; Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations; Design of retorts; Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator; Design of agitators and separators: Design of agitators and baffles; Design of centrifuge separator; Design of freezing equipment: Design of ice cream freezers and refrigerated display system; Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer; Design of conveyors and elevators: Design of belt, chain and screw conveyor, design of bucket elevator and pneumatic conveyor; Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder; Design of fermenters: Design of fermenter vessel, design problems; Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

**Practicals:** Determination of engineering properties, size, shape, volume, density and specific gravity; Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

### **FPE 323 Instrumentation and Process Control 2+1 in Food Industry**

**Theory:** Introduction, definitions, characteristics of instruments, static and dynamic characteristics; Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure; Liquid level measurement, different methods of liquid level measurement; Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale; Measurement of moisture content, specific gravity, measurement of humidity, measurement of viscosity, turbidity, color, measurement of density, brix, pH, enzyme sensors, automatic valves; Transmission: Pneumatic and electrical; Control elements, control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis, dynamic behaviour of simple process, Laplace transform, process control hardware; Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis; Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices; Controllers and indicators: Temperature control, electronic controllers, flow ratio control, atmosphere control, timers and

indicators, food sorting and grading control, discrete controllers, adaptive and intelligent controllers; Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing.

**Practicals:** Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer.

## 6. SECTION OF FOOD BUSINESS MANAGEMENT

### **FBM 121 Introduction to Economics and Business Management 2+0**

Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price elasticity and income elasticity; Markets: Types of markets and their characteristics; National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production. Law of variable proportions and returns to scale; Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Management definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid; Finance management: Definition, scope, objective; Time value of money and its accounting, Different systems of accounting: Financial accounting, cost accounting, management accounting; Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

### **FBM 311 Marketing Management and International Trade 2+0**

Marketing: Concept, functions, scope and marketing management; Process: Concepts of marketing- marketing mix, elements of marketing-mix; Market structure and consumer buying behaviour: micro- and macro-environments; Marketing research and marketing information systems; Market measurement, market forecasting, market segmentation, targeting and positioning; Allocation and marketing resources; Marketing planning process;

Product policy and planning: Product-mix, product line, product life cycle; New product development process; Product brand, packaging, services decisions; Marketing channel decisions; Retailing, wholesaling and distribution; Pricing decisions; Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry; Promotion-mix decisions; Advertising: Objectives, budget and advertising message, media planning, personal selling, publicity, sales promotion. World consumption of food: Patterns and types of food consumption across the globe; International trade : its importance, advantages, disadvantages, free trade and protection, theories of international trade; Salient features of international marketing, composition and direction of Indian exports, international marketing environment, deciding which and how to enter international market; Direct exports, indirect exports, licensing, joint ventures, direct investment and internationalization process, distribution channels; WTO and world trade agreements related to food business, export trends and prospects of food products in India; Government institutions related to international food trade: APEDA, Tea Board, Spice Board, MOFPI, etc.

### **FBM 321 Project Preparation and Management 1+1**

**Theory:** Overview of project management: Functions and viewpoints of management, evolution of project management, forms and environment of project management; Project life cycle; Project selection: Project identification and screening, project appraisal, project charter, project proposal, project scope, statement of work; Project planning and scheduling: Work breakdown structure, planning and scheduling of activity networks, network scheduling, precedence diagrams, critical path method, program evaluation and review technique, assumptions in PERT modelling, decision CPM, GERT; Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth; Project feasibility study: Post planning of project, project planning and control; New venture management<sup>2</sup>; Project cost estimation: Types

of estimates and estimating methods, dynamic project planning and scheduling, time-cost trade-offs, resource considerations in projects, resource profiles and levelling, limited resource allocation; Project implementation, monitoring and control: Project management process and role of project manager, team building and leadership in projects, organizational and behavioural issues in project management, PERT/cost method, earned value analysis; Project completion and future directions: Project completion and review; Project management: Recent trends and future directions; Computers in project management.

**Practicals:** Time value of money–Future value of single cash flow & annuity, present value of single cash flow, annuity & perpetuity. Simple interest & Compound interest. Sources of Project selection and Project identification. Project appraisal–undiscounted techniques Payback period, annual rate of return, Average returns per rupee. Project appraisal - discounted techniques:–Discounted BC ratio, Net present value, Internal rate of return, Modified internal rate of return, Profitability index, sensitivity analysis. Project planning and scheduling. Network scheduling, Critical Path Method (CPM), Program Evaluation And Review Technique (PERT), Graphical Evaluation and Review Techniques (GERT); GANT Chart; Project cost estimating methods; Time-cost trade-offs in projects; Earned Value Management Analysis. Linear Programming usage in business decision making problem: formulation, methods of solving: graphical and simplex, problems with mixed constraints: duality; concept, significance, usage & application in business decision making; Case studies will undertaken and discussed in class; Field visits to nearby agri industrial entrepreneurs.

## **FBM 411                      Personality Development and                      1+1** **Soft Skill for Food Industry**

**Theory:** Communication –Meaning, definition, models, elements and their characteristics, types. Barriers in communication. Communication skills: Structural and functional grammar, meaning and process of communication, verbal and non-verbal communication. Role of ICT in communication, recent advances in communication-internet, cyber cafe, video and tele conference, Kisan call Center and e-governance. Meaning and definition of personality, theoretical perspectives on personality-Behavioural trait and humanistic personality pattern; moulding the personality patterns. Personality development –self perception, self esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family).

**Practicals:** Listening and note taking, writing skills, oral presentation skills, field dairy and lab record, indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summerizing, abstracting, individual and group presentations. Developing questionnaire to study impact of physique, education and institutions, aspirations on personality. Collecting data through the questionnaire, analysis, report writing and presentation.

**IV FOOD PLANT OPERATIONS/(STUDENT READY)  
COURSES**

**FPO 311 Student READY–Industrial Tour 0+1**

One Industrial Tour for 15 days duration, during semester break period after V Semester shall be conducted and grading shall be done as satisfactory/Non satisfactory.

**FPO 411 Student READY-Experiential Learning Programme–I 0+7**

**FPO 412 Student READY-Experiential Learning Programme – II 0+7**

The experiential learning programme will be offered in the VII semester with a credit load of 0+14 credit hours through relevant pilot plants for processing of various commodities, preferably on campus. This shall include orientation, developing a business plan / project proposal; plan for the production; production; sales; documentation, presentation and evaluation. The scheme of operation of the student READY-experiential learning programmes are as follows:

| <b>Experiential Learning Programme Activities</b>  | <b>Credit Hrs.</b> |
|--|--------------------|
| <b>Orientation and Developing a Business Plan/ Project proposal</b><br>Identification of the product to be manufactured, Market Survey, Analysis of the existing status of the identified product and targeted market and customer, Innovativeness and Creativity, Preparation of the project proposal with supply chain of inputs, personnel plan, production plan, finance plan etc. and its preparation | 0+1                |
| <b>Plan for the Production</b><br>Organization of resources, Organizing Utility, Sequential grouping of activities, Packaging and storage, Product pricing physical inputs, man hours, depreciation etc.   | 0+1                |
| <b>Production</b><br>Regularity in production, Adhering to production plan, Product quality assessment, Maintenance of production records, Team work.  | 0+3                |
| <b>Sales</b><br>Sales strategy, sales volumes, assessment of sales performance, profit generated including C/B ratio, payback period, etc.   | 0+1                |
| <b>Documentation, Presentation and Evaluation</b>  | 0+1                |
| <b>Total Credits</b>   | <b>0+7</b>         |

**FPO 413 Student READY-Research Project 0+4**

**FPO 414 Student READY–Seminar 0+1**

**FPO 421 Student READY–Internship/In-Plant Training 0+20**

In the Final Semester of the degree program (VIII semester), the students are required to undergo in-plant training for a period of 16 weeks in Food Industry to learn about industrial work cultures and gain practical project mode research or industrial experience.

Work experience during the in-plant training would be of immense value to the students in gaining a greater understanding of the activities of the food processing industry and prepare them to take up responsibilities subsequently.

## V REMEDIAL COURSES

### BIO 111                      **Introductory Biology**                      1+1

**Theory:** Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification. Cell and cell division. Seed and seed germination. Morphology of flowering plants. Plant systematics- viz., Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

**Practicals:** Morphology of flowering plants—root, stem and leaf and their modifications. Inflorescence, flower and fruits. Description of plants. Cell, tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides.

### MAT 111                      **Introductory Mathematics**                      2+0

Straight line: Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope–point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form equation of line, General form of equation of line, Point of intersection of two straight Lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral.

Circle: Equation of circle whose centre and radius is known, General equation of circle, Equation of circle passing through three given points, Equation of circle whose diameter is line joining two points  $(X_1, y_1)$  &  $(X_2, y_2)$ , Tangent and Normal to a given circle at given point (simple problems), Condition of tangency of a line  $y = mx + c$  to the given circle  $x^2 + y^2 = a^2$ .

Differential calculus: Definition of function, limit and continuity, Simple problems on limit, Simple on continuity, Differentiation of  $x^n$ ,  $e^x$ ,  $\sin x$  &  $\cos x$  from first principal, Derivatives of sum, difference,

product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it). Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problem based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form  $y=f(x)$  (Simple problem based on it).

Integral Calculus: Integration of simple function, Integration of product of two functions, Integration by substitution method, Definite Integral (Simple problem based on it), Area under simple well – known curves (Simple problem based on it).

Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3<sup>rd</sup> order, Properties of determinants up to 3<sup>rd</sup> order and their evaluation.

## Quotes

I never teach my pupils I only provide the conditions in which they can learn

- *Albert Einstein*

Intelligence plus character-that is the goal of true education

- *Martin Luther king, Jr.*

Some of the brightest minds in the country can be found on the last benches of the class room

- *Dr.APJ Abdul Kalam*

Education is not the learning of facts, but the training of the mind to think

- *Albert Einstein*

Education is the manifestation of perfection present already in man.

Divinity is the manifestation of the religion already in man

- *Swami Vivekananda*

The highest education is that which does not merely give us information but makes our life in harmony with all existence

- *Rabindrnath Tagore*

One child, one teacher, one pen and one book can change the whole world

- *Malala Yousafzai*

By education, I mean an all-around drawing of the best child and man in body, mind and spirit

- *Mahatma Gandhi*