BS (CS)
New Course Outline
# Proposed Revised Scheme of Studies for BS (CS)

## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3101</td>
<td>Fundamentals of Computers</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>CS3102</td>
<td>Calculus and Analytical Geometry</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS3103</td>
<td>Probability and Statistics</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS3104</td>
<td>Functional English</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS3105</td>
<td>Programming Fundamentals</td>
<td>4(3+1)</td>
</tr>
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## Semester II

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<tr>
<td>CS3201</td>
<td>Multivariate Calculus</td>
<td>3(3+0)</td>
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<tr>
<td>CS3202</td>
<td>Discrete Structures</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS3203</td>
<td>Pakistan Studies/ Islamic Studies</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS3204</td>
<td>Object Oriented Programming</td>
<td>4(3+1)</td>
</tr>
<tr>
<td>CS3205</td>
<td>Digital Logic Design</td>
<td>3(2+1)</td>
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## Semester III

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<td>Computation in MATLAB</td>
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<td>CS4301</td>
<td>Data Structures and Algorithms</td>
<td>4(3+1)</td>
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<tr>
<td>CS4302</td>
<td>Communication Skills</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS4303</td>
<td>Data Communication</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>CS4304</td>
<td>Linear Algebra</td>
<td>3(3+0)</td>
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<td>CS4305</td>
<td>Artificial Intelligence</td>
<td>3(3+0)</td>
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## Semester IV

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<td>4(3+1)</td>
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<tr>
<td>CS4402</td>
<td>Operating Systems</td>
<td>4(3+1)</td>
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<tr>
<td>CS4403</td>
<td>Computer Networks</td>
<td>3(3+0)</td>
</tr>
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<td>CS4404</td>
<td>Theory of Automata</td>
<td>3(3+0)</td>
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<td>CS4405</td>
<td>Web Technologies</td>
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## Semester V

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<td>CS5502</td>
<td>Object Oriented Analysis and Design</td>
<td>3(2+1)</td>
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<tr>
<td>CS5503</td>
<td>Advanced Programming</td>
<td>4(3+1)</td>
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<tr>
<td>CS5504</td>
<td>Information Security</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>BES-475</td>
<td>Geographic Information System</td>
<td>3(3+0)</td>
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## Semester VI

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<td>CS5602</td>
<td>Software Engineering</td>
<td>3(3+0)</td>
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<td>CS5603</td>
<td>Mobile Applications Development</td>
<td>4(3+1)</td>
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<td>CS5604</td>
<td>Human Computer Interaction</td>
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<td>CS5605</td>
<td>Applied Image Processing</td>
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<td>CS6702</td>
<td>FYP - I</td>
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<td>BA565</td>
<td>Entrepreneurship</td>
<td>3(3+0)</td>
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<td>CS67XX</td>
<td>Specialization Elective - I</td>
<td>3(3+0)</td>
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<td>Specialization Elective - II</td>
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<td>CS6802</td>
<td>Professional Practices</td>
<td>3(3+0)</td>
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<td>CS6803</td>
<td>FYP - II</td>
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<td>Specialization Elective - III</td>
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**Total Credit Hours = 132**
### Distribution of Courses According to HEC Framework

1. **Computing - CS Core Courses**

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<tr>
<td>1</td>
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<td>Programming Fundamentals</td>
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<td>Object Oriented Programming</td>
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<tr>
<td>3</td>
<td>CS3205</td>
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<td>Digital Logic Design</td>
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<td>4</td>
<td>CS3202</td>
<td>18, 34</td>
<td>Discrete Structures</td>
<td>3(3+0)</td>
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<tr>
<td>5</td>
<td>CS4301</td>
<td>1</td>
<td>Data Structures and Algorithms</td>
<td>4(3+1)</td>
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<td>6</td>
<td>CS4303</td>
<td></td>
<td>Data Communication</td>
<td>3(3+0)</td>
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<td>7</td>
<td>CS4401</td>
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<td>Database Systems</td>
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<td>14</td>
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<td>Human Computer Interaction</td>
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<tr>
<td>16</td>
<td>CS6702 &amp; CS6803</td>
<td>13</td>
<td>Final Year Project (I &amp; II)</td>
<td>(0+ 3) + (0+3)</td>
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**Total Credit Hours** 59

2. **Computing - Supporting Courses**

<table>
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<tr>
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<th>Semester</th>
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<tr>
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<td>Probability and Statistics</td>
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<td>1</td>
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<td>Linear Algebra</td>
<td>3(3+0)</td>
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**Total Credit Hours** 9

3. **Computing - General Education Courses**

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<th>Course Title</th>
<th>Credit Hours</th>
<th>Semester</th>
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<tbody>
<tr>
<td>21</td>
<td>CS3101</td>
<td></td>
<td>Fundamentals of Computers</td>
<td>3(2+1)</td>
<td>1</td>
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<tr>
<td>22</td>
<td>CS3104</td>
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<td>Functional English</td>
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<tr>
<td>23</td>
<td>CS3203</td>
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<td>Pakistan Studies/Islamic Studies</td>
<td>3(3+0)</td>
<td>2</td>
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<tr>
<td>24</td>
<td>CS4302</td>
<td>22</td>
<td>Communication Skills</td>
<td>3(3+0)</td>
<td>3</td>
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<tr>
<td>25</td>
<td>CS6701</td>
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<td>Technical and Scientific Writings</td>
<td>3(3+0)</td>
<td>7</td>
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<td>Professional Practices</td>
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**Total Credit Hours** 18
4. **Computer Science - Core Courses**

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<th>Semester</th>
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<td>CS5504</td>
<td>2, 8, 10, 11</td>
<td>Information Security</td>
<td>3(3+0)</td>
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<td>28</td>
<td>CS4404</td>
<td>1, 5, 6</td>
<td>Theory of Automata</td>
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<td>31</td>
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<td>Computer Organization and Architecture</td>
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<td>32</td>
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<td>33</td>
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<td>Natural Language Processing</td>
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**Total Credit Hours** 22

5. **Computer Science - Supporting & University Elective Courses**

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<tr>
<td>34</td>
<td>CS3201</td>
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<td>Multivariate Calculus</td>
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<td>BA565</td>
<td>-</td>
<td>Entrepreneurship</td>
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**Total Credit Hours** 12

6. **7th Semester Specializations Elective Courses**

Please use the following abbreviations for specializations:

GT - General Track  
WE - Web Engineering  
CN - Computer Networks  
DS - Database Systems  
SE - Software Engineering  
PR - Pattern Recognition

<table>
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<th>Course Code</th>
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<th>Course Title</th>
<th>Credit Hours</th>
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<th>DS</th>
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<td>CS6752</td>
<td>13, 14</td>
<td>Computer Aided Software Engineering</td>
<td>3(3+0)</td>
<td>✓</td>
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<td>53</td>
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<tr>
<td>54</td>
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<td>6, 29</td>
<td>Natural Computation</td>
<td>3(3+0)</td>
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<td>55</td>
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<td>6, 13, 18, 19, 20</td>
<td>Introduction to Neural Networks</td>
<td>3(3+0)</td>
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7. 8th Semester Specializations Elective Courses

Please use the following abbreviations for specializations:

GT - General Track  
WE - Web Engineering  
CN - Computer Networks  
DS - Database Systems  
SE - Software Engineering  
PR - Pattern Recognition

<table>
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<tr>
<th>#</th>
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<th>Course Title</th>
<th>Credit Hours</th>
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<th>CN</th>
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<th>SE</th>
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<td>59</td>
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<td>60</td>
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<td>63</td>
<td>CS6821</td>
<td>11, 13, 19, 20</td>
<td>Information Retrieval and Web Search</td>
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<td>✓</td>
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<td>CS6841</td>
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<td>69</td>
<td>CS6842</td>
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<td>Database Administration</td>
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<tr>
<td>70</td>
<td>CS6843</td>
<td>-</td>
<td>ETL (Extract, Transform, Load) Programming</td>
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<td>71</td>
<td>CS6851</td>
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<td>72</td>
<td>CS6852</td>
<td>13, 14</td>
<td>Software Testing</td>
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<td>73</td>
<td>CS6853</td>
<td>12, 13, 14</td>
<td>Open Source Development</td>
<td>3(3+0)</td>
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<tr>
<td>74</td>
<td>CS6861</td>
<td>6, 13, 19, 20</td>
<td>Machine Learning</td>
<td>3(3+0)</td>
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### Revision at a Glance

During revision, the following changes and additions are performed in each of the semester and specializations elective courses.

<table>
<thead>
<tr>
<th>Semester I</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Course Code</strong></td>
<td><strong>Course Title</strong></td>
<td><strong>Credit Hours</strong></td>
<td><strong>Remarks</strong></td>
<td></td>
</tr>
</tbody>
</table>
| CS3101 | Fundamentals of Computers | 3(2+1) | • Course code is changed  
• Title is kept same  
• Contents are changed  
• Books are updated  
• Lab is included |
| CS3102 | Calculus and Analytical Geometry | 3(3+0) | • New course is added in place of Mathemantics-1  
• Course code is changed |
| CS3103 | Probability and Statistics | 3(3+0) | • Course code is changed  
• Title is kept same  
• Contents are changed  
• Books are updated |
| CS3104 | Functional English | 3(3+0) | • Course code is changed  
• Title is kept same  
• Contents are changed  
• Books are updated |
| CS3105 | Programming Fundamentals | 4(3+1) | • Course code is changed  
• Title is kept same  
• Contents are changed  
• Books are updated  
• Lab is included |
| **Total Semester Credit Hours:** |  |  |  | **16** |

<table>
<thead>
<tr>
<th>Semester II</th>
<th></th>
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<tbody>
<tr>
<td><strong>Course Code</strong></td>
<td><strong>New Title</strong></td>
<td><strong>Credit Hours</strong></td>
<td><strong>Remarks</strong></td>
<td></td>
</tr>
</tbody>
</table>
| CS3201 | Multivariate Calculus | 3(3+0) | • New course is added in place of Mathemantics-1  
• Course code is changed |
| CS3202 | Discrete Structures | 3(3+0) | • Course code is changed  
• Title is changed  
• Contents are changed  
• Books are updated |
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Old Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3203</td>
<td>Pakistan Studies/Islamic Studies</td>
<td>3(3+0)</td>
<td>• Course code is changed</td>
</tr>
<tr>
<td>CS3204</td>
<td>Object Oriented Programming</td>
<td>4(3+1)</td>
<td>• Course code is changed&lt;br&gt;• Title is kept same&lt;br&gt;• Contents are changed&lt;br&gt;• Books are updated</td>
</tr>
<tr>
<td>CS3205</td>
<td>Digital Logic Design</td>
<td>3(2+1)</td>
<td>• Moved from semester III&lt;br&gt;• Course code is changed&lt;br&gt;• Title is kept same&lt;br&gt;• Contents are changed&lt;br&gt;• Books are updated</td>
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</table>

**Total Semester Credit Hours:** 16

### Semester III

<table>
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<tr>
<th>Course Code</th>
<th>New Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>MATH-432</td>
<td>Computation in MATLAB</td>
<td>3(2+1)</td>
<td>• New course is added in place of Electronics&lt;br&gt;• Course code is changed&lt;br&gt;Code from the Department of Mathematics is used</td>
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<tr>
<td>CS4301</td>
<td>Data Structures and Algorithms</td>
<td>4(3+1)</td>
<td>• Course code is changed&lt;br&gt;• Title is changed&lt;br&gt;• Contents are changed&lt;br&gt;• Books are updated&lt;br&gt;• Lab is added</td>
</tr>
<tr>
<td>CS4302</td>
<td>Communication Skills</td>
<td>3(3+0)</td>
<td>• Course code is changed&lt;br&gt;• Title is kept same&lt;br&gt;• Contents are kept same&lt;br&gt;• Books are updated</td>
</tr>
<tr>
<td>CS4303</td>
<td>Data Communication</td>
<td>3(3+0)</td>
<td>• New course is added&lt;br&gt;• New code is used</td>
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<tr>
<td>CS4304</td>
<td>Linear Algebra</td>
<td>3(3+0)</td>
<td>• New course is added&lt;br&gt;• New code is used</td>
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<tr>
<td>CS4305</td>
<td>Artificial Intelligence</td>
<td>3(3+0)</td>
<td>• Moved from semester V&lt;br&gt;• Course code is changed&lt;br&gt;• Title is kept same&lt;br&gt;• Contents are changed&lt;br&gt;• Books are updated</td>
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**Total Semester Credit Hours:** 19
### Semester IV

<table>
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<tr>
<th>Course Code</th>
<th>New Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| CS4401      | Database Systems           | 4(3+1)       | • Moved from semester III  

• Course code is changed  

• Title is changed  

• Contents are changed  

• Books are updated  

| CS4402      | Operating Systems          | 4(3+1)       | • Course code is changed  

• Title is kept same  

• Contents are changed  

• Books are updated  

| CS4403      | Computer Networks          | 3(3+0)       | • Course code is changed  

• Title is changed  

• Contents are changed  

• Books are updated  

| CS4404      | Theory of Automata         | 3(3+0)       | • Moved from Semester VI  

• Course code is changed  

• Title is changed  

• Contents are changed  

• Books are updated  

| CS4405      | Web Technologies           | 4(3+1)       | • Course is moved from Semester V  

• Course code is changed  

• Title is kept same  

• Contents are changed  

• Books are updated  

|             | **Total Semester Credit Hours:** | **18**  |  

### Semester V

<table>
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<tr>
<th>Course Code</th>
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<th>Credit Hours</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| CS5501      | Design and Analysis of Algorithms                   | 3(3+0)       | • Course code is changed  

• Title is changed  

• Contents are changed  

• Books are updated  

| CS5502      | Object Oriented Analysis and Design                  | 3(2+1)       | • New course is added in place of Software Engineering - I  

• Course code is changed  

| CS5503      | Advanced Programming                                 | 4(3+1)       | • Course code is changed  

• Title is kept same  

• Contents are changed  

• Books are updated  

| CS5504      | Information Security                                 | 3(3+0)       | • New course is added.  


New code is used
- Geographic Information System 3(3+0)

Total Semester Credit Hours: 16

<table>
<thead>
<tr>
<th>Course Code</th>
<th>New Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
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<tr>
<td>BES-475</td>
<td>Geographic Information System</td>
<td>3(3+0)</td>
<td>- New course is added in place of Human Resource Management</td>
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<td>- Course code is changed</td>
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<td>- Code from the Department of Environmental Science is used</td>
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Semester VI

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<tr>
<td>CS5602</td>
<td>Software Engineering</td>
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<td>CS5603</td>
<td>Mobile Applications Development</td>
<td>4(3+1)</td>
<td>- Course moved from electives of semester VIII</td>
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<td>- Books are updated</td>
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<td>CS5604</td>
<td>Human Computer Interaction</td>
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<td>CS5605</td>
<td>Applied Image Processing</td>
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Total Semester Credit Hours: 17

Semester VII

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<td>BA565</td>
<td>Entrepreneurship</td>
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<td>- Course code is changed</td>
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<td>- Code from the Department of IM Studies is used</td>
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<td>CS6702</td>
<td>FYP-I</td>
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<td>- Title is changed</td>
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<tr>
<td>CS67XX</td>
<td>Specialization Elective - 1</td>
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<td>- Remarks are shown in the 7th</td>
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Total Semester Credit Hours: 17
### Semester VIII

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<th>Course Code</th>
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<th>Remarks</th>
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</thead>
</table>
| CS6801      | Natural Language Processing        | 3(3+0)       | • Course code is changed  
• Title is kept same  
• Contents are changed  
• Books are updated |
| CS6802      | Professional Practices             | 3(3+0)       | • New course is added  
• New code is used |
| CS6803      | FYP-II                             | 3(0+3)       | • Course code is changed  
• Title is changed |
| CS68XX      | Specialization Elective - III      | 3            | •Remarks are shown in the 8th semester specializations elective courses table |
| CS68XX      | Specialization Elective - IV       | 3            | •Remarks are shown in the 7th semester specializations elective courses table |

**Total Semester Credit Hours:** 15

### 7th Semester Specializations Elective Courses

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| CS6703      | Compiler Construction                 | 3(3+0)       | • Course moved into electives from semester VII  
• Course code is changed  
• Content are changed  
• Books are updated |
| CS6704      | E-Commerce Technologies & Applications | 3(3+0)       | • Course code is changed  
• Title is changed  
• Content are changed  
• Books are updated |
| CS6705      | Expert Systems                        | 3(3+0)       | • Course code is changed  
• Content are changed  
• Books are updated |
<p>| CS6706      | Introduction to Parallel              | 3(3+0)       | • New course is added |</p>
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS6721</td>
<td>Information Architecture</td>
<td>3(3+0)</td>
<td>• New course code is used</td>
</tr>
<tr>
<td>CS6722</td>
<td>Web Content Management Systems</td>
<td>3(2+1)</td>
<td>• New course is added</td>
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<tr>
<td>CS6723</td>
<td>Web Engineering</td>
<td>3(3+0)</td>
<td>• New course code is used</td>
</tr>
<tr>
<td>CS6731</td>
<td>Routing and Switching</td>
<td>3(3+0)</td>
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</tr>
<tr>
<td>CS6732</td>
<td>Internet of Things (IoT)</td>
<td>3(3+0)</td>
<td>• New course is added</td>
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<td>CS6733</td>
<td>Network Programming</td>
<td>3(3+0)</td>
<td>• New course is added</td>
</tr>
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<td>CS6734</td>
<td>Wireless and Mobile Networks</td>
<td>3(3+0)</td>
<td>• New course is added</td>
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<tr>
<td>CS6741</td>
<td>Advanced Database Systems</td>
<td>3(3+0)</td>
<td>• New course is added</td>
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<tr>
<td>CS6742</td>
<td>Fundamentals of Data Warehousing</td>
<td>3(3+0)</td>
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<td>CS6751</td>
<td>Usability Engineering</td>
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<td>CS6752</td>
<td>Computer Aided Software Engineering</td>
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<td>CS6753</td>
<td>Software Architecture and Design</td>
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<td>• New course is added</td>
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· Books are updated
· New course is added
· New course code is used

CS6852 Software Testing 3(2+1)

CS6853 Open Source Development 3(2+1)

CS6861 Machine Learning 3(3+0)

Courses Archived

The following courses are archived due to not offering any more.

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<td>CS323</td>
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<td>CS432</td>
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<td>CS444</td>
<td>Computer Organization and Assembly Language</td>
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<td>8</td>
<td>CS445</td>
<td>Data Communication and Networking</td>
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<td>CS446</td>
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<td>CS557</td>
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<td>11</td>
<td>CS566</td>
<td>Foreign and Regional Language</td>
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<td>CS674</td>
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<td>CS677</td>
<td>Data Mining and Data Warehousing</td>
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<td>CS687</td>
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<td>19</td>
<td>CS686</td>
<td>Modeling and Simulation</td>
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<td>20</td>
<td>CS689</td>
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</tbody>
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Semester I
Courses
Course Code | Course Title          | Credit Hours |
-------------|-----------------------|--------------|
CS3101       | Fundamentals of Computers | 3(2+1)          |

Prerequisites: Nil

Course Description: This course is designed for students with little or no computer experience. This course introduces computer concepts, hardware components, basic computer operations and use of software applications to solve problems. Students will have complete understanding and use of personal computers and application software such as Microsoft Word, Excel and PowerPoint.

Aims and Objectives: Students successfully completing this course should be able to:
- Develop a vocabulary of key terms related to the computer and to software programs.
- Identify the components of a personal computer system.
- Demonstrate mouse and keyboard functions.
- Demonstrate window and menu commands and how they are used.
- Demonstrate how to organize files and documents on a USB/hard drive.
- Compose, format and edit a word document.
- Send email messages and navigate and search through the internet.


Recommended Books


Bibliography


<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS3102</td>
<td>Calculus and Analytic Geometry</td>
<td>3(3+0)</td>
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</table>

Prerequisites: Nil

Course Description: The course focuses on differential and integral calculus and other topics that are relevant to an undergraduate program studies.

Aims and Objectives:
- The aim of this course is to give students background of calculus necessary for the proposed computer science studies in the curriculum.


Recommended Books

Course Code | Course Title                | Credit Hours
-----------|----------------------------|-------------
CS3103      | Probability and Statistics | 3(3+0)      

Prerequisites: Nil

Course Description: Probability has extensive application in many computer science disciplines. This course is intended to fill the gap in students’ knowledge of probability.

Aims and Objectives: After completing the course, the student will be able to:
- Understand some advanced probability concepts and use them for problem solving in computer science.


Recommended Books


Prerequisites: Nil

Course Description: This course focuses on teaching of basic language skills: reading, speaking, writing, and listening. The aim is to give students good foundations in basic English with a focus on both accuracy and fluency required for academic progress as well performing specific functions in real life. The course will equip students with the ability to: ask/answer questions, make suggestions, express certainty/uncertainty, give reasons, ask for permission, describe things, agree and disagree, and express likes and dislikes, etc.

Aims and Objectives: After completing the course, the students will be able to:
1. Use grammar and language structure in context.
2. Teaching English through use.
3. Teach different language structures needed in different situations.
4. Make learning English a meaningful and interesting activity

**Course Contents:** Course contents are divided into the following functions:

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<th>Function</th>
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<td>d)</td>
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<td></td>
<td>Guessing the Meanings of Words</td>
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<tr>
<td></td>
<td>Informal Letters: Beginning and Ending</td>
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<td>Understanding Directions</td>
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<th>Seeking Agreement and Confirmation</th>
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<td>d)</td>
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<td>The Present Perfect and Simple Past Tense</td>
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Recommended Books


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<tr>
<td>CS3105</td>
<td>Programming Fundamentals</td>
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Prerequisites: Nil

Course Description: This is the first programming courses in this program. It provides the core knowledge to begin programming. The course covers creating programs to explore data types, conditions, loops, variables, and expressions; working with different kinds of data and seeing how they affect memory.

Aims and Objectives: When students complete this course, they will be able to:

- Understand the motivation for programming for a Computer Science (CS) graduate.
- Understand the basic components of a program development environment.
- Analyze a problem and devise a solution for it.
- Implement small programs.
- Define a problem and implement its sub-problems using functions.

Course Contents: Introduction to Programming and Importance for a CS Graduate, Basics of Programming and Software Development, C++ Development Environment and Basic Program Construction, Header Files and Library Files, Variables and Data Types, Operators (Arithmetic, Logical, Increment, Decrement) and Precedence, Type Conversion, Input and Output Statements in C++, IF Statement, IF-ELSE Statement, ELSE-IF Statement, Conditional Operator Switch Statement, GOTO Statement, Arrays, One Dimensional and Two Dimensional Arrays, FOR Loop, Nested FOR loops, Loops with Arrays, WHILE Loop, DO-WHILE Loop, Break
Statement, Continue Statement, Functions and its Importance, Parts of Functions, Passing Arguments to Functions, Returning Values from Functions, Inline Functions, Default Arguments, Recursion, Strings, String Manipulation Functions, Structures and its Importance, Declaring Structures and Structures Variables, Accessing Structures Members, Nested Structures, Passing Structures Function, Enumerations, Array of Structures, Pointers and its Importance, Pointers and Arrays, Pointers and Function (Call by Value and Call by Reference), Pointers and Strings, File Handling in C++, Reading from a File, Writing to a File.

Recommended Books


Bibliography

Semester II
Courses
Prerequisites: Calculus and Analytical Geometry

Course Description: This is an extension of single variable calculus. It focuses on the calculus as it applies to functions of two or more variables. The concept learnt in this course will be useful in analyzing geometry of curves and surfaces.

Aims and Objectives: On completing this course, students will have:
- An understanding of the basic concepts of multivariable calculus.
- Fluency with such concepts as parametric curves, matrix algebra, gradients, directional derivatives, and multiple integrals will be gained.
- Physical interpretation of these concepts and application in constrained-unconstrained optimization will be acquired.

Course Contents: Calculus of parametric curves, polar coordinates, coordinates and vectors in three-dimensions, dot and cross products, lines and planes in three-dimensions, conic sections and quadratic surfaces, parametric curves in three-dimensions, functions of two and three variables, partial derivatives, tangent planes and differentiability, the chain rule, the gradient and directional derivatives, maxima and minima, Lagrange multipliers, double integrals over rectangles and general regions, double integrals in polar coordinates, applications of double integrals, surface area as double integral, triple integral, cylindrical and spherical coordinates, vector fields and line integrals, Greens theorem, divergence and curl, Stokes theorem, divergence theorem.

Recommended Books


Prerequisites: Calculus and Analytical Geometry, Multivariate Calculus

Course Description: This course is designed to provide students of computer science with several topics and ideas that will help them to develop and analyze algorithms as well as enable them to think about and solve problems in new ways. This course introduces the discrete structures that can be applied to computer science problems.

Aims and Objectives: When students complete this course, they will be able to:
- Express a logic sentence in terms of predicates, quantifiers, and logical connectives.
- Use mathematically correct terminology and notation.
• Apply the rules of inference and methods of proof including direct and indirect proof forms, proof by contradiction, and mathematical induction.
• Count some different types of discrete structures.
• Use tree and graph algorithms to solve problems.


Recommended Books


Bibliography


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<tr>
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<td>CS3203</td>
<td>Pakistan Studies/Islamic Studies</td>
<td>3(3+0)</td>
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**Prerequisites:** Nil

**Pakistan Studies:**

**Course Description:** This course introduces students about the historical background of the creation of Pakistan. It focuses on major historical events both national and international and their impact.

**Aims and Objectives:** The course is aimed to:
• Sensitize students about the importance of Pakistan’s geographical and strategic position in South Asia.
• Promote the knowledge of Pakistani culture and civilization.
• Aware new generation about the current affairs and important pillars of Pakistan’s political system
Course Contents: Ideology of Pakistan in the Historical Perspective, Two Nation Theory, Pakistan Movement, Creation of Pakistan and Role of Quaid-e-Azam, Initial Difficulties, Islamization in Pakistan, The Land of Pakistan

Recommended Books


Islamic Studies:

Course Description: The purpose of the course is to introduce to students the Islamic teachings about basic beliefs, practices, Qura’n and sunnah of the holy prophet (S.A.W.S.) and social, moral and cultural aspects of Islamic way of life.

Aims and Objectives: After completing this course, the students will:
- Have knowledge of and ability to articulate major themes in the study of Islam, gender, and the state, and political system of Islam
- Be able to give an account of pluralism in modern Muslim family law
- Have developed an understanding of central themes in contemporary Muslim family law debates, as well as their historical roots.


Recommended Books


Bibliography


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<th>Course Title</th>
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<td>CS3204</td>
<td>Object Oriented Programming</td>
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</table>

Prerequisites: Programming Fundamentals

Course Description: This course discusses the object oriented model in programming. Students taking this course would have already taken a course on programming. This will help build good quality software using object-oriented techniques.
Aims and Objectives: When students complete this course, they will be able to:

- Understand the importance of OOP as compared to Structured Programming.
- Understand the basic constructs of a C++ program.
- Define a problem and implement its solution using classes and objects.
- Effectively use and implement OOP analysis and design.
- Understand object-oriented programming features in C++.
- Understand object-oriented concepts and how they are supported by C++.
- Gain some practical experience of C++.

Course Contents: Object Oriented Programming (OOP) and its Significance as a Modeling Technique. Comparison of Structured Programming and OOP, Classes and Objects in C++, Abstraction, New User Defined Data Types, Creating Objects from Classes, Accessing Member, Access Specifiers, Member Functions, Defining Member Functions, Constructors and Properties, Default Constructor, Constructor Overloading, Copy Constructor, Deep Copy, Shallow Copy, Destructors, “this” Pointer, Constant Member Function, Static Variables, Accessing Static Data Member, Static Member Function, Comparison of Global Variables and Static Variable, Arrays of Objects, Pointer to Objects Templates, Function Templates, Class Templates, Data Encapsulation and Abstraction, Importance of Data Encapsulation and Abstraction, Correctly Using the Access Modifiers, Friend Functions, Composition, Aggregation, Operator Overloading, Overloading Assignment Operator, Friend Function and Operator Overloading, Unary Operators Overloading, Inheritance and Importance, Inheritance in C++, Comparison of Overloading and Overriding, Hierarchy of Inheritance, Types of Inheritance, Private Inheritance, Protected Inheritance, Multiple Inheritance Problem in Multiple Inheritance, Polymorphism and Importance, Virtual Functions, Static Binding, Dynamic Binding, Abstract Classes and Concrete Classes, Virtual Destructors, Virtual Functions and Pure Virtual Functions, Virtual Functions Usage, Dynamic Dispatch, Namespaces and Using Namespaces, Memory Management and Importance, Memory Areas (Heap, Stack), Use of new Operator, malloc() and calloc() Functions Calls.

Recommended Books


Bibliography

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<td>Digital Logic Design</td>
<td>3(2+1)</td>
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</table>

**Prerequisites:** Nil

**Course Description:** This course introduces digital Logic to the students. The main objective of this course is to establish proficiency in fundamental concepts of Digital logic, and to teach the students Boolean Logic, Boolean algebra, gates, functions, multiple logic circuit designs. A key part of this course is to make the students understand the background processing in the computer.

**Aims and Objectives:** When students complete this course, they will be able to:

- Understand the numbering system, boolean algebra, logic gates.
- Understand boolean functions, how to simplify them by using different techniques, and design logic circuit for them.
- Understand the combinational logic circuits, adders, subtractors, decoder/encoder, multiplexer/de-multiplexed.
- Understand the sequential logic circuits, working, purpose and circuitry of flip-flops, registers, counters and memory units.
- Understand the asynchronous sequential logic.
- Use of digital logic simulators, such that the students get hands on familiarity with the concepts they come across in the course.


**Recommended Books**

Semester III
Courses
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH-432</td>
<td>Computation in MATLAB</td>
<td>3(2+1)</td>
</tr>
</tbody>
</table>

**Prerequisites:** Object Oriented Programming

**Course Description:** This course familiarizes students with the implementation of mathematical concepts in MATLAB.

**Aims and Objectives:** When students complete this course, they will be able to:
- Write small programs for mathematical problems and to perform computations in MATLAB.
- Use MATLAB effectively.

**Course Contents:** Introduction to MATLAB Windows, Built-in Functions, Arrays, Matrices, Script Files, Plots, Functions and Function Files, Loops, Selection Statements, Polynomials, Curve Fitting and Interpolation.

**Recommended Books**


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS4301</td>
<td>Data Structures and Algorithms</td>
<td>4(3+1)</td>
</tr>
</tbody>
</table>

**Prerequisites:** Programming Fundamentals

**Course Description:** The purpose of this course is to provide the students with solid foundations in the basic concepts of programming: data structures and algorithms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter. This course is also about showing the correctness of algorithms and studying their computational complexities. This course offers the students a mixture of theoretical knowledge and practical experience.

**Aims and Objectives:** Students successfully completing this course should be able to:
- Be familiar with basic techniques of algorithm analysis.
- Be familiar with writing recursive methods.
- Master the implementation of linked data structures such as linked lists and binary trees.
- Be familiar with several sub-quadratic sorting algorithms including quicksort, mergesort and heapsort.
Course Contents: Introduction and Overview, Abstract Data Type, Arrays, Stacks(Push and Pop), Infix, Postfix and Prefix, Basic Operations, Queues(Insertion, Deletion, De-queues), Heap, Lists, Linked Lists, Searching(Binary and Sequential), Sorting, Sorting and Hashing, Recursion, Trees, Linked Lists Implementation, Binary Trees, B-Trees, Trees Traversal, Basic Operations, Traversals Sets, Graph, Representation of Directed and Undirected Graphs, Traversals, Minimum Cost Spanning Tree, Complexity(Space and Time).

Recommended Books


<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS4302</td>
<td>Communication Skills</td>
<td>3(3+0)</td>
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</tbody>
</table>

Prerequisites: Functional English

Course Description: This course aims to develop students’ ability to focus on the outcome, tune in to their audience and develop their message for clarity and impact. It enhances their ability to create an environment for open discussion and ongoing dialogue which is crucial for communication success.

Aims and Objectives: The course aims to:
- Enable the students to meet their real-life communication needs.
- Provide well defined goals for more effective communications
- Provide the ability to create an open environment for communication
- Provide the skill to communicate clearly
- Provide emotional intelligence to deal with difficult situations

Course Contents: Paragraph writing: Practice in writing a good, unified and coherent paragraph. Essay writing, CV and job application, Translation skills, Study skills: Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension, Academic skills: Letter/memo writing, minutes of meetings, use of library and internet, Presentation skills: Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended Books


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS4303</td>
<td>Data Communication</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Prerequisites:** Nil

**Course Description:** Data communication is the fundamental course about the concept, design and management of data over a network. This course focuses on the components of communication system, the representation of data and the transmission mechanisms. The main focus of the course is on the physical layer of the OSI model.

**Aims and Objectives:** When students complete this course, they will be able to:
- Identify the different components and their respective roles in a communication system.
- How the data is represented in analog and digital forms.
- Identify the transmission mechanism and the induced challenges.

Recommended Books


Bibliography


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS4304</td>
<td>Linear Algebra</td>
<td>3(3+0)</td>
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</tbody>
</table>

Prerequisites: Nil

Course Description: This elementary course in linear algebra prepares students for learning advanced concepts in computer science.

Aims and Objectives: After studying this course, students will be able:
- To understand the use of linear algebra in some computer science concepts and apply it to computer science problems.


Recommended Books


Bibliography

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS4305</td>
<td>Artificial Intelligence</td>
<td>3(3+0)</td>
</tr>
</tbody>
</table>

**Prerequisites:** Programming Fundamentals, Discrete Structures

**Course Description:** Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and reacts like humans. This course introduces Artificial Intelligence. It covers the basics of modern AI as well as some of the representative applications of AI.


**Recommended Books**


**Bibliography**

Semester IV
Courses
Prerequisites: Data Structures and Algorithms

Course Description: Establish proficiency in the fundamental concepts of database systems and the database system development life cycle of an enterprise database. It discusses the theoretical foundations of database architecture, Relational Algebra and Relational calculus. This course also focuses on the principles, design and implementation of multi-user databases and its applications in client/server environment.

Aims and Objectives: When students successfully complete this course, they will be able to:
- Understand intricacies involved in the design and implementation of a database system.
- Have in-depth knowledge of entity-relationship (ER) modeling
- Demonstrate competence with the fundamental tasks involved in gathering and analyzing user requirements, build conceptual, logical, and physical data models that reflect the organization’s requirements.
- Apply normalization techniques.
- Query a relational DBMS to create and maintain databases in a client server environment.

Course Contents: Introduction to database systems, The Relational Data Model, Relational Algebra and Relational Calculus, Database environment, Database Management System, Conceptual database modeling using the entity-relationship model and Enhanced Entity-Relationship modeling, Schema quality through the study of functional dependencies and normalization, Logical and Physical Database Design, The SQL (DDL, DML, and DCL), Database application development, data integrity, constraints (entity integrity, referential integrity, domain integrity etc.), Database Transaction Management.

Recommended Books


Bibliography

**Course Code**: CS4402  
**Course Title**: Operating Systems  
**Credit Hours**: 4(3+1)

**Prerequisites**: Programming Fundamentals, Data Structure and Algorithms

**Course Description**: This course will introduce the core concepts of operating systems, such as processes and threads, scheduling, synchronization, memory management, file systems, input and output device management and security. The course will consist of assigned reading, weekly lectures, a midterm and final exam, and a sequence of programming assignments. The goal of the readings and lectures is to introduce the core concepts. The goal of the programming assignments is to give students some exposure to operating system code. Students are expected to read the assigned materials prior to each class, and to participate in in-class discussions.

**Aims and Objectives**: When students complete this course, they will be able to:
- To understand the services provided by and the design of an operating system.
- To understand what a process is and how processes are synchronized and scheduled.
- To understand different approaches to memory management.


**Recommended Books**


**Bibliography**


**Course Code**: CS4403  
**Course Title**: Computer Networks  
**Credit Hours**: 3(3+0)

**Prerequisites**: Data Communication

**Course Description**: This course familiarizes the students about the fundamental concepts of computer networks, its components and design. The main focus is on the data link, network and...
transport layers. The course discusses the design, working and different protocols working on these layers.

**Aims and Objectives:** When students complete this course, they will be able to:
- Understand the fundamental concepts of networking.
- Know different protocols and working.
- Identify the challenges involved in data flow and error control.


**Recommended Books**


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS4404</td>
<td>Theory of Automata</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Prerequisites:** Programming Fundamentals, Discrete Structures, Data Structures and Algorithms

**Course Description:** This course serves as an introduction to the basic theory of Computer Science and formal methods of computation. This course will present the theory of finite automata, as the first step towards learning advanced topics, such as compiler design. It will also enable the student to apply the concepts learned in fundamental courses such as Discrete Mathematics, in a theoretical setting; in particular, the application of proof techniques. The applications of finite automata towards text processing will be discussed. This course will also develop an understanding of computation through Turing Machines.

**Aims and Objectives:** Students successfully completing this course should be able to:
- Understand the working of computer at abstract level.
- Design software and some electronic circuits.
- Understand the basic theory behind computer languages.
- Have a sound background for Translator software.

**Course Contents:** Introduction to Language: Language as a set, string, string terminologies, alphabet, operations on languages (Union, Concatenation, Kleene Closure), Language Representation: Recursive Definition, Regular Expression (Basic Regular Expressions, Complex Regular Expressions using notational short hands), Grammars, Automata Introduction: What is Automata? Types of Automata, Parts of Automata, Determinism, Finite Automata (FA): Definition of FA, Elements of FA, Nondeterministic Finite Automata (NFA), Deterministic Finite Automata (DFA), Working of FA, Regular Expression to NFA conversion, NFA to DFA conversion, Minimization of number of states in a DFA, DFA coding in C language, Kleene’s Theorem: Transition Graph (TG), Generalized Transition Graph (GTG), Statement and Proof of Kleene’s Theorem, Finite Automata With output: Moore Machine, Mealy Machine, Moore=Mealy, Context Free Grammars: Definition, Derivation, Problems in Context Free Grammars (Ambiguity, Left Recursion, Common Prefixes), Methods for removal of these problems, Chomsky Normal Form (CNF), Pushdown Automata (PDA): Definition of PDA, Elements of PDA, Creation of PDA i.e. CFG=FA, Turing Machines: Definition of Turing Machines, Elements of Turing Machines, Creation of Turing Machines, Pumping Lemma.

**Recommended Books**


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<tr>
<th>Course Code</th>
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<th>Credit Hours</th>
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<tr>
<td>CS4405</td>
<td>Web Technologies</td>
<td>4(3+1)</td>
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</tbody>
</table>

**Prerequisites:** Fundamentals of Computers, Object Oriented Programming

**Course Description:** This course provides a detailed presentation and understanding of the basic concepts and principles of the World Wide Web and the essential web development languages, tools, and technologies. Course content will focus on introducing and familiarizing students with the basic tools required for web programming including HTML, CSS, JavaScript, and server-side programming using PHP. Questions such as what are they, when should we use these languages, for what purpose and to what extent these languages help us create modern, engaging and stable websites will be covered. Students will experience how to create basic web pages with HTML, including basic structuring of page content, apply basic formatting styles using CSS, understanding JavaScript for basic interactivity and client-side scripting, and create dynamic web pages by implementing server-side script to perform operations on a web server. A key part of this course is its problem-based approach which requires students to design and create a website of ever-increasing sophistication as the course progresses.
Aims and Objectives: When students complete this course, they will be able to:

- Know the fundamentals of web application architecture and web programming.
- Apply a structured approach to identifying needs, interests, and functionality of a website.
- Design dynamic websites that meet specified needs and interests.
- Write well-structured, easily maintained, standards-compliant, accessible HTML code.
- Write well-structured, easily maintained, standards-compliant CSS code to present HTML pages in different ways.
- Use JavaScript for client-side scripting and add dynamic content to pages.
- Use PHP to implement server-side script for creating dynamic web pages and access databases.
- Design and implement an interactive web site(s) with regard to issues of usability, accessibility, and internationalisation.
- Further study web technologies, both those that exist today and those that will be developed in the future.
- Work in collaborative environment by working in group assignments.


Recommended Books


Bibliography

Semester V
Courses
Course Code | Course Title | Credit Hours
---|---|---
CS5501 | Design and Analysis of Algorithms | 3(3+0)

**Prerequisites:** Programming Fundamentals, Data Structures and Algorithms

**Course Description:** This core course covers good principles of algorithm design, elementary analysis of algorithms, and fundamental data structures. The emphasis is on choosing appropriate data structures and designing correct and efficient algorithms to operate on these data structures.

**Aims and Objectives:** When students successfully complete this course, they will be able to:
- Understand how to design computer software.
- What can be the most efficient solution (algorithm) for the in hand problems.
- How a very time consuming task can be made very efficiently.
- How to utilize multiple cores of computer using parallelism.

**Course Contents:** Algorithm introduction, properties of correct algorithms, factors influencing the performance of algorithms (not in control of the programmer), of algorithms (in control of the programmer), Analysis of Algorithms: computational complexity, order of growth and runtime of an algorithm, T(n), some examples to calculate the T(n) of algorithms (including examples from searching and sorting), Asymptotic Notations, usefulness and limitations of the Asymptotic notation, Implementation of algorithms, rules for implementation, empirical analysis, Introduction to Generating functions, Divide and conquer approach: full exploration using examples, complete understanding of recursion, Basic Recurrences, Recurrence Solutions (e.g. using master theorem, iterative method, substitution method), Examples to calculate the T(n) of recursive algorithms, Dynamic programming, Greedy algorithms, Evolutionary Algorithms, Genetic Algorithms, Swarm Optimization Algorithms, Ant Colony Optimization Algorithms, Parallel Algorithms and Parallel Programming, Introduction to supercomputing.

**Recommended Books**


**Bibliography**

Prerequisites: Object Oriented Programming

Course Description: The course introduces the concepts and methods required for the development of large software intensive systems. The aim is to develop a broad understanding of the discipline of software engineering. The course focuses on the object-oriented approach for analysis and design. Students will understand the difference between writing programs and doing analysis and design. Problem analysis and solution design will be emphasized. Students will work in teams and will be responsible for analysis, design and implementation of a software system. Automated Software engineering tools will be introduced in several stages of the development process. It provides a brief account of associated professional and management issues.

Aims and Objectives: The course is designed to:
- Develop a working understanding of formal object-oriented analysis and design processes.
- Develop an understanding of the application of object oriented analysis and design practices from a software project management perspective.
- Provide details of software development and make students visualize software development process.
- Enable students to identify, formulate, and solve software development problems.
- Make students build object oriented analysis and design artifacts
- Introduce the techniques, skills, and modern engineering tools necessary for software engineering practice.

Course Contents: Software development life cycle (SDLC), Understanding large scale project perspective, Object Oriented Analysis and Development concepts. Analysis vs Object Oriented Analysis (OOA), Object Modeling, Object Modeling Technique (OMT), Unified Modeling Language (UML) for modeling, using UML modeling tools, OOA: Requirement gathering and development, Requirements categories FURPS+, Modeling and analyzing requirements, Analysis modeling (Scenarios, Use Case, User Stories). Requirement prioritization, verifying and validating requirements, Requirement specification, Object Oriented Design (OOD): Principles of OOD, SOLID (Single-responsibility Principle, Open-Closed Principle, Liskov Substitution Principle, Interface Segregation Principle, Dependency Inversion Principle), Identifying objects and entities, Designing Data Model (ERD), Relationships and associations. Mapping concepts, O/R Mapping, Shadow information and scaffolding, Mapping metadata, Mapping inheritance, Mapping object relationships, Mapping relational database relationships. UML modeling (structured and behavior diagrams. Concept of static, dynamic and functional model), Structural diagrams and use, Behavioral diagrams and use, User Interface (UI) design process, State machines, Architectural analysis, Architectural styles, Software implementation, Use of right tools for implementation, Selecting algorithms, Software testing:Test Case design, Levels of testing: Unit testing, Integration testing, Acceptance testing, Regression testing, Testing object-oriented systems, Use-case based testing, Class diagram based testing, Sequence diagram-based
testing, Writing and using basic unit tests, Concept of deployment and cutover, Basic deployment tasks.

**Recommended Books**


**Bibliography**


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<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS5503</td>
<td>Advanced Programming</td>
<td>4(3+1)</td>
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</table>

**Prerequisites:** Object Oriented Programming, Operating Systems

**Course Description:** This course comprises of advanced programming topics in the Java programming Language. This course builds on the earlier programming offered on Object Oriented Programming. Advanced concepts of program design, implementation and testing will be introduced within a framework of object oriented programming using the Java programming language.

**Aims and Objectives:** This course assumes that students know the basic concepts of Object Oriented Programming. When students complete this course, they will be able to:

- Create Java application using sound OOP practices.
- Create multi-threaded applications which can execute faster on current multi-core architectures.
- Create network and distributed applications.
- Create event driven Graphical User Interfaces (GUIs).
- Create Java applications connected to databases.
- Understand how Java can be used for Functional programming.

**Course Contents:** Java Platform, Java Virtual Machine and Portability, Classes and Object Creation in Java, OOP Concepts in Java, Data Encapsulation and Abstraction, Inheritance and Polymorphism, Abstract Classes and Interfaces in Java, Java Packages, Inner Classes and Usage, Accessing Private Members, Java Collections and Generics, Exception Handling and Importance, Throwing and Catching Exceptions, try-catch-finally Blocks, Threads and
Importance, Creating Threads, Starting Threads, Seep, Join, Priority, Daemon Threads, Thread Synchronization and Importance, Sharing Objects Between Threads and Race Conditions, Synchronized Methods and Synchronized Blocks, wait(), notify(), notifyall(), Explicit Locks for Synchronization, features in the Java Concurrent Package, Reading and Writing String Values from a File, Preserving Object State using Serialization, Network Programming, Java Sockets and the java.net package, TCP Based Programming, UDP Based Programming, Sending Objects Over the Network Using Serialization, Java Remote Method Invocation (RMI), Graphical User Interfaces (GUIs), Event Driven Programming and using it with GUIs, Java Database Connectivity (JDBC), Functional Programming and Importance, Lambdas, Data Streams in Java.

**Recommended Books**


**Bibliography**


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<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS5504</td>
<td>Information Security</td>
<td>3(3+0)</td>
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</table>

**Prerequisites:** Object Oriented Programming, Database Systems, Computer Networks, Web Technologies

**Course Description:** The protection of information assets underpins the commercial viability and profitability of all enterprises and the effectiveness of public sector organizations. It should not be left to chance. If you work in an organization concerned (directly or indirectly) with valuable information assets, this practical course will enable you to understand and manage strategic and operational aspects of information security, including IT governance and risk analysis and management. It will also provide the knowledge and skills needed to plan the implementation of an information security management system that provides efficient, effective safeguards and responds to your organization’s needs.

**Course Objectives:** When students complete this course, they will be able to:

1. Understand contemporary issues in information security management
2. Analyze and prioritize information security risks
3. Identify countermeasures and review techniques appropriate to the management of information security risks
4. Understand the policy and technology trade-offs involved in developing information security systems of adequate quality
5. Locate, read, comprehend and evaluate developments in the field as they appear in contemporary professional and research publications.

**Recommended Books**


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<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>BES-475</td>
<td>Geographic Information System</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Prerequisites:** Nil

**Course Description:** The course introduces the principles of Geographic Information System as tool for data collection and analysis.

**Aims and Objectives:** When students complete this course, they will be able to:
- Understand fundamental concepts and practices of Geographic Information Systems (GIS).
- Apply basic graphic and data visualization concepts.
• Demonstrate proficiency in the use of GIS tools to create maps that are fit-for-purpose and effectively convey the information they are intended to.
• Give examples of interdisciplinary applications of Geospatial Information Science and Technology.


Recommended Books

7. Luder D.R. Aerial Photographic Interpretation (Latest ed.).
8. Waless H.R. Introduction to Aerial Stereo-photographs (Latest ed.).
Semester VI
Courses
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS561</td>
<td>Computer Organization and Architecture</td>
<td>4(4+0)</td>
</tr>
</tbody>
</table>

Prerequisites: Digital Logic Design

Course Description: Modern computer technology requires an understanding of both hardware and software, as the interaction between the two offers a framework for mastering the fundamentals of computing. This course covers basics of modern computer organization and architectures. The emphasis is on understanding the interaction between computer hardware and software at various levels. The students will learn the concepts of computer technology, performance evaluation, instruction set design, computer arithmetic, data path and control unit design of processors and enhancing performance with pipelining.

Aims and Objectives: When students complete this course, they will be able to:
- Understand the underlying organization of modern computing systems.
- Understand microprocessor organization and architecture.
- Understand performance analysis and evaluation.
- Understand arithmetic logic unit and control unit implementations.
- Understand pipelined processor organization and hazards.
- Understand memory hierarchy and storage devices.
- Understand multiprocessors.

Course Contents: Computer Architecture and Importance for Computer Science Graduates, Instruction Set Architectures (ISA), Complex Instruction Set Computing (CISC), Reduced Instruction Set Computing (RISC), Operations of the Computer Hardware, Assembly Language, Registers, Data and Instruction Representation, Different Types of Instructions, Loops and IF Statements in Assembly, Supporting Procedures/Functions in Computer Hardware, Supporting Different Data Types in Hardware, Immediate and Addresses in Instructions, Compiling and Linking Processes to Convert a C/Java Program into Assembly and Converting that into Machine Code, Review of Number Systems, Signed and Unsigned Data Types, Arithmetic Operations (Subtraction, Multiplication, Division) in Hardware, Float Data Types and Arithmetic Operations on Float, Evaluating Performance of a System, Latency, Response Time, and Throughput, CPU Execution Time, Calculating CPU Execution Time for a Program, Benchmarks and Amdahl’s Law, Processor Design, Building a 32-bit ALU, Processor Data path, Designing a Processor to Execute Instructions and Include Control Unit, Pipelining and Hazards in Pipelining and Solutions, Memory Hierarchy, Caches, Measuring and Improving Cache Performance, Direct Mapped Cache, Fully Associative Caches and Cache Optimizations, Virtual Memory, Virtual Machines. Storage and other I/O topics, Multiprocessors, Multi-cores and Clusters.

Recommended Books

Bibliography


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<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS5602</td>
<td>Software Engineering</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Prerequisites:** Object Oriented Analysis and Design

**Course Description:** This course builds upon the concepts presented in Object Oriented Analysis and Design course. The students will be provided with more concise description of state of the art software process models and application of software engineering concepts as used in a professional software development environment. This course covers advanced theoretical concepts in software engineering and provides an extensive hands-on experience in dealing with various issues of software development. It involves a semester-long group software development project. Emphasis will be placed on agile software development methodologies for team development, quality assessment, and knowledge management in software engineering.

**Aims and Objectives:** After completing his course, the students will be able to:

- Use and apply different state of the art software development methodologies.
- Understand success and failure indicators, advantages, and disadvantages of different methodologies.
- Understand and apply agile software development through Extreme Programming methodology which focuses on human factor along with technical details of software development.
- Have a hands-on experience with a complete software development project simulating the industry like environment through practices of extreme programming methodology.


**Recommended Books**


**Bibliography**


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<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS5603</td>
<td>Mobile Applications Development</td>
<td>4(3+1)</td>
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</table>

**Prerequisites:** Programming Fundamentals, Object Oriented Programming

**Course Description:** This course introduces mobile applications programming. The goal of this course is to teach and train students how to design, implement, test, debug and publish smartphone applications on smartphone platforms, especially Android. Students will learn how to take their innovative ideas from conception to the apps market through a series of rigorous hands-on programming assignments and group projects. This is an introductory course aimed at undergraduate students, who have object oriented programming experience. However, there is a significant amount of programming in this course requiring a commitment on the part of the student. A key part of this course is group projects where students will work in small teams for joint problem solving.

**Aims and Objectives:** When students complete this course, they will be able to:

- Describe those aspects of mobile programming that make it unique from programming for other platforms.
- Critique mobile applications on their design pros and cons.
- Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces.
- Program mobile applications for the Android operating system that use basic and advanced phone features.
- Design, implement, test, debug and publish smartphone applications.
- Deploy applications to the Android marketplace for distribution.
- Create innovative and robust example mobile applications that will be valuable addition to their programming portfolio.
- Work in collaborative environments by working in group projects.

**Course Contents:** Android Platform and Architecture, Comparison of Android and Other Platforms, Configuring Development Environment, Activities, Services, Broadcast Receiver, Fragments, Intents, Designing Interface Using Views and Widgets, Linear Layout, Relative
Layout, Table Layout, ScrollView Layout, List View, Actionbar, Dialogs and Notification, Multi-threading, Location and Maps Services, Shared Preferences, Creating and Using Database, Content Providers, Accessing External Storage, Displaying Videos and Listing Audios Using Media Player, Accessing and Handling Sensors, Publishing and Deploying Applications on Android Market.

**Recommended Books**


**Bibliography**


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS5604</td>
<td>Human Computer Interaction</td>
<td>3(3+0)</td>
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</table>

**Prerequisites:** Fundamentals of Computers, Programming Fundamentals

**Description:** This course aims to give students some basic understanding of the area of Human Computer Interaction and introduces students to various methods and techniques that could be used to design and evaluate interactive systems.

**Aims and Objectives:** Students successfully completing this course should be able to:
- Demonstrate knowledge and understanding of the main concepts (conceptual model, metaphors, and paradigms) that influence human-computer interaction
- Understand to design, prototype and evaluate a user interface for an interactive system.
- Choose appropriate methods of evaluating an interactive system.

Recommended Books


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<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tr>
<td>CS5605</td>
<td>Applied Image Processing</td>
<td>3(2+1)</td>
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</table>

Prerequisites: Nil

Course Description: The course provides an opportunity to students to gain an insight into applied image processing. Students will implement image processing algorithms in MATLAB or other tools and complete a graduate level project.

Aims and Objectives: When students complete this course, they will be able to:

- Implement image processing algorithms in MATLAB or other appropriate tools.
- Gain familiarity with the practical aspects of the concepts and techniques in digital image processing.

Course Contents: Intensity Transformations, Linear and Nonlinear Spatial Filtering, Filtering in the Frequency Domain, Image Restoration and Registration, Color Image Processing, Wavelets, Image Data Compression, Morphological Image Processing, Image Segmentation, Regions and Boundary Representation and Description, and Object Recognition.

Recommended Books

Semester VII
Courses
Prerequisites: Nil

Course Description: This course introduces students to different aspects of technical writing in the context of academic writing for computer science.

Aims and Objectives: When students complete this course, they will be able to:

- Understand requirements of technical and academic writings in computer science.
- Have familiarity of different aspects of technical writing.
- Have improved technical writing skills.
- Have understanding of how to avoid informal language in academic writing.


Recommended Books

### Course Code
| BA565  | Entrepreneurship |

### Course Title
Entrepreneurship

### Credit Hours
3(3+0)

**Prerequisites:** Nil

**Course Description:** This course is designed to help students evaluate the business skills and commitment necessary to successfully operate an entrepreneurial venture and review the challenges and rewards of entrepreneurship. Students will learn about themselves, their decisions, and their goals to determine how entrepreneurship can play a role in their lives. Students will also be introduced to entrepreneurship from an economic perspective and the concepts of environmentally sustainable practices and social entrepreneurship.

**Aims and Objectives:** When students complete this course, they will be able to:
- Identify and assess sources of support for small businesses and entrepreneurs.
- Identify the critical factors that are used to identify business start-up ideas – including forms of ownership.
- Identify the financial, marketing, legal, human resource, operations, and general management skills that are necessary to successfully launch and operate a successful new venture.
- Identify the critical concepts of business planning.
- Increase the chances for business success.
- Seek out financing sources for start-ups.
- Discuss examples of current entrepreneurs.


**Recommended Books**


**Bibliography**

Seventh (7th) Semester Specializations Elective Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6703</td>
<td>Compiler Construction</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Specialization:** General Track

**Prerequisites:** Programming Fundamentals, Theory of Automata

**Course Description:** The course is intended to teach the students the basic techniques that underlie the practice of Compiler Construction. The course will introduce the theory and tools that can be employed in order to perform syntax-directed translation of a high-level programming language into an executable code. These techniques can also be employed in wider areas of application, whenever we need a syntax-directed analysis of symbolic expressions and languages and their translation into a lower-level description. They have multiple applications for man-machine interaction, including verification and program analysis. In addition to the exposition of techniques for compilation, the course will also discuss various aspects of the runtime environment into which the high-level code is translated. This will provide deeper insights into the more advanced semantics aspects of programming languages, such as recursion, dynamic memory allocation, types and their inferences, object orientation, concurrency and multi-threading.

**Aims & Course Objectives:** Students successfully completing this course should be able to:
- Understand programming language concepts deeply.
- Understand processing of programming languages by computers.
- Have full command on techniques used by Translator software.

Recommended Books


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS6704</td>
<td>E-Commerce Technologies &amp; Applications</td>
<td>3(3+0)</td>
</tr>
</tbody>
</table>

Specializations: General Track

Prerequisites: Fundamentals of Computers, Web Technologies

Course Description: This course will help students to learn about electronic commerce concepts, applications of electronic commerce, types of electronic commerce, how people, organization and industries take benefits from electronic commerce. role of electronic commerce in our daily life.

Aims and Objectives: When students complete this course, they will be able to:
- Understand electronic commerce transactions.
- Electronic e-commerce models.
- Business life cycle.
- Credit card, debit card and visa cards transactions.
- How to protect from Fraudulent activities on the web doing businesses.
- On-Line banking.
- To design and allow students to gain firsthand experience in studying and developing real-world systems for e-commerce.


Recommended Books


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CS6705</td>
<td>Expert Systems</td>
<td>3(3+0)</td>
</tr>
</tbody>
</table>

Specializations: Artificial Intelligence, Database Systems

Prerequisites: Artificial Intelligence


Recommended Books

Course Code: CS6706
Course Title: Introduction to Parallel Computing
Credit Hours: 3(3+0)

Specializations: General Track

Prerequisites: Advanced Programming, Computer Organization and Architecture

Course Description: Single processor systems have become obsolete and the future of computing is in Parallelism. This course is an introductory course on parallel computing. It covers both the hardware and software aspect of parallel computing along with a discussion on parallel algorithms.

Aims and Objectives: Students successfully completing this course should be able to:
- Understand the basic concepts of parallel computing.
- Understand the parallelism available at the hardware level.
- Understand how to design parallel algorithms and write simple parallel programs.


Recommended Books


Bibliography

Course Code: CS6721  
Course Title: Information Architecture  
Credit Hours: 3(3+0)

Specializations: Web Engineering, Database Systems, Software Engineering, General Track

Prerequisites: Web Technologies

Course Description: The post-AJAXian Web 2.0 world of wikis, folksonomies, and mashups makes well-planned information architecture even more essential. How to present large volumes of information to people who need to find what they're looking for quickly? This course will enable information architects, designers, and web site developers to build large-scale and maintainable web sites that are appealing and easy to navigate. This course will cover emerging technologies with recent examples, new scenarios, and information on best practices.

Aims and Objectives: When students complete this course, they will be able to:
- Understand the fundamental components of an architecture, illustrating the interconnected nature of these systems.
- Know about the latest concepts of the social web including Tagging, Folksonomies, Social Classification, and Guided Navigation.
- Understand the tools, techniques, and methods that takes from research to strategy and design to implementation.
- Series of short essays that provide practical tips and philosophical advice for those who work on information architecture.
- Business context of practicing and promoting information architecture, including recent lessons on how to handle enterprise architecture.
- Case studies on the evolution of large information architectures, illustrating best practices along the way.


Recommended Books

Course Code: CS6722  
Course Title: Web Content Management Systems  
Credit Hours: 3(2+1)

Specializations: Web Engineering, Database Systems, Software Engineering, General Track

Prerequisites: Web Technologies

Course Description: Advancement in information technologies, especially the in the area of World Wide Web (WWW) enabled companies and individuals to expend their businesses by developing attractive websites. In a rapidly changing world, the need for online publishers to keep up with the needs and expectations of their site visitors is paramount. Today, many web publishers use content management systems (CMS) to allow them to instantly and dynamically update web pages and properties as new content becomes available so that every visit to a site is engaging, informative, and meaningful. This course explores the use of the three most popular open source web-based content management systems—WordPress, Joomla, and Drupal—to create dynamic and flexible websites and landing pages. Students explore the fundamentals of planning dynamic websites, CMS database management, developing CSS-controlled site templates, and creating database-driven websites through the planning and creation of their own topic-based sites.

Aims and Objectives: When students complete this course, they will be able to:
- Introduce learners to the three most popular open source content management systems (CMS) in use on the web today, including WordPress, Drupal, and Joomla.
- Understand the difference between a CMS website, a static website, and websites using other server-side technologies.
- Understand the benefits of working with a server-side database and the power it brings to creating and managing websites.
- Compare and contrast the three most popular open source CMS.
- Create and deploy websites using CMS, including creating and editing content, adding functionality, and creating custom templates and themes.
- Understand ongoing maintenance considerations with CMS websites.
- Help in freelancing and outsourcing.


Recommended Books


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS6723</td>
<td>Web Engineering</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Specializations:** Web Engineering, Software Engineering, General Track

**Prerequisites:** Advanced Programming, Web Technologies, Software Engineering

**Course Description:** The World Wide Web has become a major delivery platform for information resources. Many applications continue to be developed in an ad-hoc way, contributing to problems of usability, maintainability, quality and reliability. Web Engineering introduces a structured methodology utilized in software engineering to web development projects. This course examines systematic, disciplined and quantifiable approaches to developing high-quality, reliable and usable web applications. The course addresses the concepts, methods, technologies, and techniques of developing Web sites that collect, organize and expose information resources.

**Aims and Objectives:** When students complete this course, they will be able to:
- Understand the concepts, principles and methods of Web engineering.
- Apply the principles, and methods of Web engineering to Web applications development.
- Analyze and design comprehensive systems for the creation, dissemination, storage, retrieval, and use of electronic records and documents.
- Learn techniques and evaluation metrics for ensuring the proper operability, maintenance and security of a web application.
- Apply the web engineering methodologies for web application development

Recommended Books


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CS6731</td>
<td>Routing and Switching</td>
<td>3(3+0)</td>
</tr>
</tbody>
</table>

**Specializations:** Computer Networks, General Track

**Prerequisites:** Computer Networks

**Course Description:** This course is a study of Routing and Switching fundamentals, and how the Internet is integrated into the computing environment to enable organizations to share resources, collaborate, and meet organizational goals. In the Computer Networks essentials and the creation of simple Local Area Networks (LANs) introduced, Networking Technologies, are expanded upon to incorporate the linking of these simple networks to each other and to the Internet, to create an internetwork. Routing and Switching devices such as switches and routers will be examined in great detail. Students will focus on techniques to analyze, plan, and manage an enterprise network. In support of these techniques, lab activities will include sub-netting, packet-sniffing, and switch and router configuration.

**Aims and Objectives:** When students complete this course, they will be able to:
- Configure and subdivide an IP network.
- Use advanced routing concepts such as CIDR, summarization, and VLSM.
- Identify the differences between IPv4 and IPv6 5.
- Configure a router dealing with modes, prompts, passwords, context-sensitive help, and enhanced editing feature.
- Configure HyperTerminal to access routers and switches.
- Manipulate the router boot process.
- Use Cisco Discovery Protocol.


Recommended Books


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6732</td>
<td>Internet of Things</td>
<td>3(3+0)</td>
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</table>

Specializations: Computer Networks, General Track

Prerequisites: Programming Fundamentals, Computer Networks

Course Description: The module is designed to provide students with a solid technical introduction to the Internet of Things (IoT). The course is broadly divided into two parts, namely development at the edge and development in the cloud. A systems engineering approach is adopted reviewing the key technologies employed at different levels of the IoT stack and how they are integrated to form complete IoT systems.

Aims and Objectives: When students complete this course, they will be able to:
- To introduce students to the concepts underlying the Internet of Things (IoT).
- To provide overview list of popular protocols and standards helping power IoT devices, apps and applications.
- To introduce devices including sensors, low power processors, hubs/gateways and cloud computing platforms.

Course Contents: Introduction to IOT and Importance, Elements of IoT Ecosystem, Technology Drivers, Business Drivers, Typical IoT Applications, IoT Protocols and Development Platforms (Arduino, Raspberry Pi, Particle Core, Electric Imp, Pinoccio), Advantages and Disadvantages, Fast, Reliable, Lightweight and Bidirectional Characteristics of IoT Protocols, Protocols such as HTTP, Web sockets and Message Queuing Telemetry Transport (MQTT) Protocols in addition to Nano IP, Content Centric Networking (CCN), Time Synchronized Mesh

**Recommended Books**


<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6733</td>
<td>Network Programming</td>
<td>3(3+0)</td>
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</table>

**Specializations:** Computer Networks, General Track

**Prerequisite:** Computer Networks, Advanced programming

**Course Description:** This course focuses on the network programming. This course will help understand the students about all the networking concepts, their working and applications.

**Aims and Objectives:** When students complete this course, they will be able to:
- Analyse the requirements of a networked programming environment and identify the issues to be solved.
- Create conceptual solutions to those issues and implement a programming solution.
- Understand the key protocols that support the Internet.
- Apply several common programming interfaces to network communication.
- Understand the use of TCP/UDP Sockets.


Recommended Books


<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6734</td>
<td>Wireless and Mobile Networks</td>
<td>3(3+0)</td>
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</table>

Specializations: Computer Networks, General Track

Prerequisites: Computer Networks

Course Description: Wireless and mobile networking is one of the fastest growing segments of the computer industry. Wireless network has been around for many years and it has already started to dominate the wired network. This course is focused on the introduction and fundamental concepts about wireless and mobile networks. Students will be able to understand how wireless standards and protocols are developed. Furthermore, students will be exposed to the history and future trends in wireless and mobile technologies.

Aims and Objectives: When students complete this course, they will be able to:

- The fundamental concepts about the wireless and mobile networks.
- The techniques in the design and operation of wireless networks.
- Students will be able to survey the breadth of wireless and mobile devices and protocols in commercial use today.
- The students will be familiar with the wireless networks, its configuration and use.

Strategies, Handoff Strategies, co-channel Interference and System Capacity, Trunking and
Grade of Service, Mobile Network Generations (1G, 2G, 3G, 4G and 5G Concepts), Wireless
Local Area Networks (WLANs), 802.11 Networks and Versions (802.11 a, b, g, n), ad-hoc
Wireless Personal Area Networks (WPANs), Bluetooth Standard 802.15 and Version, Infrared
Communication, Femtocells, Multi-hop Relay Networks, Wireless Mesh Networks,
Homogeneous and Heterogeneous Networks, Integration and Challenges, Coordinated
Multipoint (CoMP) and Cooperative Communication Concepts and Advantages.

Recommended Books

   Prentice Hall.

Bibliography


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<tr>
<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6741</td>
<td>Advanced Database Systems</td>
<td>3(3+0)</td>
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</table>

Prerequisites: Database Systems, Software Engineering, General Track

Course Description: This course is designed for the students seeking career in database
designing to master some of the advanced concepts of database systems.

Aims and Objectives: When students complete this course, they will be able to:

- Understanding of advanced concepts in database systems.
- Discuss and evaluate methods of storing, managing and interrogating complex data.
- Explain and evaluate the fundamental theories and requirements that influence the design
  of modern database systems.

Course Contents: Advanced Normalization, Multi-Valued Functional Dependency, Database
Security, Possible threats to database, Computer-Based Counter Measures, Authorization and
Authentication, Access Controls, Backup and Recovery, Views, Integrity Constraints,
Encryption, RAID, Database Concurrency, Transactions and Its ACID Properties, Anomalies
due to concurrent execution of transaction and Concurrency Control, Serializability, Lock-Based
Concurrency Control, handling Deadlocks in concurrency, Time-Stamping technique for
concurrency control, Optimistic Methods, Granularity of Data Items, Database Recovery,
Transactions and Recovery, Recovery Facilities (Backup, Log File, Check-Pointing), Recovery
Protocols, Deferred Updates, Immediate Updates, Shadow Paging, Query Optimization
Techniques (Join Ordering, Nested Query Planning, Cost Estimation), Distributed Databases, DDBMS, Homogeneous vs. Heterogeneous DDBMS, Distribution Transparencies, Distributed Database Design, Data allocation, Fragmentation, Object Oriented Database and OODBMS, Comparison of OO Data Modeling vs. Conceptual Data Modeling

Text Book


Bibliography


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<th>Course Code</th>
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<tr>
<td>CS6742</td>
<td>Fundamentals of Data Warehousing</td>
<td>3(3+0)</td>
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</table>

Specializations: Database Systems, General Track

Prerequisites: Database Systems

Course Description: The primary focus of this course is on the basic concept of Data Warehousing. The course concentrates on topics like: Planning and requirements gathering for data warehousing, data warehouse architecture, dimensional model design for data warehousing, extracting, transforming, and loading strategies.

Aims and Objectives: Students successfully completing this course should be able to:
- Overview of a data warehouse development project, and identify key factors in the success or failure of such projects.
- Identify key data warehousing products, services, tools and consultancy requirements.
- Implement key features of a data warehouse within popular relational DBMSs.

Course Contents: Introduction to Data Warehousing and Decision-Support Systems, Operational vs Informational Systems, online transaction processing (OLTP) and online analytical processing (OLAP), Data Warehouses and Data Marts, Building Blocks and Components of Data warehousing, requirements and planning, requirements gathering methods

**Recommended Books**


<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tr>
<td>CS6751</td>
<td>Usability Engineering</td>
<td>3(3+0)</td>
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</table>

**Specializations:** Software Engineering, Web Engineering, General Track

**Prerequisites:** Nil

**Course Description:** Usability engineering is integral to the design process of an individual software product or service in terms of how the end-users perceive and use that product or design. The objective of this course is to provide students an advanced understanding of the role of usability engineering in the software design process. The students will also have practical experience with tools and methods that are used as part of the usability engineering process.

**Aims and Objectives:** After completing the course, students should be able to:
- Understand the concept of usability engineering and its importance in software development.
- Learn the concept and apply techniques of usability engineering.

**Course Contents:** Usability Definitions, Justification for Usability, User Centered Design, Interaction Design, Users, Tasks, Usability Engineering, Interface Evaluation, Usability Methods, Usability Testing, Usability Data Analysis and Reporting, User Experience.

**Text Book**

Bibliography


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<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6752</td>
<td>Computer Aided Software Engineering</td>
<td>3(3+0)</td>
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</table>

**Specializations:** Software Engineering, General Track

**Prerequisites:** Advanced Programming, Software Engineering

**Course Description:** This course provides an overview of the professional development environment which accommodates different automation tools for different phases in a development process. CASE (*computer-aided software engineering*) is the use of a computer-assisted method to organize and control the development of software. The course puts emphasis on using a complete automated development environment including project management, team management, testing and build.

**Aims and Objectives:** After completing the course, students should be able to:
- Understand different perspectives for CASE tools classification.
- Understand the cost of using and building CASE tools.
- Use different CASE tools for each software development phase.
- Compare and contrast the fitness of existing CASE Tools to the needs of specific software development context.

**Course Contents:** Setting up a proper development environment, development environment vs staging, vs. production environment, need for a staging environment, concept of staging database, release management, sandbox, Fundamentals of project management, team management, source code management, configuration management and revision control, Development IDEs, Automated Testing, source code integration and continuous integration, automated build and deployment.

**Recommended Books**


**Bibliography**


<table>
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<th>Course Code</th>
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<tbody>
<tr>
<td>CS6753</td>
<td>Software Architecture and Design</td>
<td>3(3+0)</td>
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</tbody>
</table>

**Specializations:** Software Engineering, General Track

**Prerequisites:** Software Engineering

**Course Description:** To understand the importance of architecture in software development and to introduce general guidelines for software architecture design and quality requirements.

**Aims and Objectives:** When students complete this course, they will be able to:
- Understand fundamentals of software architecture.
- Understand quality requirements of a software system.
- Understand fundamental principles and guidelines for software architecture design, architectural styles, patterns, and frameworks.
- Understand software architecture design and evaluation processes.

**Course Contents:** Introduction to the fundamentals of software architecture, Software architecture and quality requirements of a software system, Fundamental principles and guidelines for software architecture design, architectural styles, patterns, and frameworks, Methods, techniques, and tools for describing software architecture and documenting design rationale, Software architecture design and evaluation processes, Future challenges and emerging trends in software architecture discipline.

**Recommended Books**


**Bibliography**

Course Code: CS6761  
Course Title: Natural Computation  
Credit Hours: 3(3+0)

Specializations: Pattern Recognition, Database Systems, General Track

Prerequisites: Data Structures and Algorithms, Artificial Intelligence

Course Description: The aim of the course is to acquaint students with problems in search and optimization and give them a basic knowledge of the computational techniques used to solve such problems. The course focuses on heuristic methods and covers a spectrum of such methods including both population-based and single evolution method. The course aims to provide students working knowledge of GA, ACO, PSO, and other techniques for solving computationally hard problems. The objective is to enable students to apply the heuristic framework to practical problems.

Aims and Objectives: Upon completing this course,
- Students will have knowledge of search and optimization problems and their complexity, and the computational technique to solve them.
- They will understand the working of the heuristic methods and be able apply them to known optimization problems in resource allocation, routing, etc.

Course Contents: Search and optimization problem; Heuristic methods for search and optimization: local versus global search, single-evolution versus population based methods, hybrid and mimetic methods; Tabu search (TS); Simulated annealing (SA); reactive search optimization; Genetic Algorithms (GA): selection, recombination, and mutation, fitness and objective function, inversion, replacement, and other operators, crowding, niching, island, and cellular models, the schema theorem; Ant Colony Optimization (ACO); Particle Swarm Optimization (PSO); Differential evolution; DNA computing; hybrid algorithms, mimetic algorithms, and pareto-optimization; application to travelling salesman, hub location, bin-packing, routing, and other problems.

Recommended Books

**Course Code**: CS6762  
**Course Title**: Introduction to Neural Networks  
**Credit Hours**: 3(3+0)

**Specializations**: Pattern Recognition, Database Systems, General Track

**Prerequisites**: Data Structures and Algorithms, Advanced Programming, Calculus and Analytical Geometry, Linear Algebra, Probability and Statistics

**Course Description**: This is a preliminary course in neural networks. The aim of the course is to introduce students to learning and pattern recognition techniques based on the neural network model. Learning objectives include enabling students to gain a knowledge of basic NN models based on single and multilayer perceptrons. Concept of self-organizing systems and competitive learning are introduced through the example of SOMs.

**Aims and Objectives**: When students complete this course, they will be able to:
- Implement neural networks based on single and multi-perceptron models and apply the models to the recognition and learning problems. Furthermore, they will have the basic knowledge to study the topic of NNs at advanced levels.

**Course Contents**: Human brain, models of a neuron, neural network architecture, knowledge representation, the learning process, hebbian learning, memory-based learning, competitive learning, Btzaman learning, memory, adaption, statistical learning theory; Single-layer perceptrons: adaptive filtering problems, unconstrained optimization techniques, linear least square filters, least-mean square algorithms, learning curves, learning rate annealing techniques, perceptron, perceptron convergence theorem; Multi-layer perceptron: back-propagation algorithm, XOR problem, feature detection, back-propagation and differentiation, strengths and limitations of back-propagation; Self-organizing maps: feature-mapping models, the SOM algorithm, properties of feature map.

**Recommended Books**

Semester VIII
Courses
Prerequisites: Artificial Intelligence

Course Description: This course covers the introduction to Natural language Processing. Natural language processing (NLP) is a field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages and, in particular, concerned with programming computers to fruitfully process large natural language corpora.


Recommended Books


Prerequisites: Nil

Course Description: The aim of this module is to help students develop an understanding of the fundamental professional, ethical, and legal issues and how they are being developed and applied.

Aims and Objective: When students complete this course, they will be able to:
- Understand the concepts of key, ethical, managerial and legal issues typically encountered by an IT professional.
- Identify, access and critically review appropriate and relevant literature drawn from academic, technical, legal, professional business sources.
- Evaluate and critically reflect upon self-presentation.
- Work with others.

**Course Contents:** Historical, Social, and Economic Context of Computing (Software Engineering, Computer Science, Information Technology); Definitions of Computing (Software Engineering, Computer Science, Information Technology), Subject Areas and Professional Activities, Professional Societies, Professional Ethics, Professional Competency and Life-long Learning, Uses and Misuses, and Risks of Software, Information Security and Privacy, Business Practices and Economics of Software, Intellectual Property and Software Law (Cyber Law), Social Responsibilities, Software Related Contracts, Software House Organization.

**Recommended Books**


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**Eighth (8th) Semester Specializations Elective Courses**

<table>
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<th>Course Code</th>
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<tr>
<td>CS6804</td>
<td>Computer Graphics and Imaging</td>
<td>3(2+1)</td>
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</tbody>
</table>

**Specialization:** General Track, Pattern Recognition

**Prerequisites:** Linear Algebra, Object Oriented Programming

**Course Description:** This is a beginning course in computer graphics and imaging. The focus is on computational geometry, animation, and simulation. Various issues in graphics and imaging are discussed and mathematical concepts to model and deal with them are introduced.

**Aims and Objectives:** After completing this course:
- Students will have knowledge of the issues and solutions in computer graphics and will be able to handle such graphing tasks such as designing interactive video games and games for mobile devices.

**Course Content:** Creating Images with OpenGL, Mathematical Concepts: Triangles, Normals, Interpolation. Concept of Light and Color and Impact on Display and Printer, Scanline Rendering, OpenGL Pipeline, Triangles, Rasterization, Transformations, Shading, Triangle

**Recommended Books**


**Referene Books**


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<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6805</td>
<td>Numerical Computing</td>
<td>3(2+1)</td>
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</tbody>
</table>

**Specialization:** General Track

**Prerequisites:** Calculus and analytic Geometry, Multivariate Calculus, Linear Algebra.

**Course Description:** The course introduces numerical computational methods for various mathematical operations. Numerical techniques for computing integrals, performing differentiation, and solving linear and non-linear equations are covered.

**Aims and Objectives:** After covering this course:
- Students will be able to implement different numerical computational techniques and think of their applications in computer science.

Recommended Books


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CS6806</td>
<td>Digital Image Processing</td>
<td>3(3+0)</td>
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</tbody>
</table>

Specializations: Pattern Recognition, General Track

Prerequisites: Calculus and Analytical Geometry, Linear Algebra, Artificial Intelligence

Course Description: This is an introductory course in digital image processing. The course covers preliminary topics in DIP with emphasis on the mathematics for image processing and enhancement, filtering, segmentation, and restoration issues image processing. The aim is to enable students gain familiarity with digital image processing problems, techniques, and methods.

Aims and Objectives: After completing this course,
- Students would have a basic understanding of the issues involved in image processing and the approaches, algorithms, and tools used to solve them.
- Students are able to compare and evaluate different approaches, and think about alternate solutions.
- Students are able to apply existing techniques to practical problems and undertake an undergrad level project in the area of image processing.

Course Contents: Introduction to Digital Image Processing (DIP); Fundamentals of Digital Image: visual perception, light and electromagnetic spectrum, sensing and acquisition, sampling and quantization, basic relationships between pixels, mathematical tools for digital image processing; Transformation and spatial filtering in spatial and frequency domain: smoothing and filtering, combining spatial enhancement methods, selective filtering; Image restoration and reconstruction: restoration by spatial and frequency domain filtering, linear position invariant degradations, estimation of the degradation function, Wiener, least-squares, and mean filters, image reconstruction from projections; Image segmentation: point, line, and edge detection, thresholding, region based segmentation, and the use of motion in segmentation.

Recommended Books


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<tbody>
<tr>
<td>CS6807</td>
<td>Telecommunication Systems</td>
<td>3(3+0)</td>
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</table>

**Specializations:** Computer Networks, General Track

**Prerequisites:** Computer Networks

**Course Description:** This course will focus on theoretical frameworks and fundamental concepts behind the design and analysis of telecommunication networks (voice and data). Various algorithmic and optimization techniques used for efficient functioning of modern telecommunication networks will be taught.

**Aims and Objectives:** When students complete this course, they will be able to:

- Basic components of telecommunication systems.
- The challenges involved in guaranteeing QoS in telecommunication system.
- Different algorithms and processes involved in the design and management of telecommunication system.


**Recommended Books**


**Bibliography**


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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>CS6808</td>
<td>Network Security</td>
<td>3(3+0)</td>
</tr>
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</table>

**Specializations:** Computer Networks, General Track

**Prerequisites:** Data Communication, Computer Networks

**Course Description:** This course helps students to learn about cryptography, network security, the need to protect computer networks from unauthorized users and to exercise personal freedom on the network.

**Aims and Objectives:** When students complete this course, they will be able to:

- Understand network security.
- Services of network security.
- Types of techniques used for network security.
- Secret key cryptography and public key cryptography.
- Message authentication codes.
- Firewalls and protections of sensitive information.

Recommended Books


<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CS6809</td>
<td>Introduction to Bioinformatics</td>
<td>3(3+0)</td>
</tr>
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</table>

Specializations: General Track, Database Systems, Software Engineering

Prerequisites: Nil

Course Description: This course introduces the emerging area of Bioinformatics. This is a cross disciplinary course which highlights the main computational processes related to Biology.

Aims and Objectives: When students complete this course, they will be able to:
- Receive an introduction and historical perspective to the field of bioinformatics
- Learn the key methods and tools used in bioinformatics
- Build a solid foundation and acquire the vocabulary in bioinformatics for further research

Course Contents: Origin of the Field, Advances in Biology and Computers, Brief Overview of Key Biological Concepts Related to DNA, RNA, Nucleotides, Amino Acids, Proteins, Protein Interaction, Databases and Web Resources, How to Write Algorithms, Calculate Complexities, Nucleotide Analysis Principals and Tools, Sequence Similarity, Dot Matrix, Dynamic Programming for Local, Global Pair Wise Alignment Using Smith-Waterman and Needle-Wunsch Algorithms, GAP Penalties Including Affine GAP Penalty, Scoring and Substitution Matrices (PAM & BLOSUM), Multiple Sequence Alignment, BLAST and FASTA, Dynamic Programming Algorithms, Statistical Models, Artificial Intelligence Algorithms, Protein Analysis Including Protein Structure Prediction from a Sequence, Phylogenetics, Mutations, Evolution and Protein Families, Clustering, Predictions Using Distance Methods (such as UPGMA etc.).

Recommended Books

1. Attwood, T. K., & Parry-Smith, D. J. *Introduction to Bioinformatics (Latest ed.)*. Pearson Education
Course Code | Course Title | Credit Hours
---|---|---
CS6810 | Differential Equations | 3(3+0)

**Specializations:** General Track

**Prerequisites:** Calculus and Analytic Geometry

**Course Description:** This is a first course in differential equations. The focus is on the geometric interpretation and solution of ordinary differential equations and their application in mathematical modeling in various fields.

**Aims and Objectives:** The course will enable students to:
- Interpret and solve differential equations of the first order and think of their use in modelling and problem-solving in computer science.


**Recommended Books**

Specializations: Web Engineering, Database Systems, Software Engineering, General Track

Prerequisites: Linear Algebra, Probability and Statistics, Advanced Programming, Web Technologies

Course Description: The plethora of information and content available on the public Internet wrought forth a boom in the early 2000s in the area of web search engines. Companies such as Alta Vista, Excite, and Yahoo were the players, and the game had ambitious objectives for all the unknown web pages that existed in cyberspace: (1) locate them in some fashion (through links, through guessing, etc.); (2) obtain the content from those pages; and (3) make that content available to users who enter in a few search terms into an input box on a web page. This is an introductory course for students covering the practices, issues, and theoretical foundations of organizing and analyzing information and information content for the purpose of providing intellectual access to textual and non-textual information resources. This course will introduce students to the principles of information retrieval and search engines systems. It will cover algorithms, design, and implementation of modern information retrieval systems. Topics include: retrieval system design and implementation, text analysis techniques, retrieval models (e.g., Boolean, vector space, probabilistic, and learning-based methods), search evaluation, retrieval feedback, search log mining, and applications in web information management.

Aims and Objectives: When students complete this course, they will be able to:
- Understand the basics and core concepts of information retrieval especially web search engines.
- Give an account of the structure of a web search engine.
- Learn to process, index, retrieve, and analyze textual data.
- Learn to evaluate information retrieval systems.
- Learn about web search, crawling and link analysis.
- Build working systems that help users find useful information on the Web.
- Learn about the state of the art in information retrieval research.

Recommended Books


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<tr>
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<tbody>
<tr>
<td>CS6822</td>
<td>Service Oriented Architecture</td>
<td>3(3+0)</td>
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Specializations: Web Engineering, Software Engineering, General Track

Prerequisites: Web Technologies, Advanced Programming

Course Description: In the past, organizations have adopted computer applications to improve and automate their business processes. These applications have not been implemented according to a strategic plan or based on a common integrated IT infrastructure. Instead, it was based on the needs of each individual department of the company and always according to current technologies. Thus, most organizations have developed information infrastructures consisting of a set of autonomous and in many cases heterogeneous systems. As a result, the need for automated and integrated business processes has increased over the years but organizations were unable to build an integrated IT infrastructure as heterogeneous applications have had several connection problems. In recent years, Service Oriented Architectures (SOA) and technologies are widely used to help organizations overcome these problems. This course focuses on service-oriented architectural model and the service-orientation design paradigm. It will describe Service Oriented Architecture (SOA) concepts and principles, as well as quality considerations for developing modern software systems from a technical and organizational perspective. Specifically, the course will cover principles of SOA design and SOA design patterns. Furthermore, this course covers a wide-range of technologies for gaining the skills to design, build, and maintain a Service-Oriented Architecture (SOA).

Aims and Objectives: When students complete this course, they will be able to:
- Understand the main concepts and principles of SOA.
- Understanding of the strengths and weaknesses of SOA.
- Understand SOA challenges mainly regarding security, governance, testing, and maintenance.
- Implement and deploy simple web services using a suitable development platform.

Recommended Books


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<tr>
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<th>Course Title</th>
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<tr>
<td>CS6823</td>
<td>Wearable Technology</td>
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</table>

Specializations: Web Engineering, General Track

Prerequisites: Mobile Applications Development

Course Description: This course invites students to examine the wearable technologies that are just starting to become part of our everyday lives. Wearables live on our wrists, attached to our eyeglasses, and embedded in our clothes. Wearable technologies field has been experiencing explosive growth with exciting applications in the fields of medicine, sports, fitness, entertainment, as well as new ways for people to interact, communicate, and experience the environment around them. This course gives an overview of ecosystem and current and future prospects of the wearable technologies, study the technology building blocks that empower wearable computing, master mobile programming skills for wearable devices, and turn creative ideas into innovative wearable products. It also introduces the basic open-source hardware and software platforms to provide elementary but insightful techniques for students to start their own projects. Through the introduction of wearable technology, the course aims at inspiring students’ creativities and interests in generating innovative designs for future wearables systems. This is a agile course which will focus on new and emerging technologies. The individual topics may change if there is a significant new technology available at the start of the course.

Aims and Objectives: When students complete this course, they will be able to:

- Understanding and insight knowledge of wearable technologies and a wide range of cutting-edge projects in the related fields.
- Learn different aspects and issues of using wearable gadgets for solving different daily life problems.
• Learn the basics and differences of a wide range of wearable APIs and SDKs.
• Designing and creating of their projects in the field of wearable technology.
• Implement and deploy simple Android applications for suitable wearable devices.


Recommended Books


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<tr>
<td>CS6831</td>
<td>Emerging Computer Networks</td>
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</table>

Specializations: Computer Networks, General Track

Prerequisites: Wireless and Mobile Networks

Course Description: This course focuses on the advance topics in the area of computer networks. The course consists of both a reading/lecture/discussion component and a project component. The focus will be on the existing technologies in addition to why some of them are not sufficient due to lack of support in technology or changes in fundamental assumptions.

Aims and Objectives: When students complete this course, they will be able to:
• Comparison of current network technologies with futuristic technologies.
• Understanding the requirements of future in relation with connectivity and communication.
• Effective utilization of network resources in comparison of physical and virtual environment.
• Understanding High speed data networks such as 5G and millimetre wave.

Recommended Books


Bibliography


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<td>Network Administration</td>
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</table>

Specializations: Computer Networks, General Track

Prerequisite: Computer Networks

Course Description: The focus of this course is to manage the local area network under different network operating systems.

Aims and Objectives: When students complete this course, they will be able to:
- Creating and designing a computer network.
- Managing computer networks under different network operating systems.
- Troubleshooting for any network related issues.


Recommended Books


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<td>CS6841</td>
<td>Big Data Concepts</td>
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</table>

**Specializations**: Database Systems, Software Engineering, General Track

**Prerequisites**: Database Systems

**Course Description**: This introductory course in big data helps you understand concepts and issues related to big data systems. Big data consists of very large or complex data sets that cannot adequately be stored, processed or analyzed through traditional, relational database technologies. It also includes a wide variety of data types and high-velocity data streams. You gain an understanding of the concepts and issues related to designing and using big data systems.

**Aims and Objectives**: Students successfully completing this course should be able to understand:

- What Big Data is?
- The components necessary to build a Big Data environment.
- Map-Reduce Programming Paradigm.
- The Hadoop ecosystem.

**Course Contents**: Introduction to the Big Data and its problems, Big data and its impacts, Current challenges, trends, and applications, Management of unstructured and structured data, Distributed computing and distributed infrastructure. Introduction to large scale file systems, operations and parallel processing algorithms. Technologies for Big Data management, Big Data
technology and tools, Cloud and Big Data, Operational Databases (relational and non-relational databases, key value pair database, document database, graph database) special consideration made to the Map-Reduce paradigm and the Hadoop ecosystem.

Recommended Books


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<tr>
<td>CS6842</td>
<td>Database Administration</td>
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</tbody>
</table>

Specializations: Database Systems, General Track

Prerequisites: Database Systems

Course Description: Establish expertise in fundamental concepts of Database Administration. This course concentrates on the principles, rules, techniques, tools used in a Database administration.

Aims and Objectives: Students successfully completing this course should be able to:
- Understand SQL queries of a database system.
- Have in-depth knowledge of RDBMS and Database architecture.
- Strong concept of managing memory areas, performance and tuning of database.
- Apply backup and recovery techniques.

Recommended Books


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<tr>
<td>CS6843</td>
<td>ETL (Extract, Transform, Load) Programming</td>
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</table>

**Specializations:** Database Systems, General Track

**Prerequisites:** Nil

**Course Description:** This course focuses on ETL solutions. The designed audience should have adequate SQL programming skills and basic data warehouse concept. This course covers the core components of ETL architecture.

**Aims and Objectives:** Upon completion of this course, the audience should be able to:
- Understand Power Centre core components and how data flow through each component.

**Course Contents:** Basic ETL and data warehouse concept, connectivity from/to different types of data source/target, mapping specification and mapping development, creating and running workflow and session, using repository to copy/deploy/maintain ETL codes, debugging mapping, checking log files and finding performance bottleneck, illustrating the best practices of designing ETL solution, Architecture, Administrator’s Components of an ETL tool, working with source/target, running and monitoring job execution, Transformations: Source Qualifier, Expression, Filter, Lookup, Router, Update Strategy, Sequence Generator, Normalizer, Other Transformations, Debugging A Mapping: Error Logging, Check Log Files, Debug Step by Step, Reusing/Sharing Designer Objects: Reusable Transformation, Maplet, Advanced Designer Topic: Slowly-Changing Dimension, Dynamic Lookup, Mapping Parameter and Variable, Foreign-Key Based Loading, Understand Mapping Specification, Advanced Workflow Manager Topic: Parameter File, Worklet, Control Task, Command Task, E-mail Task, Event Raise/Wait Task, Code Promotion

**Recommended Books**

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>CS6851</td>
<td>Software Project Management</td>
<td>3(3+0)</td>
</tr>
</tbody>
</table>

**Specializations:** Software Engineering, Database Systems, General Track

**Prerequisites:** Software Engineering

**Course Description:** This course describes the key aspects of a software project and project management. The focus is placed on project management knowledge areas and associated processes as described by Project Management Institute (PMI).

**Aims and Objectives:** After completing the course, students should be able to:
- Identify organizational influences and project life cycle.
- Work with project management processes.
- Initiate and plan a project.
- Plan for project time management.
- Plan project budget, quality, and communications.
- Plan for risk, procurements, and stakeholder management.
- Execute a project and manage project work, scope, schedules, and cost.
- Control a project and close a project.


**Recommended Books**


**Bibliography**

**Course Code**: CS6822  
**Course Title**: Software Testing  
**Credit Hours**: 3(3+0)

**Specializations**: Software Engineering, General Track

**Prerequisites**: Advanced Programming, Software Engineering

**Course Description**: This course presents theory and practice of software testing. It covers structural testing including such topics as syntax testing, mutation testing, tools for software testing, testing specifications, black-box and white-box testing, code inspections, metrics, usability testing, testing documentation, website testing, security testing, beta testing, quality assurance, and software safety.

**Aims and Objectives**: After completing the course, students should be able to:
- Understand the concepts and theory related to software testing.
- Understand different testing techniques used in designing test plans, developing test suites, and evaluating test suite coverage.
- Understand the relationship between black-box and white-box testing and know how to apply as appropriate.
- Learn to use automated testing tools in order to measure code coverage.
- Understand how software developers can integrate a testing framework into code development in order to incrementally develop and test code.


**Recommended Books**


**Bibliography**:

Course Code | Course Title | Credit Hours
---|---|---
CS6853 | Open Source Development | 3(3+0)

Specializations: Software Engineering, Web Engineering, General Track

Prerequisites: Software Engineering, Object Oriented Analysis and Design, Advance Programming

Course Description: The course introduces concepts, principles and applications of open source software. Discusses open source software development process. Cover economy, business, and societal and intellectual property aspects of open source software.

Aims and Objectives: Upon successful completion of the course the student will be able to:
- Understand concepts, strategies, and methodologies related to open source software development.
- Understand the business, economy, societal and intellectual property issues of open source software.
- Be familiar with open source software products and development tools currently available on the market.

Course Contents: The origins of the Open Source approach, The Open Source Definition, licenses (MPL, GPL, LGPL, etc.) and their effects; Contrasting and comparing open source vs. traditional development methodologies, a comparison of the Free Software Foundation and the Open Source community; a comparison of Open Source software and proprietary software; benefits, costs, risks; current issues and challenges, Open Source project management tools, Source code management and revision control, the Concurrent Versions System, problem reporting, clearing houses, groupware; major Open Source applications/projects: e.g. office suites, graphical products; major Open Source commercial organizations and their contributions; software development using Open Source methodologies and tools.

Recommended Books


Bibliography

Course Code: CS6861
Course Title: Machine Learning
Credit Hours: 3(3+0)

Specializations: Pattern Recognition, Database Systems, General Track

Prerequisites: Statistics and Probability, Linear Algebra, Advanced Programming, Data Structures and Algorithms

Course Description: The aim of the course is to give students a basic understanding of the theory of machine learning, and its techniques and algorithms. Further, the objective of the course is to prepare students to learn machine learning at an advanced level.

Aims and Objectives: After completing this course:
- Students will be able to understand the theory of machine learning at a preliminary level and learn and apply some basic machine learning techniques.

Course Contents: Linear regression with one variable, linear algebra review, linear regression with multiple variables, logistic regression, regularization, neural networks, neural network learning, deep learning, fast nearest neighbor method, machine learning system design, support vector machines, unsupervised learning, dimensionality reduction, anomaly detection, recommender system, large-scale machine learning. Some advanced topics including Markov decision processes, dynamic programming, and deep reinforcement learning.

Recommended Books

BS (CS)
Old Course Outline
A Student majoring in Bachelor in Computer Science (BCS) must complete minimum of 132 Credit Hours courses. The courses list is as follows:

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<td>BCS111</td>
<td>Fundamentals of Computers.</td>
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<tr>
<td>BCS112</td>
<td>Mathematics-I</td>
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<td>BCS113</td>
<td>Probability and Statistics</td>
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<td>BCS115</td>
<td>Programming Concepts</td>
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<tr>
<td>BCS121</td>
<td>Programming Languages-I</td>
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<tr>
<td>BCS122</td>
<td>Mathematics-II</td>
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<td>BCS123</td>
<td>Physics</td>
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<td>BCS124</td>
<td>Discrete Mathematics</td>
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<td>BCS125</td>
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<td>Database-I</td>
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<td>Data Structures</td>
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<td>Business Communication</td>
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<td>Computer Organization and Assembly Language Programming</td>
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**Semester VI**

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<td>BCS472</td>
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<tr>
<td>BCS482</td>
<td><strong>NATURAL LANGUAGE PROCESSING</strong></td>
<td></td>
</tr>
<tr>
<td>BCS483</td>
<td><strong>SOFTWARE PROJECT-II</strong></td>
<td>3</td>
</tr>
<tr>
<td>e) <strong>Elective (any two)</strong></td>
<td></td>
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<tr>
<td>BCS484</td>
<td>Digital Image Processing</td>
<td>3</td>
</tr>
<tr>
<td>BCS485</td>
<td>Network Security</td>
<td>3</td>
</tr>
<tr>
<td>BCS486</td>
<td>Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>BCS487</td>
<td>Database Administration</td>
<td>3</td>
</tr>
<tr>
<td>BCS488</td>
<td>Telecommunication systems</td>
<td>3</td>
</tr>
<tr>
<td>BCS489</td>
<td>Multimedia Technologies</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Semester Cred Hrs</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Note:**
1. Only those elective courses will be offered whose teaching staff will be available.
2. Students can select any of the two offered elective courses of their choice.
3. Only those elective courses will be offered whose students’ strength will be 10 or above.

2) (The courses and semester plan can be modified subject to the decision of board of studies.)

---

3) **Computer Science Courses**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Title</th>
<th>T/Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fundamentals of Computers</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>Programming Concepts</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Programming Languages-I</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>Digital Logic Design</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Database-I</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Data Structures</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Database-II</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>Programming Languages-II</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>Operating Systems</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>Computer Organization and Assembly language Programming</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>Data Communications and Networking</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>Internet Programming</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>Artificial Intelligence</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>Programming Languages-III</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td>Software Engineering –I</td>
<td>3</td>
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<tr>
<td>17.</td>
<td>Network Strategies</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>19.</td>
<td>Automata Theory</td>
<td>3</td>
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<tr>
<td>20.</td>
<td>Computer Graphics</td>
<td>4</td>
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<tr>
<td>21.</td>
<td>Software Engineering –II</td>
<td>3</td>
</tr>
<tr>
<td>22.</td>
<td>Compiler construction</td>
<td>3</td>
</tr>
<tr>
<td>23.</td>
<td>Wireless and Mobile communication</td>
<td>3</td>
</tr>
<tr>
<td>24.</td>
<td>Software Project Management</td>
<td>3</td>
</tr>
<tr>
<td>25.</td>
<td>Natural Language Processing</td>
<td>3</td>
</tr>
<tr>
<td>26.</td>
<td>Software Project-I</td>
<td>3</td>
</tr>
<tr>
<td>27.</td>
<td>Software Project-II</td>
<td>3</td>
</tr>
</tbody>
</table>

**Cred Hrs of Compulsory Courses** 89

Elective subjects (6 credit hours in semester 7 and 6 credit hours in semester 8)

- Digital Signal Processing
- E-Commerce Applications & Technologies
- Expert Systems
- Data Mining and Data Warehousing
### Management Information System
- Distributed Computing
- Digital Image Processing
- Network Security
- Modeling and Simulation
- Database Administration
- Telecommunication System
- Multimedia Technologies

<table>
<thead>
<tr>
<th>Cred Hrs of Elective Courses (four to be chosen)</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Cred. Hrs of Computer Science courses</strong></td>
<td>101</td>
</tr>
</tbody>
</table>

#### Mathematics Courses

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Title</th>
<th>T/Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mathematics-I</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>Discrete Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Mathematics-II</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Statistics &amp; Probability</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Numerical Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Cred. Hrs of Mathematics courses**: 16

#### Natural Sciences Courses

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Title</th>
<th>T/Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Physics</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>Electronics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Cred. Hrs of Natural Sciences courses**: 6

#### Social Sciences Courses

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Title</th>
<th>T/Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Functional English</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>Pakistan Study/ Islamic Studies</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Business Communication</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Cred. Hrs of Social Sciences courses**: 9
University of Peshawar

Department of Computer Science

UNDERGRADUATE CURRICULUM

(1) BCS

Code: BCS111
Credit Hours: 3

Fundamentals of Computers

Basic of Computer
a) Introduction and history of Computers.
b) Types of Computer
c) Computer Organization

Computer Software
a) Software Introduction
b) Types of Software
c) PC Platform.
d) Computer Virus.

Data Processing and Storage
a) Data Processing Techniques
b) Data Storage (Bit, Byte, RAM, ROM, cache Memory, Secondary Storage (FDD, HDD, Tape, CD).

The Processor
a) Bus, Port
b) Computer Motherboard.
1. Microprocessor
2. Math Co-processor
3. Memory Chip
4. Support Chips
5. Built-in programs
6. Expansion Slots

**Input and Output Devices.**

a) Input Devices
1. Keyboard and its types
2. Point and Draw devices
3. Scanner, Digital Camera, Speech recognition system and multimedia

b) Output Devices
1. Monitor(Graphic Adopter, Size, Resolution and Types of Monitors)
2. Printers and Types (Dot matrix, inkjet and laser)
3. Plotters (Raster and Pen)
4. Presentation Graphics and special function terminals (ATMs POSs)

**Windows**

a) Windows Introduction
b) Finding Files, Installing Printers
c) The Desktop and types of windows(application, document, dialog)
d) Elements of an application window
e) Understanding folders, copying, detecting and moving files

**Word Processing (MS Word)**

a) Basic concepts and features
b) Creating, saving, editing, formatting and printing documents
c) Working with Tables

**Electronic Spreadsheet (MS Excel)**

a) Basic concepts and features
b) Creating, saving Excel sheet, editing the sheet
c) Managing formula, formatting the sheet and printing the sheet
d) Working on workbook

**Basics of Internet usage**

a) Introduction
b) World Wide Web and Web sites
c) Introduction to Internet based services and use of E-mail.

**Books:**


**Code:** BCS112  
**Credit Hours:** 3

**Mathematics-1(Calculus-1)**

**Real and Complex Numbers**

a) Real Numbers
b) Complex numbers

**Functions, Limit and Continuity of a function.**
a) Functions
b) Graphs
c) Sequences
d) Limit and Continuity of a function of one variable

Differentiation-I
a) Differentiation
b) Product and Quotient Rules
c) Tangent
d) Normal

Differentiation-II
a) Chain Rule
b) Implicit differentiation

Application of Differentiation-I
a) Roll’s and Mean Value Theorem
b) Taylor’s Theorem
c) Maclaurin’s Theorem

Application of Differentiation-II
a) Newton’s and Picard’s method and its application
b) Maxima
c) Minima

Indeterminate forms
a) L’Hospital’s Rule
b) Application of L’Hospital’s Rule

Integration
a) Basic Integration
b) Integration by identities
c) Integration by substitutions
d) Integration of trigonometric functions
e) Integration by parts

Application of Integration
a) Area and Volume by integration
b) Differential Equations (Separable variables techniques)

Books:

Code: BCS113 Credit Hours: 3

Probability and Statistics

Introduction
a) Meaning of statistics
b) Importance of statistics in various fields
c) Population and Sample
d) Variables
e) Statistical data
Statistical Measures of Data
a) Measures of Central Tendency, Mean, Median, Mode and quartiles
b) Measures of Variation: Range, Standard Deviation, Variance and Coefficient of Variation.

Sets and Probability
a) The concept of a Set
b) Set Operations and Algebra of Sets
c) Permutations and Combinations
d) The Concept of Probability
e) Theorems of Probability
f) Conditional Probability

Random Variables and Probability Distribution
a) Concepts of a Random Variable
b) Discrete Probability Distributions
c) Continuous Probability Distributions
d) Joint Distribution of two random variables
e) Mathematical Expectations

Special Probability Distributions
a) Binomial Distribution
b) Poisson Distribution
c) Hypergeometric Distribution
d) Uniform Distribution
e) Normal distribution

Sampling Theory
a) Sampling Distribution
b) Sampling Distribution of the Mean
c) Sampling Distribution of the differences of means
d) Sampling Distribution of Proportions
e) Sampling Distribution of the Difference of Proportions

Statistical Inference
a) Point estimation
b) Properties of a good estimator
c) Confidence Intervals
d) Statistical Hypothesis
e) Testing a Statistical Hypotheses Tests Concerning Means
f) Tests Concerning Means
g) Tests Concerning Difference between two Means
h) Goodness of Fit Test and Test for Independence

Simple Linear Regression and Correlation
a) Simple Linear Regression
b) Least Squares estimation of the Regression Parameters
c) Inference concerning the Regression Coefficients
d) Linear Correlation
e) The coefficient of correlation
f) Properties of the coefficient of correlation

Books:

Code: BCS114
Credit Hours: 3

**Functional English**

**Function** Asking and answering questions

a) Structure The Present perfect
b) Reading Guessing the meanings of words
c) Writing Informal letters: beginning and ending
d) Listening Understanding directions

**Function** Seeking Agreement and Confirmation

a) Structure The Present Perfect and simple past tense
b) Reading Guessing the meanings of words
c) Writing Joining Sentences
d) Listening Listening to a narrative account

**Function** Agreeing and Disagreeing

a) Structure Reported Speech
b) Reading Predicting
c) Writing Informal letters
d) Listening Giving advice

**Function** Possibility/Impossibility

a) Structure Conditionals
b) Reading Skimming and Scanning
c) Writing Formal letters
d) Listening Listening to talk/lecture

**Function** Certainty/Uncertainty: obligations

a) Structure The Passive
b) Reading Function in a text
c) Writing Formal letters
d) Listening Listening to an interview

**Function** Preferences/Interactions

a) Structure The ing form
b) Reading Reading the main idea and supporting details in text
c) Writing Formal letters
d) Listening Listening to a talk/lecture

**Function** Permission

a) Structure The Past Perfect and future perfect tense
b) Reading Classification
c) Writing Applying for a job
d) Listening Listening to a radio broadcast

**Function** Appreciation, regret and indifference

a) Structure Relative Clauses
b) Reading Thermatization
c) Writing Note Taking
d) Listening to an argument

<table>
<thead>
<tr>
<th>Function</th>
<th>Suggesting/Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Structure Relative Clauses</td>
<td></td>
</tr>
<tr>
<td>b) Reading Facts and Opinion</td>
<td></td>
</tr>
<tr>
<td>c) Writing Summarizing</td>
<td></td>
</tr>
<tr>
<td>d) Listening Listening to a story.</td>
<td></td>
</tr>
</tbody>
</table>

Books:

Code: BCS115 Credit Hours: 4

**Programming Concepts**

**Introduction to Computer Program**
- a) Computer program concepts, High level languages, 4 GL
- b) Editor, Compiler, Source Program, Object Program

**Computer Program Engineering**
- a) Introduction, problem solving techniques, qualities of a good program
- b) Program life cycle

**Computer Program Basics**
- a) Basic program structure, (Input, Output, process)
- b) Constant, Variable, data types, operators, expression, statement

**I/O and Debugging**
Input/Output statements, debugging procedures, errors logical, syntax

**Transfer of control structures**
- a) Conditional/Conditional
- b) Simple decision (if-then-else)
- c) Complex decision(case structure/nested decision)

**Repetition**
For structure, while structure, repeat structure Recursion

**Arrays**
Arrays (introduction, single, multidimensional)

**Functions and Subprograms, Recursion**

Storage Classes
Memory Management Model
String Handling
Character testing and Data Conversion
Far pointer and VDU (Video Display Unit)
Bit wise operators
Union
Preprocessor. Commands
Files (All access modes,) character I/O on file, line oriented I/O on file, file
Management, Non-Text file I/O
Command Line Arguments (hard coding vs flexible coding)
Calling interrupt
Re-direction Request

**Books:**
2. Mian Altafullah, *C Theory & Practice*.

Code: BCS121          Credit hours: 4

**Programming Language-I(C++)**

**Overview of Arrays and Functions**
- a) Arrays (Fundamentals, Arrays as Class member data, as Objects, Strings)
- b) Function (Declaration, Calling, passing arguments, returning values)
- c) Function overloading inline functions.

**Structures and Unions**
Structures (Structure specification & definition, Accessing structure elements)

**Enumerated Data Type and Storage Classes**
Enumerated data declaration and use, Automatic, External and Static variables, Registers

**Introduction to Objects Oriented programming**
- a) Advantages of Object Oriented approach, Objects
- b) Classes, Inheritance, Reusability, creating new data types
- c) Polymorphism, overloading.

**Dealing with Classes and Objects in C++**
- a) Specifying and using Classes and Objects, Constructors and Destructors
- b) Objects and function argument, Returning objects from functions

**Operator overloading, Inheritance, pointer, special functions, and Files & Streams**
Operator overloading (Unary operators, Binary operators, Data Conversion, pitfalls)
- a) Inheritance
  - 1. Derived and Base Classes, Derived Class Constructors
  - 2. Overriding member functions, class hierarchies, Public & Private Inheritance.
  - 3. Levels of Inheritance, Multiple inheritance.
- b) Pointers
  - 1. Address and Pointers, Pointers and Arrays
  - 2. Pointers and Functions, Pointers and Strings, Memory allocation and deallocation
- c) Some Special Types of Functions
  - 1. Virtual Functions, friend functions, static functions.
- d) Files and Streams
  - 1. Streams, String I/O, Character I/O Object I/O with multiple objects
  - 2. File pointers, Disk I/O with member functions, error Handling
  - 3. Redirection of input and Output Command Line Arguments, Printer Output.

**Books:**

Code: BCS122          Credit Hours: 3

**Mathematics-II(Algebra-II)**

**Vector-I**
- a) Vectors

106
b) Vector Analysis

Vector-II
a) Calculus of vectors
b) Application of Vector Calculus

Infinite Series
a) Sequence, Monotonic Sequence, Infinite Series
b) Convergence, integral Tests, Convergence Test, Comparison Test
c) Alternating Series, Conditional Convergence

Functions of Several Variables
a) Functions of several variables
b) Limit and continuity of function of several variables
c) Partial derivatives

Hyperbolic Functions
a) Hyperbolic Functions
b) Calculus of Hyperbolic Functions

Higher Integration
a) Reduction Formula
b) Some more techniques of integration

Application of integration
a) Line integral
b) Multiple integrals
c) Double and triple integrals

First order differential equations
First order differential equations

Second order differential equations
Second order differential equations

Books:

Code: BCS123 Credit Hours: 3

7) Physics

Electrostatics
a) Coulomb’s Law
b) Coulomb’s Law and its experimental verification
c) Electric Charge
d) Charge quantized
e) Electric fields
f) Gauss’ Law
g) Electric Potential
h) Flux of electric field, Gausses law and its application
i) Electric potential as line integral potentials due to charge distribution, potential and field due to dipole
j) Capacitors and dielectrics
k) Equation of continuity
l) Capacity of a spherical and parallel plate capacitor, polarization of matter
m) Gauss's law in dielectrics, electric susceptibility and dielectric constant
n) Energy density of electrostatic field

**Electric Current and Magnetic Fields**
a) Current and magnetic field, electric current, Ohm’s law
b) Equation of continuity
c) Field due to a current interaction of magnetic field with current
d) Magnetic induction vector B, Biot Savart law
e) Field due to a straight and circular current
f) Ampere’s law, Ampere’s circuital theorem
g) Fields due to a solenoid and a toroid, thermo electrically feedback
h) Pelter and Thomson’s effect, total e.m.f in thermocouple
i) Photo Voltaic effect pi electric effect
j) Faraday’s law, Faraday’s law of electromagnetic induction and its
k) Differential form
l) Self induction, self inductance of a toroidal solenoid, mutual induction
m) Mutual inductance of toroidal solenoid
n) Magnetic fields in matter-1, magnetization vector, the magnetic intensity
o) Vector H
p) Magnetic energy, dia, para and ferro magnetism phlegmatic hysteresis

**Maxwell’s Equations**
a) Maxwell’s equations
b) Maxwell’s equations, wave equations and its plane, wave solution in free pace
c) Relation between the propagation vector
d) Electric and magnetic vectors in a plane wave poynting vector

**Books:**

**Discrete Mathematics**

Credit Hours: 4

Logic: propositional logic, rules of propositional logic, predicate logic, symbols, tautologies, quantifiers, inference rules, Introduction to Logic Programming.
Recursion: definition, recursive function, examples of recursive functions.
Sets: terminology, operations, set identities.
Counting: sum rule, product rule, pigeon-hole principle, permutations, combinations, using trees in counting, inclusion-exclusion principle, discrete probability.
Trees and Graphs: terminology, binary trees, recursive definition of a binary tree, applications of binary trees, directed and un-directed graphs, adjacency matrix.
Boolean Algebra: Boolean operators and functions, functional completeness, combinational circuits.
Functions and Relations: types of functions, types of relations.
Regular Expressions: regular grammar, context-free grammar.

**Books:**
Pakistan Studies

a) Ideology of Pakistan in the historical perspective
b) Two nation theory
c) Pakistan movement
d) Creation of Pakistan and role of Quaid-e-Azam
e) Initial difficulties
f) Islamization in Pakistan
g) The land of Pakistan

Books:
2. I.H. Qureshi, The struggle for Pakistan.

Islamic Studies

a) Definition and meaning of Islam
b) The place of Quran in Islamic World Nations
c) The Hadith
d) The Political System of Islam
e) The Legal System of Islam
f) Principles of an Islamic state and chances of their people

Books:
5. Al-Quran(a contemporary translation).
6. Ishtiaq Ahmad, The concept of an Islamic state.
7. Dr. Ismail Al Farooqi, Jinnah and Pakistan of Islamic identify.

Code: BCS231 Credit Hours: 3

Digital Logic Design

Numbering Systems
a) Number Representation, Conversion, and Arithmetic in/between Binary, Octal, Decimal, Hexadecimal Numbering Systems
b) Complements and Complement Arithmetic, Binary Coding Schemes, Binary Logic, ICs

Boolean Algebra and Logic Gates
a) Definitions, Theorems and Properties, Boolean Algebra theorem Proving, Duality Principle
b) Boolean Functions, Standard and Canonical Forms of Boolean, Functions, Conversion between standard and canonical forms, Logic Gates, Implementation of Boolean Functions with AND, OR, and Not Gates.

Simplification of Boolean Functions
Simplification by Algebraic Manipulation, Map and Tabulation Methods, Boolean Function Implementation with NAND and NOR Gates.

**Combinational Logic**
- b) EOR and ENOR Functions, their Applications and Implementations

**Combinational Logic with MSI and LSI**
- a) Binary Parallel Adder, Decimal Adder, BCD Adder, Magnitude Comparator, Decoders, Demultiplexors, Encoders, Multiplexers, ROMs, PLAs
- b) Implementation of Boolean Function with Decoders, Multiplexers, ROMs, and PLAs.

**Sequential Logic**
- b) Design and Analysis Procedures for Sequential Circuits, Designing and analyzing Counters and Other Sequential Circuits, State Machines.

**Registers, Counters, and Memory Unit**
Registers, Counters, Timing Sequence and Memory Unit.

**Asynchronous Sequential Logic**
- a) Analysis Procedure, Circuits with Latches, Design procedure
- b) Reduction of State and Flow Tables, Race Free State Assignment

**Digital Integrated Circuits**
- a) Bipolar Transistor Characteristics, RTL and DTL Circuits
- b) Transistor-Transistor Logic, Emitter-Coupled Logic (ECL)
- c) Metal Oxide Semiconductor (MOS), CMOS

**Books:**

**Code:** BCS232
**Credit Hours:** 4

**Database-I**

**Database Foundation**
- a) Introduction, Data and Information, Components, Advantages
- b) Data Association, Entities, Keys and its Types, Attributes
- c) Data Associations, Data Structure Diagram

**E-R Model**
- a) Basic Constructs (Symbols), Degree of Relationships, Cardinality, Gerund
- b) Modelling time dependent Data Super Types, sub Types

**Data Models**
- a) Hierarchical, Network, Relational Comparison of all Data Models
- b) Relation, Characteristics of Relation, Converting E-R Model into Relations.

**Normalization (1NF, 2NF, 3NF, 4NF, 5NF)**

**Relational Algebra, Relational Calculus**

**Database Design (Conceptual Design, Physical Design)**
SQL
a) Introduction: Creating, Altering, and Deleting table
b) Inserting, Updating, and Deleting Rows, Querying Tables
c) SQL Functions.
   1. Arithmetic: Group (AVG, COUNT, MAX, MIN,SUM)
   2. DATE, Special Functions (IN, BETWEEN, LIKE, NULL)
d) Managing Multiple Tables

Books:

Code: BCS233 Credit Hours: 3

Data Structures

Introduction
Linear Structures: Arrays
a) Linked implementation
b) Odd shaped Arrays
c) Right Triangular
d) Isosceles triangular

Notations and their conversion (using stack)

Stacks & Queues
a) Stacks
b) Queues
c) Basic Operations

Lists
a) Linked Lists
b) Types of Linked Lists

Trees
a) Linked implementation
b) Binary Trees
c) B-Trees

Trees Traversal
a) Basic Operations
b) Traversals Sets

Graphs
a) Representation of directed and undirected graphs
b) Traversals
c) Minimum cost spanning tree

Files
a) File organizations: Sequential
b) Indexed Sequential
c) Direct (Hashing)
d) Inverted
e) Use of B-Tree Indexes
f) Merging files

**Sorting & Searching**

a) Internal Sorting
   1. Selection
   2. Insertion
   3. Quick, Using recursion & stack
   4. Tree
   5. Heap

b) External Sorting
   1. Balanced Merged Sort
   2. Poly-phase Merged Sort

c) Searching
   1. Binary Search
   2. Sequential Search for ordered and unordered list

**Books:**


**Business Communications**

**An Overview of Communication**

a) Defining communication, importance of communication concepts of communications.

b) Barriers of communication, Nonverbal communication, Principles of effective communications.

**Business Communication in Context**

a) Business communication and the global context.
   1. Background to international communication, and the national cultural variables.
   2. Individual cultural variables.

b) Business communication and ethics Influences on personal ethics, communication and ethical issues.

**Business communication and technology**

a) Managing information with in organization
   1. History of technological developments.
   2. Challenges to the organization made by the new technologies.

b) E-mail and other technologies for communication
   1. Defining e-mail, using e-mail, understanding how email works.
   3. CD-ROM Database, Teleconference, Faxes.

c) Managing information our sides the organization

**Message design**

a) Process of preparing effective business messages
   1. Five planning steps, Basic organizational plans, Beginning and ending.
   2. Composing the message.

b) The appearance and the design of business message business letters, memorandums, special timesaving message media

c) Good news and natural messages

d) Organizational plan favorable Replies, neutral messages

**Written communication: Major Plans for letters and MEMOS**

a) Bad/+
b) 123-News messages
   1. The right attitude, plans for bad news messages.
   2. Negative replies to request, Unfavorable unsolicited messages

c) Persuasive written messages.
   1. Organization of persuasive messages.
   2. Persuasive request persuasive sales letters.

Written communication: Reports
a) Short reports
   1. Suggestions for short reports, information memorandum reports.
   2. Analytical memorandum reports, letter reports.
b) Long formal reports (prefatory and supplement selection, presentation of long reports
c) Proposals (Purpose, kinds, parts, sort proposals, long formal proposals)
d) Writing style and appearance

Strategies for oral communication
a) Strategies for successful speaking and successful listening
   1. Strategies for improving oral presentation, Strategies for reducing stage fright.
   2. Strategies for improving listing skills.

Books:

Code: BCS235 Credit Hours: 3

Electronics

Direct Current Circuits
a) Joules’ Law
b) Circuit Analysis
c) Kirchhoff’s Rules
d) Wheatstone Bridge

Alternating Currents
a) Sinusoidal Signals, Frequency, amplitude and phase, uns, value, power factor.
b) Capacitive reactance
c) Inductive reactance
d) RL Filter
e) RC Filter
f) Differentiating and integrating factor
g) Transient currents
h) Transition and Diffusion Capacitance
i) Reese Recovery Time
j) Zener Diode
k) Light Emitting Diode.

Diode Applications
a) Load Line Analysis
b) Series/Parallel and Series-Parallel Configurations.
c) AND/OR Gates
d) Half wave and full wave rectifier.
e) Clippers and clampers
f) Voltage multiplier circuits, junction.
Transistor
a) Transistor Construction
b) Transistor Operation
c) Different Configurations
d) Transistor amplifying action
e) Limits of Operations
f) DC Biasing
g) Fixed Bias Circuit
h) Emitter Stabilized bias circuit
i) Voltage Divider biased
j) BJT transistor Modeling
k) BJT small signal analysis

Amplifiers
a) Differential and Common mode operation
b) Op-amp basic
c) Op-amp application

Books:

Code: BCS241 Credit Hours: 3

(b) Databases-II

Database Administration
a) Introduction, Layers of Database Administration, DBA Functions and Responsibilities

Database Integrity
a) Introduction
b) Integrity Rules
1. Entity Integrity
2. referential
a) Insertion Rule
b) Deletion Rule (Restrict, Nullity, Cascade)
c) Range of values, Not Null, Selection Based Entry(Radio Button, Check Boxes LOV)

Database Security
a) Introduction
b) Physical Security, (Locks, Logbooks, Staff, Categorization)
c) Database Security
1. View, authorization, Table Subject, Object, Privileges, User defined Procedures
2. encryption

Database Recovery
a) Introduction, Reasons of Database Failures, Database Recovery Facilities
1. Backup Logs (Transaction Log, Database Change Log)
b) Database Recovery Methods (Restore, Roll Forward, Roll Backward)
c) Transaction processing

Database Concurrency
a) Introduction, the problem of Lost Updation
b) Concurrency Control Methods (Optimistic Approach, Pessimistic Approach)
c) Managing the Deadlock, Transaction Integrity
Distributed Databases  
  a)  Introduction, Types of Distributed Databases  
  b)  Advantages and Disadvantages of Distributed Database 

Object Oriented Databases  
  a)  Introduction to Object Oriented Paradigm  
  b)  Differences in Object Model and Design  
  c)  Object oriented Analysis and Design  
  d)  Cost and benefits of Object data bases 

Books:  
  4.  Tools: Any SQL based DBMS. 

Code: BCS242  

Programming Language-II(Visual C++) 

Templates  
  a)  Function and Class Templates, Overloading Templates, Overriding Templates  
  b)  Templates and Inheritance, Templates and Friend Functions 

Exception Handling  
Basic Bug Traps, C++ Exception Handling and Resumption 

Basic GUI Programming  
  1.  Documents and Views, Status Bars and Tool Bars, Dialog Boxes, Controls, Property Pages and Sheets, Drawing Functions, Menus  
  2.  Bitmaps and Bit Operations, Printing and Previewing 

ActiveX Applications and Controls  
Developing ActiveX Controls and Applications 

Socket Programming 

Communication Among Processes  
Process Synchronization, Exchange Data through Pipes and Shared Memory, Clipboards, Using OLE 

Advance Programming Techniques  
Database Access, SQL, Multithreading, MFC Library 

Debugging  
Understanding Debugging, Basic Debugging Operations 

Books:  

Code: BCS243  

Credit Hours: 4
Operating Systems

Introduction
a) Definitions
b) Evolution
c) Structure and Functions

Process Management
a) Processes, Process States, Process State Models
b) Process Synchronization and Inter-Process Communication. Classical IPC Problems
c) Process Scheduling
d) Process Management in Windows NT and UNIX

Memory Management
a) Real Memory Organization and Management
b) Virtual Memory Organization: Paging, Segmentation, Combined Paging and Segmentation

File Systems
a) Files
b) Directory Systems
c) File System Implementation
d) Security
e) Protection Mechanisms

Input/Output Management
a) Principles of I/O Hardware
b) Principles of I/O Software
c) Disks
d) Clocks
e) Terminals

Deadlock
a) Resources
b) Deadlock
c) Deadlock Detection
d) Deadlock recovery
e) Deadlock Avoidance
f) Deadlock Prevention
g) Other issues

An overview of major Operating Systems
a) Unix
b) NT
c) Windows

Distributed Operating Systems
a) Network Operating Systems
b) Distributed Operating System

Case Studies
a) Unix
b) NT
c) Windows
Books:

Code: BCS244 Credit Hours: 3
Computer Organization and Assembly Language Programming

Computer Organization
Data and Instruction Representation.

Assembly Language Programming
a) ASCII Code Assembler Directives vs Machine Instructions.
b) Keyboard Input and Screen Output.
c) Addressing & Instruction Formats/types
   i. Op-code encoding.
   ii. Addressing modes.
   iii. Addressing types.
d) Detailed study of different/Instruction types-I
   i  Data-transfer instructions.
   ii Data transfer instructions.
   iii Arithmetic instructions.
   iv Logical instructions, program control instructions.
e) Conversion between ASCII Strings and Binary Numbers
f) Stack Operations
g) Debugging
h) Interrupts
i) Macros
j) Video Output
k) Disk I/O

Books:

Code: BCS245 Credit Hours: 4
Data Communications and Networking

Data transmission & Networking Concept
a) Introduction to data communication, advantages of digital communication, A communication Model.
b) Codes for digital signal transmission
c) Parallel and serial transmission
d) Synchronous and Asynchronous Transmission
e) Baseband and Broadband Transmission
f) Simplex, Half-duplex and Full-duplex transmission
g) Modems, types of Modems, properties of modems
h) Topologies: Bus,Star,Ring,Tree,Mesh.
i) Need of Networks, Peer- to-Peer networks, Client- Server networks, Hybrid networks
j) Circuit Switching, Message Switching and Packet Switching

Transmission Impairments
a) Attenuation
b) Delay Distortion
c) Noise
d) Channel Capacity

Transmission Media
a) Guided Transmission Media, Twisted Pair, Coaxial Cable and Optical Fiber.
b) Wireless Transmission - Terrestrial & Satellite Microwave and Broadcast Radio

Data Encoding
a) Digital and Analog transmission.
b) Digital Data & Digital Signals
c) Digital Data & Analog Signals
d) Analog Data & Digital Signals
e) Analog data & Analog Signals

Data Communication Interface
a) Line Configuration, Interfacing, Null Modem
b) Point to point and multipoint link

Data Link Control
Flow Control Techniques:
  a) Polling Selection, Request to send/clear
  b) XON/XOFF
  c) Stop & Wait
  d) Sliding Window

ERROR DETECTION/CORRECTION & CONTROL TECHNIQUES
Error Detection and Correction Techniques:
1. Parity bit method
2. Vertical and horizontal redundancy checking
3. Cyclic redundancy checking (CRC).
Error Control Techniques:
1. Stop and Wait ARQ
2. Go-Back-N ARQ
3. Selective-Reject ARQ
4. High Level Data Link Control Protocols (HDLC)

Multiplexing
a) Frequency Division Multiplexing
b) Synchronous and Statistical Time Division Multiplexing

INTERNETWORKING DEVICES
a) Hubs
b) Switches
c) Routers
d) NICs
NETWORK MODELS

a) TCP/IP Model
b) OSI Model

LAN ARCHITECTURES

a) Ethernet, Token Ring, FDDI, Token Bus, ARCNet, AppleTalk.

Books:

Code: BCS351 Credit Hours: 3

8) Internet Programming

HTML (Hypertext Markup Language)

a) Internet, Web and HTML Fundamentals
b) What is HTML
c) The World Wide Web and Web Servers
d) Working of Web Browsers
e) HTML’s Role on the Web
f) Way of launching the Web Site

Creating Static Web Pages with HTML

a) Creating a Web page and entering Text
b) Changing and Customizations
c) Display Text in List
d) Adding Graphics into Web Pages
e) Hypertext and Creating Links
f) Issuing Links with other HTML Tags

Advance HTML

a) Tables, Forms, Images
b) Frames
c) Multimedia Objects

JavaScript

a) Data types
b) Control Structures
c) Object & Function
d) Event Handling

VB Script

Introduction, Data Types, Syntax, Controls, etc.

Active Server Pages

Personal Home Page

Common Gateway Interface (CGI) Script

Database Connectivity
a) Using ASP
b) Using CGI
c) Using PHP

Books:

Code: BCS352
Credit Hours: 3

**Artificial Intelligence**

Basic Concepts: Intelligence, Artificial Intelligence, Branches of Artificial Intelligence.
Techniques: Searching (Blind search, knowledge-directed search); Knowledge Representation (Logic, Rules, Semantic Networks, scripts).

Books:

Code: BCS353
Credit Hrs: 3

**Analysis of Algorithm**

Introduction, Properties of algorithms, features of algorithms, factors influencing the performance of algorithms (not in control of the programmer), Analysis of Algorithms, classification of algorithms, computational complexity, Asymptotic Notations, usefulness and limitations of the Asymptotic notation, Basic Recurrences, Recurrence Solutions, Factors influencing the execution time of an algorithm, some examples to calculate the T(n) of algorithms (including examples from searching and sorting), implementation of algorithms, rules for implementation, empirical analysis, Introduction to Generation functions, system approach, algorithms and systems, dynamic programming, greedy algorithms, divide and conquer approach.

Books:

Code: BCS354
Credit Hrs: 4
Programming Language III

Introduction to Java
a) Introduction, Data Types, Syntax etc.
b) Writing Simple Java Console Application

Applets
a) Introduction to AWT and Applets, Use of AWT components in Java Application
b) Writing Simple Applets

Servlets
a) Introduction to Servlets, Servlets Life Cycle
b) Developing Basic Servlets
c) Using doPost, doGet, Service according to HTML Form Methods
d) SSI (Server Side Include)
e) Session Management

Advanced Java
a) Packages and Interface
b) Exceptions

Java Class Libraries
a) Threads
b) Writing Java Application
c) The Java Class Libraries

Books:

Software Engineering-1

Introduction
a) The Evolving Role of Software
b) Software: A Crisis on the horizon, Software Myths

The Process
a) Software Engineering- A Layered Technology
c) The prototyping Model, The Red Model, Evolutionary Software Process Models

Project Management Concepts

System Engineering
a) Computer-Based System, the Modeling Engineering Hierarchy
b) Information Engineering, Information Strategy planning, Business Area Analysis
c) Product Engineering, Modeling The system Architecture
d) System Modeling and Simulation, System Specification

Analysis Concepts and Principles
a) Requirements analysis, Communication Techniques, Analysis Principle
b) Software Prototyping, Specification Review

**Analysis Modeling**
a) A Brief History, the Elements of the analysis Model, data Modeling
b) Functional Modeling and information Flow, Behavioral Modeling
c) The Mechanics of STRUCTURED Analysis, The Data Dictionary
d) An Overview of Other Classical Analysis Methods

**Design Concept and Principle**
a) The Design process, Design Principles, Design Concepts, Effective Modular Design
b) Design Heuristics for Effective Modularity, the Design Model, Design Documentation

**Design Methods**
b) Transform Mapping, Transaction Mapping, Design Post Processing
c) Architectural Design Optimization, interface Design, Human Computer Interface Design
d) Interface Design Guidelines, Procedural Design

**Software Testing Methods**
a) Software Testing Fundamental, test case Design, White Box
b) Basic path testing, Control Structure Testing, Black Box Testing
c) Testing for Specialised Environments
d) Strategies approaches to software testing and strategic issues
e) Unit testing and Integrating testing.

**Books:**

**Network Strategies**

**Switching circuit and packet switching**
a) switching networks, circuit-switching networks, switching concepts
b) Routing in circuit in switched networks, control signaling
c) Packet switching principles, routing, congestion control, X.25 protocols

**Frame relay and asynchronous transfer mode (ATM):**
a) back ground, frame relay protocol architecture, frame relay, call control
b) user data transfer, network function, congestion control,
c) protocol architecture, ATM logical connection, ATM cells, transmission of ATM cards
d) ATM adaption layer, traffic and conjunction control
e) ISDN and broadband ISDN, channels, user access, isdn protocol, broadband protocol

**Internetworking and network security:**
a) principles of internetworking connectionless and connection oriented internetworking
b) the internet protocol, routing protocol, IPv4, IPv6(IPng), ICMPv6
c) security requirements and attacks, privacy with conventional encryption message
d) authentication and hash function, public key encryption and digital signatures
e) NetBIOS Names, NetBIOS background and names

**Protocols and architecture:**
a) Internet protocol address resolution protocols(ARP)
b) Internet control message protocol (ICMP)
c) Internet group management protocol (IGMP)
d) Border gateway protocol (BGP).
e) Routing information protocol (RIP), Open shortest path first (OSPF).

Transport protocol
a) Transport layer, transport services, protocol mechanisms
b) Transmission control protocol, TCP header
c) User data gram protocol, UDP header
d) Ports and sockets

Network/Data Link Control protocol and Microsoft networking protocol suite:
a) High level data link control protocols (HDLC), Serial Line Internet Control protocol (SLIP), Point–to-point protocol (PPP)
b) Application/file System driver, Transport driver interface
c) Protocol (TCP/IP, NW link, NetBEUI, AFP, DLC), network driver interface specification (NDIS)

Distributed application protocol:
a) Abstract syntax notation one (ASN 1), network management–SNMPV2
b) Electronic mail–SMTP and MIME

URL and URI
a) Uniform resource locators (URL) and Universal resource identifiers (URI).

HTTP, FTP, TFTP:
a) Hypertext transfer protocol (HTTP), Dynamic host configuration protocol (DHCP)
   File transfer protocol (FTP), TFTP

Books:

Code: BCS361 Credit Hours: 3

Computer Architecture

Computer Architecture Introduction
a) Introduction to Computer Architecture
b) Evolution of computers (form Mechanical to Electronic)

Basics of Computer Architecture
a) Hardware and firmware
b) Basics of computer architecture
c) Introduction
d) Computer structure
e) Type of computers and future trend computer instruction se

Detailed Study of different Instruction types
a) 1/0 instructions reduced instruction sets computers
b) case study: RISC (University of California Berkeley)

Execution
a) Introduction to Execution unit (EU)
b) Register sections
c) General register design
d) Combinatorial Design of Adders

**ALU Design & BIT SLICE Processor Control Unit**

a) ALU design
b) BIT SLICE Processor Control Unit
   1. Basic concept
   2. Design Methods (Hardware control design and micro programmed control unit)

**Memory Organization**

a) Primary memory design (ROM/RAM)
b) Secondary memory (Hard disk, floppy disk, CD-ROM) Cache Memory, Virtual Memory Management

**Input/Output Design**

a) Cache Memory
   1. Associative mapping
   2. Direct mapping
b) Segmentation and Mapping, and input / output design
   1. Programmed I/O
   2. Standard I/O unconditional programmed I/O
   3. Interrupt I/O
   4. Computer Organization
   5. Microprocessor and its supports circuitry
   6. Peripheral devices

**Books:**

Code: BCS362 Credit Hours: 3

**Numerical Analysis**

**Error Analysis**

a) Definition of error, Sources of error, Significant digits, Precision and accuracy
b) Effect of Rounding errors in arithmetic operations, Numerical Cancellation
c) Evaluation functions by series expansion and estimation of errors

**Non-Linear Equations**

a) Methods to solve Non-Linear equations, Simple interactive procedure
b) Acceleration of convergence, Newton’s Raphons Methods, the Bisection method
c) The Secant methods, methods of False portion, Multiple Roots, Zeros of Polynomials

**Linear System of Equations**

a) Basic concept, Methods to solve a system of linear equations, Cramer’s rule
b) Guassian elimination method, Triangular decomposition method
c) Triangular decomposition for symmetric matrices
d) Solution of Tridiagonal system of equation, Jacobi’s method, Guass-seidel method

**Finite Differences**

a) Difference table, Detection and correction of error in a difference table
b) Forward difference operator, Backward difference operator, Central difference operator
c) Shift operator, Mean operator, Relationship between operators
Interpolation
a) Choice of a suitable interpolation Formula
b) Type of interpolation Formulas for Equally-paced data points
c) Type of interpolation Formulas for Unequally spaced data points
d) Newton’s Forward Difference interpolation Formula
e) Newton’s Backward Difference interpolation Formula
f) Interpolation with Central Difference Formula, Stirling’s interpolation Formula
g) Bessel’s Interpolation Formula, Everett’s interpolation Formula
h) Guassian Interpolation Formula, Lagrange’s Formula Iterative, Interpolation Method
i) Error Estimation in Interpolation

Numerical Differentiation
a) Derivation of Differentiation Formulas, Relationship Between Operator E and D
b) Derivatives Using Newton’s Forward Difference Formula
c) Derivatives Using Newton’s Backward Difference Formula
d) Derivatives Using Central Difference Formula

Numerical Integration-I
a) Derivative of Integration Formulas, Trapezoidal Rule, Simpson’s 1/3rd Rule
b) Boole’s Rule, Weddle’s Rule, Estimation of error in some Newton-cotes formula
c) Error in Trapezoidal Rule, Error in Simpson’s 1/3rd Rule, Automatic Subdivision of Interval

Numerical Integration-II and Ordinary Differential Equation
a) Repeated use of Trapezoidal Rule, Romberg’s Integration Method
b) Ordinary Differential Equations
   1. Classification of differential equations, Categories of ODEs
   2. Linear and Non-Linear ODEs, Boundary Conditions, Methods to solve ODEs,
   3. Numerical Methods to solve ODEs, Picard’s Method
c) Taylor Series Methods, Euler’s Methods and variations

Ordinary Differential Equations
a) Runge-Kutta Methods, Predictor-Corrector Methods
b) Milne-Simpson Predictor-corrector Method, Adams-bashforth
c) Adams-Moulton Method
d) Solution of simultaneous and Higher-order ordinary differential equations
e) Solution of First order Simultaneous differential equations, Solution of an nth order differential equations

Books:

Code: BCS363 Credit Hours: 3

(a) Automata Theory

Regular Languages
Regular Grammars

Finite-State Automata

Compiler-Writing Tools
Lex, Yacc, etc
Transducers and Relationship among Them

Context-Free Languages and Grammars

Language Recognition
Parsers

Properties of Formal Languages

Turning Computability and Undesirability

Books:

Code: BCS364
Credit Hours: 4

Computer Graphics

Fundamentals
a) Introduction, Pints and Lines
b) Planes and Co-Ordinates, Lines Segments

Fundamentals (Continued)
a) Perpendicular Lines, Vectors, Pixels and Frame Buffers
b) Vector Generation Character Generation, Displaying The Frame Buffer

Graphic I/O Device
a) Calligraphic Refresh Display
b) Raster Refresh Display
c) Keyboard
d) Graphic Tablet

drawing Algorithms
a) Lines
b) Bresenham’s Algorithm
c) Curves
d) Rectangle
e) Rounded Rectangles

2-D Transformations
a) Uses for Transformations
b) Modeling, Mapping
c) 2-D Co-Ordinate Transformations
d) Matrix Representation
e) Homogeneous Co-Ordinates

3-D Transformations and Projections
a) Parallel and Perspective Projections
b) Rotations

Scan Conversion Techniques
a) Real – Time Scan Conversion
b) Run – Length Encoding
Polygons
   a) Inside Test
   b) Algorithm for Filling Polygons
   c) Seed Fill Algorithms
   d) Inclusion of Polygons as Graphics System Primitive

Clipping and Windowing
   a) Viewing Transformation
   b) Specification of Window and View Port
   c) Clipping Algorithms
   d) Sutherland-Cohen Algorithm for Clipping Lines
   e) Sutherland-Hodgman Algorithm for Clipping Polygons
   f) Addition of Clipping
   g) Windowing to Graphic System

Books:

Code: BCS365                   Credit Hours: 3

B. Software Engineering-II

OBJECT ORIENTED ANALYSIS AND DESIGN

Introduction
   a) Introduction & Definitions
   b) OO Modeling Concepts
   c) OO Developments

Modeling as a Design Technique
   a) Object Modeling Technique

Object Modeling
   a) Objects & Class
   b) Links & Associations
   c) Generalization & Inheritance
   d) Grouping Constructs
   e) Aggregation
   f) Abstract Class
   g) Multiple Inheritance, Meta Data, Candidate Key

Dynamic Modeling
   a) Events & States.
   b) Operations, Nested State Diagram
   c) Concurrency, Advanced Dynamic Modeling Concepts

Functional Modeling
   a) Functional Models, DFD
   b) Specifying Operations, Constraints
   c) Relation of Functional to Object and Dynamic Model

Design Methodology
   a) Methodology review
b) OMT as Software Engineering Methodology  
c) OMT Methodology, Impact of OO approach

**System Design**

a) Overview of System Design  
b) Breaking of System into Sub Systems  
c) Identifying Concurrency  
d) Allocating Subsystems to Processors and Tasks  
e) Management of Data Store  
f) Handling Global Recurs  
g) Choosing Software Control Implementation  
h) Handling Boundary Conditions  
i) Setting Traded-off Priorities  
j) Common Architectural Framework  
k) Architecture of ATM System

**Implementation**

a) Form Design to Implementation  
b) Implementation using programming languages  
c) Implementation using Database System  
d) Implementation using Outside a Computer

**OO Testing**

a) Testing OOA and Models  
b) OO Testing Strategies  
c) Test Case Design for OO Software  
d) Testing methods applicable at class levels  
e) Inter class test case design

**Object Diagram Compiler**

a) Background  
b) Problem Statement  
c) Analysis  
d) System Design  
e) Object Design  
f) Implementation

**Books:**


Code: BCS471  
Cred Hrs: 3

**Compiler Construction**

**Compiler and Interpreters**

a) Compiler  
b) Interpreter

**Compilation Process**

**Organization of Compiler**
Analysis
  a) Lexical
  b) Syntax
  c) Semantic

Symbol Tables

Recognizer
  a) Top-Down Recognizer
  b) Bottom up recognizer

Error Detection and Recovery

Storage Allocation

Code Generation Code Optimization
  a) Code Generation
  b) Code Optimization

Books:

Wireless and Mobile communications

Code: BCS472                        Cred Hrs: 3
Principles of wireless communication
  1) Technologies used for wireless communications.
  2) Major wireless standards.
  3) The problems characterising wireless and mobile computing.
  4) Limitations of the wireless technology.

Wireless networks
  1) The main components of a Wireless LAN.
  2) Modes of Operation for Wireless LANs (Infrastructure Mode, Adhoc Mode).
  3) Compatibility of different technologies.
  4) Main components of a satellite-based network.

Wireless LANs Standards
  802.11 and its flavors (802.11a, 802.11b, 802.11g), HIPERLAN.
a) Characteristics of radio propagation

b) Fading, Multipath propagation

c) Narrowband digital modulation

The need for modulation. Binary and multi-level (M-ary) amplitude-shift keying (ASK), frequency-shift keying (FSK) and phase-shift keying (PSK).

MOBILE COMPUTING

Introduction, need for mobile computing.

Radio Channel Characterisation
Multipath propagation, Co-channel interference, Exponential power delay profile, Propagation effects - scattering, ground reflection, fading. Log-normal shadowing, Coherence Bandwidth.

PHY Layer techniques
Wideband modulation techniques to cope with intersymbol interference (Diversity, Spread Spectrum, Frequency Hopping, Direct Sequence, Adaptive Equalisation, Orthogonal Frequency Division Multiplexing).

MAC protocols
MAC protocols for digital cellular systems such as GSM. MAC protocols for wireless LANs such as IEEE802.11 and HIPERLAN I and II. The near far effect. Hidden and exposed terminals. Collision Avoidance (RTS-CTS) protocols.

The Cellular Concept--System Design Fundamentals
Frequency reuse, Reuse distance, Cluster size, Channel assignment strategies, Handoff strategies, Co-channel interference and system capacity, Trunking and grade of service

Wideband CDMA concept/principles
Example:-Global System for Mobile W-CDMA(3G) UMTS.

g) Protocols supporting mobility

1) The functions of the main protocols for mobile stations
   a) Mobile network layer protocols such as mobile-IP, Dynamic Host Configuration Protocol (DHCP).
   b) Mobile transport layer protocols such as mobile-TCP, indirect-TCP.
   c) Wireless Application Protocol (WAP), Bluetooth.

h) 2) Understand the range of applicability of each protocol

BOOKS:
**Software Project-I**

**Digital Signal Processing**

**Digital Signal Processing and DSP Systems**
Need for DSP  
Advantages of DSP Systems

**A Model of a DSP System**
Input  
Signal Conditioning  
Anti-Aliasing Filters  
Analog-to-Digital Converter  
Processor  
Digital-to-Analog Converter  
Output Smoothing Filter  
Output Transducer  
DSP Processors  
DSP Format Types  
Alternative Formats for Commercial DSP Processors

**How Numbers are processed in a DSP**
Polynomials  
Transcendental Functions  
Series Expansions  
Limits  
Integration  
Oscillatory Motion  
Complex Numbers

**Acquisition of the Signal**
Sampling Theory  
Sampling Resolution  
Aliasing  
Reconstruction

**Application Examples-Filters**
Filtering  
Sample Filter  
Types of Filters  
Bessel  
Butterworth  
Elliptical

**Fourier Series**
Insights to be gained from Fourier series  
Fourier Series  
Nyquist Frequency

**Orthogonality and Quadrature**
Orthogonality – Basic Building Blocks of DSP  
Quadrature – Signal 90 degrees of phase with each other

**Transforms**
The Z- Transform
DFT – Discrete Fourier Transform
Laplace Transform

Finite Impulse Response Filter – FIR
What is it?
Stability
Cost
Design Methodology
Design Examples
Convolution

Infinite Impulse Response Filter – IIR
What is it?
Stability
Cost
Design Methodology
Design Examples

DSP Tools
Programming Language
Mathematical Tools
Special Purpose Tools
Development Package

DSP and the Future
New User
DSP Directions
Future Technologies

Books:

Code: BCS475 Cred Hrs: 3

E-Commerce Applications and Technologies


Electronic Payments Systems: Electronic money, electronic contracts, micro-payments, authenticity, integrity and reliability of transactions, the encryption and digital signature techniques available to support secure transactions on the internet.


Distributed Systems and Software: Architectural models for distributed systems, server techniques, remote procedure call and multicast communication, emerging standard and platforms (CORBA, DCOM), distributed transactions, concurrency control, reliability and security issues.
Network and Web Programming: Client-server system design; interprocess communication; sockets; blocking and nonblocking I/O; multithreaded process; iterative and concurrent server designs; Web programming includes HTML, JAVA, Web page design and construction.

Open Systems for E-Commerce: Introduction to open system standards and protocols. Transaction protocols. Electronic commerce applications using open system and artificial intelligence technologies. Application of intelligent agents for automated transaction processing. Integration of Web programming techniques with information and communication systems.

Project in E-Commerce Technologies: An individual or a team project on E-Commerce technologies. *Project in E-Commerce Technologies are designed to allow students to gain first hand experience in studying and developing real-world systems for E-Commerce. These could be conducted either individually or by teamwork. Possible projects include, but are not limited to: Online Banking and Financial Systems Supply Chain, Web-based Forecasting and pricing Electronic Payment Systems, Internet Shopping, Virtual Store or Virtual Campus, Electronic Office, Cryptography Servers, Security Fire Wall, Network Management and Quality of Service, Distributed System Technologies in CORBA or DCOM,

HTML (Hypertext Markup Language): Internet, web & HTMLK Fundamentals, The world Wide Web & Web Servers,
Creating Static Web Pages with HTML:
Advanced HTML:
JavaScript: Data Type, Control Structures, Object & Function, Event Handling.
VB Script: Introduction, Data Types, Syntax, Control, etc,
Active Server Pages:
Common Gateway Interface (CGI) Script:
Database Connectivity: Using ASP, Using CGI,

Books:

Code: BCS476 Cred Hrs: 3

Expert Systems

Introduction, The Principles of operation of expert systems. State transition model: Expert system models: Planning actions, solving a problem, diagnosis, Producing advice; how to backtrack; a structure for expert system.
The structure of state spaces: connectivity, form; the implicit description of state spaces; search: depth and breadth first search.
Functions for handling lists: functions for search; best first search.
Eliciting knowledge from on expert: interviewing, examples, problem solving, psychological techniques.
Knowledge representation schemes: rules, semantic nets, logic, frames.
Some existing expert systems: MYCIN, DENDRAL, MACSYMA, PROSPECTOR.
Characteristics of knowledge-bases systems, features of problem solvers, Architectural principals.
The choices of system (language/package) production pit falls.

Books:

Code: BCS477 Cred Hrs: 3

(a) Data Mining & Data Warehousing

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Books:

Code: BCS478  
Management Information System

Information systems, strategic role of information systems, organizations and business process, information management and decision making, ethical and social impact of IS. Computers and IS Software and hardware data resources and telecommunication ensuring quality in information system, enhancing decision making. Accounting, Executive, Decision support, Management Marketing Information Systems. Controlling and managing international information system.

Books:

Code: BCS479  
Distributed Computing


Books:

Code: BCS481  
Software Project Management

Introduction to Software Project Management
a) Introduction, the increasing Demand for Software
b) The Role of Management in Software Development  
c) Gaining acceptance for New Development Procedures

Software Development Problems  
Basic Problem, Risk analysis

Software Development under Contract  
a) The Customer-Developer Relationship, the Cost-Pls vs Fixed Price Dilemma  
b) Other Customer-Developer Relationships, the Request for Proposal (RFP)  
c) The Proposal, F) the Proposal Review and STECTION Process, the Proposal Selection Board  
d) Proposal Evaluation Methods Some Additional Proposal Considerations

The Software Development Cycle  
a) Variations on a Waterfall Theme, the concept Phase, the Software Requirements Phase  
b) The Design Phase, the Implementation Phase, the Integration Test Phase  
c) The Atmosphere During the Integration and Test phase  
d) Problems During the Integration and Test Phase

The Maintenance Phase  
a) The Atmosphere During the Maintenance Phase, Problem During the Maintenance Phase  
b) IEEE standard1074: a standard for Software Life Cycle process  
c) The Selection of the Project software Life Model Project Management Processes  
d) Pre-Development Process, Development Process, Post-Development process  
e) Integral Processes

Managing Software Engineering and handling Large Projects  
a) The Software Project Organizational Structure, the Team Structure  
b) Basic reporting Techniques, Status Report, Project Status meetings  
c) General Guidelines for Managing Software Engineers, Large Need Not Mean Difficult  
d) Stepwise Refinement, the Work Breakdown Structure, Handling Large Project

Software Project Management in a Clinc/Server Environment  
a) An Introduction to Clinc/Server Environments, the Network  
b) Project Management Advantages and Disadvantage of a Clinc/Server Environment  
c) Selecting a Clinc/Server Environments, Project Management  
d) Tips for Managing Clinc/Server Environments

Project Support Functions & Software Development Standards  
a) Project management Support, Software Configuration Control (SCC)  
b) Software Quality Assurance (SQA), Development Standard: the Necessary Evil  
c) An Overview of Software Development Standards, US DOS Standard 2167  
d) The IEEE Software Engineering Standards, European Software Standards  
e) The Ada standards, Other software Development Standards

Project Scheduling and Preparation of Estimates  
a) Scheduling: the Problem, the Project Development Plan, Scheduling Activities and Milestones  
b) Gantt Charts, PERT Charts and the Critical Path, Scheduling Personnel  
c) Scheduling Resources, Monitoring and updating the Schedule  
d) Some General Guideline for Scheduling and Planning  
e) Estimation the Problem, Project Estimates Stepwise Estimation  
f) Estimating New Development, the Constructive Cost Model  
g) Function Point Analysis, the Constructive Cost Model (COCOMO)  
h) Non-Development Overhead
Books:


Code: BCS482  Cred Hrs: 3

(i) Natural Language Processing

**Monolingual Natural Language Processing:**
Difference between natural and formal languages.
Natural language understanding: syntax, semantics, phonetics, morphology, discourse analysis.
anaphora/cataphora, cohesion/coherence, ellipses, ambiguity (structural, lexical, transient, discourse).
Natural language Generation: steps in generation.
Natural Language Interfaces.

**Machine Translation:**
Translation steps: analysis, transfer and generation.
Translation Strategies: direct translation, interlingua and transfer.
Types: Bilingual, Multi-lingual.
Dictionary design: monolingual, bilingual.
Units of translation: word, sentence, discourse.
Some operational and R&D machine translation systems.
Speech translation, benefits of machine translation, integration of machine translation to other fields of computer science, Urdu, Pashto and machine translation.

Books:


Code: BCS483  Cred Hrs: 3

**Software Project-II**

Code: BCS484  Cred Hrs: 3

(b) Digital Image Processing

**Introduction**
Images as Digital Objects
Images Storage and Display
Image Acquisition
Image Types and Application

**Bi-Level Images**
Usefulness of Bi-Level Images
Connectivity and Geometry
Measurable Properties of Regions
Area
Perimeter
Length
Moments – Center of Mass
Simple Shapes
Derivative and Complex Shape Measures
Operations on Bi-Level Image
Boundary enhancement
Erosion and dilation
Sketionization
Chain Code
Run-Length Coding

Grey-Level Images
Introduction to Multiple Levels and Histograms
Thresholding
Selecting a Single Threshold
Selecting Multiple Threshold
Grey-Level Modification
Line and Edges
Geometric Operation
Noise
Color

Classifying and Recognizing Object
Features
Statistical Pattern Analysis
Decision Functions
Template Matching
Structural Methods
1. Representing Relationship
2. Identifying Components

Counting and Classifying Objects
Counting Simple Objects
Classifying Seeds
Classifying Galaxies
Detecting Forged Signatures

Computer Readable Codes
The Universal Product Code
Fonts for Machine Readable Text
Reading Printed Text
The General OCR Problem

Scientific Images
Chromatography and DNA Sequencing: Biology
Stellar Image: Astronomy
Voyager Image Color Synthesis
Making Distance Measurements: Archaeology

Books:
Network Security

Principles and practices of Network Security, potential threats in connected environment and strategies to avoid, classical and contemporary cryptographic theories, cryptography as a tool to secure network communication, Odern SPN ciphers, block and stream ciphers. DES algorithm and public key cryptography. Linear cryptanalysis, key distribution and management, digital signatures and authentication. Data communication security protocols like IPSec, SSL etc. Secure voice communications, viruses and worms, denial of service attacks, firewalls. Digital Cash. Bio Authentication Algorithms.

Books:

Modeling and Simulation

Introduction to OPNET: Introduction, Tool Environment, System Buttons, Tools, Online Documentation.
Introduction to Network Simulation: M/M/1 Queue Example, objectives, M/M/1 Queue Extensions.
Multiple Access Protocols: Objectives, Preparation, Aloha, CSMA, Ethernet, Token Ring, Conclusions.
Frame Relay: Objectives, Preparation, Network Model, Specify Probes, Prepare a simulation Set Object, Conclusions, extensions.
Fiber Distributed Data Interface: Objectives, Network Model, Specify Probes, Simulation, Execution and Result Analysis, Conclusions.

Books

Database Administration


Books:

Telecommunication systems

Introduction to media, bandwidth and noise, twisted pair (UTP, STP), coaxial cables (types and specification), optical fibers (types), introduction to optical sources and detectors, microwave links, satellite communication and infrared links, switching, circuit and packet switching, introduction to mobile and cellular communication, block diagram and current trend.


Books:

Multimedia Technologies

Introduction to multimedia programming, scope of multimedia programming, convention and trends, media used in current application (including digital video, audio, and graphics), system level issues of performance synchronization, storage and server schemes, dynamic Interactivity, hyperlinking, multimedia, device control, distributed media development and delivery, non-standard media and programming frame works, introduction to multi-media networks.

Books: