# BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

**HYDERABAD CAMPUS**

# II SEMESTER 2021-2022

## COURSE HANDOUT (PART II)

**Date: 03/01/2022**

In addition to Part I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

**Course No. :** CS G523

**Course Title :** Software for Embedded Systems

**Instructors** : Soumya J

**Description:** Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

## Objective:

Introduce the students to the issues and challenges in developing software for embedded systems. Educate them in formal modeling, design and development methodologies. Expose them to tools and techniques used for developing such software.

## Scope:

The course will review basics of Embedded and Real-time systems and generic software processes. The primary focus will be on identifying specific issues related to embedded software development within the usual phases of software development cycle –requirements, design, implementation and testing. A number of illustrative examples willbe used as ad- hoc case studies for different phases to bring out the issues and challenges in the process. Specific technologies, operating environments and development tools will be also used as part of the practical aspects of the course.

## Course Description:

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

## Text Book:

**T1** Bruce Powel Douglass, “Real – Time UML: Advances in the UML for Real – Time Systems”, 3rd Edition, 2004.

**T2** Dive into Python, https:/[/www.python.org/](http://www.python.org/)

**T3** Programming Robots with ROS: A Practical Introduction to the Robot Operating System by Brian Gerkey, Morgan L. Quigley, and William D. Smart. https:/[/www.ros.or](http://www.ros.org/)g[/](http://www.ros.org/)

## Reference books:

**R1** Frank Vahid and Toby Givargis, “Embedded System design”, Wiley.

**R2** James Rumbaugh, Ivar Jacobson and Grady Booch, “The Unified Modeling Language Reference Manual”, 2nd edition, Pearson Education, 2005.

**R3** Luciano Lavagno, Grant Martin and Bran V Selic, “UML for Real: Design of Embedded Real-Time systems”, Kluwer Academic Publishers, 2003.

R4 <http://www.temida.si/~bojan/IPIT_2014/literatura/UML_Reference_Manual.pdf> R5 <http://wiki.ros.org/Books>

R6 https://processing.org/

## Lecture Modules & Learning Objectives

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| --- | --- | --- |
| **Module** | **Title** | **Learning Objectives** |
| **1** | Introduction to Embedded Systems | Review of basics and understanding issues in Embedded Systems |
| **2** | Embedded System Modeling | Techniques for Modeling Embedded Systems |
| **3** | Software Design of a Product | Software Development Methodologies and phases |
| **4** | Software Design for Real – Time / Embedded Systems | Understanding the Software design process by identifying and analyzing requirements for embedded systems software |
| **5** | Design, implementation and testing | Understanding high level architectural framework(s) and design patterns applicable for embedded software. Understanding detailed design issues, implementation issues, Testing methodology for embedded system. |
| **6** | Operating system and run time environments for Robots | Robot Operating System and its use for developing applications |

* 1. **Lecture Schedule**

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| --- | --- | --- | --- |
| **Mod #** | **Lect #** | **Topics** | **References** |
| **1** | **1 – 2** | **Introduction to embedded system** | |
| 1 | Introduction to embedded and real – time system | R1 |
| 2 | Characteristics of software for embedded and real – time systems | T1and R1 |
| **2** | **3 – 7** | **Object Oriented modeling** | |
| 3 – 6 | Object oriented programming using Python | T2 and Class notes |
| 7 | Embedded systems and Object oriented approach- | Class notes |
| **3** | **8 – 16** | **Software design of a product** | |
| 8 – 10 | Object oriented modeling and design with UML | T1, R2 and R3 |

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| --- | --- | --- | --- |
|  | 11 – 13 | UML, UML diagrams, use cases and scenarios – Identification, Details and Diagrams | T1, R2 and R3 |
| **14 – 16** | Analysis – Object Discovery & Identification, Objects Associations &  Attributes, Classes and Relationships, State and Behavior, State charts and Scenarios | T1, R2 and R3 |
| **4** | **17 – 23** | **Software development for Real – time / Embedded/ networked systems** | |
| 17-21 | Processing programming environment | R6 |
| 22 – 23 | Processing and Arduino communication | R6 |
| **5** | **24 – 26** | **Operating systems and Run-time Environments in Embedded system** | |
| 24 – 26 | Robot Operating System: Introduction | T3, R5 |
| **6** | **27 – 35** | **Embedded systems- Interactions with environment using sensors** | |
| 27 | Publisher-Subscriber using Python | R5 |
| 28 – 29 | Navigation using ROS- Use of sensors for distance |  |
| 30 – 35 | Path planning using ROS- Issues |  |
| **7** | **36 - 37** | Modeling Embedded Devices |  |
| 38 | UML Mapping - Revisit of software engineering to make it suit for Real – time  / Embedded system | R3 |
| 39 – 40 | Models for Embedded Software design | R3 |

* 1. **Evaluation Scheme**:

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| --- | --- | --- | --- |
| **Components** | **Weightage** | **Date & Time** | **Remarks** |
| Mid-Sem | 30% | As Per Time Table | Closed Book |
| Assignments/Labs/Project/ Presentation | 30% | Throughout the semester | Open Book |
| Comprehensive Examination | 40% | As per Time Table | Open+Closed Book |

* 1. **Projects:**
     + Project will include the following components:

1. Problem Identification, Specification, and Use Cases.
2. Requirements Analysis, State-charting.
3. Modular Design/Detailed Design
4. Prototype Implementation as part of the Labs and classes
   * + Students should present their work as presentation seminars and should attend others presentations.
     + Projects will be evaluated individually through presentation / demonstration.
     + Projects are to be completed in time with no postponements.

## Malpractice Regulations:

1. Any student or team of students found involved in mal practices in working out projects will be awarded negative marks equal to the weightage of that project and will be blacklisted.
2. Any student or team of students found repeatedly – more than once across all courses – involved in mal-practices will be reported to the Disciplinary Committee for further action. This will be in addition to the sanction mentioned above.
3. A mal-practice - in this context - will include but not be limited to:
   * Submitting some other student’s / team’s solution(s) as one’s own;
   * Copying some other student’s / team’s data or code or other forms of a solution;
   * Seeing some other student’s / team’s data or code or other forms of asolution;
   * Permitting some other student / team to see or to copy or to submit one’s own solution;
   * OR other equivalent forms of plagiarism wherein the student or team does not work out the solution and/or uses some other solution or part thereof (such as downloading it from the web).
4. The degree of mal-practice (the size of the solution involved or the number of students involved) will not be considered as mitigating evidence. Failure on the part of instructor(s) to detect mal-practice at or before the time of evaluation may not prevent sanctions later on.
5. **Chamber Consultation Hour**: To be announced in the class.
6. **Notice**: Notice concerning this course will be displayed on CMS

## Makeup Policy:

* + Permission of the Instructor is required to take a make-up
  + Make-up applications must be given to the Instructor personally.
  + A make-up test shall be granted only in genuine cases wherein the Instructor’s judgment - the student would be physically unable to appear for the test.
  + In case of an unanticipated illness preventing a student from appearing for a test, the student must present a Medical Certificate from BITS medical centre.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no

type of academic dishonesty is acceptable.

## Instructor-in-Charge CS G523