



**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani**  
**Pilani Campus**  
**AUGS/ AGSR Division**

**FIRST SEMESTER 2020-2021**  
**COURSE HANDOUT**

**Date:14.08.2020**

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

**Course No** : **EEE G627**  
**Course Title** : **Network Embedded Applications**  
**Instructor-in-Charge** : **Meetha. V. Shenoy**

**1. Course Description:** This course deals with the three main application areas of Network Embedded Systems – Wireless Sensor Networks, Automotive Networks, and Industrial Networks. The course covers Deployment Issues, Network Architecture design, Network Protocol stack design including Modular and Cross-Layer Design. The course also provides an overview of the Network Security, Middleware Issues in designing networked embedded applications

**2. Scope and Objective of the Course:**

The course intends to cover the issues involved in the design of networked embedded systems. The course discusses the three major enablers of IoT systems- Wireless Sensor Networks, Industrial and Building Automation Networks, and Vehicular Networks. The course also deals with the security and privacy issues, middleware, and performance analysis of networked embedded systems. This course introduces the students to standard Network simulation tools, development environments and gives a hands-on experience in developing various networked embedded applications.

No	Course Outcome (CO)
CO1	To give an introduction to Deeply Embedded Systems
CO2	To design and develop Applications using Wireless Sensor Networks
CO3	To design and develop Networking Systems for Industrial Automation
CO4	To design and develop Networking Systems for Inter and Intra Vehicular Systems
CO5	To familiarize with Network Simulation tools and Protocol stack implementation on Embedded Hardware

**3. Text Books:**

None Required

**4. Reference Books:**

- R1. R.Zurawski, Network Embedded Systems, CRC press, 2009.
- R2. G.Pottie, W.Kaiser, Principles of Embedded Networked System Design
- R3. Raj Kamal, Embedded Systems, Tata McGraw Hill, New Delhi, 2003
- R4. Published papers in Journals, Transactions.
- R5. IETF Drafts and RFCs



## **Content Structure**

1. Wireless Sensor Networks
  - 1.1 Introduction to Wireless Sensor Network Technologies and Applications
  - 1.2 WSN Architectures
  - 1.3 WSN Design Challenges
  - 1.4 WSN Deployment
  - 1.5 WSN Protocol Stack
    - 1.5.1 Time Synchronization
    - 1.5.2 Localization
    - 1.5.3 MAC
    - 1.5.4 Routing
    - 1.5.5 Applications
    - 1.5.6 Building & Debugging WSN
2. Industrial Automation & Network Embedded Systems
  - 2.1. Computer Integrated Manufacturing & Field Buses
  - 2.2. Wired and Wireless Ethernet based Network Embedded Systems
  - 2.3. Industrial Networks
    - 2.3.1. Modified Ethernet
    - 2.3.2. Top of Ethernet
    - 2.3.3. Top of TCP/IP
  - 2.4. Wireless Industrial Networks
  - 2.5. Hybrid Wired and Wireless Systems
3. Vehicular Networked Embedded Systems
  - 3.1. Embedded Networks for Car Domains
  - 3.2. Intra -vehicular Network Embedded Systems
    - 3.2.1. Event Triggered Systems
    - 3.2.2. Time Triggered Systems
  - 3.3. Inter-Vehicular Network Embedded Systems
4. Architectures for M2M & IoT
5. Security aspects of Networked Embedded Systems

## **5.1 Lecture Plan**

Lecture No	Lecture Topics	Remarks
1-2	Introduction to the course- Network Embedded Systems	Introduction to Networking Concepts- Basics
3	Introduction to WSN- Categories, Characteristics, Applications, Deployment Issues, Hardware	



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4-5	Time Synchronization in WSN	
6-7	Localization in WSN	
8-9	MAC in WSN	
10-11	Routing in WSN	
12-13	Case Studies in WSN, Hardware Implementation overview	
14	Security in Wireless Networks	Security –for WSN considerations
15-16	Performance Metrics, Analysis	Developing goals for performance, Performance metrics, Architectural considerations
17-18	Non-IP Based WPAN	802.15 standards, Z-wave
19-20	IP Based WPAN, WLAN	6LoWPAN , RPL, 802.11 standards
21-22	Long-Range Communication Protocols (WAN)	4G,5G,Lora, LoRAWAN, Sigfox
23-24	Industrial Automation Networks	Modified Ethernet, Top of Ethernet & Top of TCP/IP networks (eg: Modbus, EPL)
25-26	Building & Home Automation Networks	LonWorks, BACNet, Z wave
27	Hybrid Wireless & Wired Network	Challenges, Wireless Hart
28-29	Case Studies, IIoT	
30	Vehicular Network- Introduction	Standards and technologies
31-32	Intra-vehicular Networks	CAN, Lin, Flexray
33-34	Inter-vehicular Networks	V2V,V2I,V2R protocols
35	Case Studies	
36-37	Architectures for M2M and IoT	M2M Vs IoT difference, Other concepts relevant to the implementation of these systems, Middleware Issues, Routers & Gateways- SDN
38-40	Threats challenges and Concerns of IoT Security & Privacy	Building Secure IoT Systems, Encryption, Cryptography on small devices, Hashing
40-42	Advanced Topics, Performance Analysis Case Studies	



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**6. Evaluation Scheme:**

Component	Duration	Weightage (%)	Date & Time
Test 1	30 mins	10	September 10-20 (During class hour)
Test 2	30 mins	15	October 9-20 (During class hour)
Test 3	30 mins	10	November 10-20 (During class hour)
Lab Tasks, Quiz/ Test	TBA	15	Announced Quiz/Test , Lab Tasks Throughout the semester
Project +Simulation	TBA	15	Continuous Evaluation
Comprehensive Examination	120mins	35	As announced in Time Table

• Project- Group project. Students are expected to design a networked embedded system, simulate the network, and derive performance analysis. The scope of simulation will be decided in consultation with IC

Simulation/Lab related Activities: Network simulator tools- Netsim, Cooja will be utilized for the simulation related work. Lab sheets will be provided for network simulation. Additional videos may be provided as and when required for demonstrating the practical implementation of networks.

**7. Chamber Consultation Hour:** Saturday 1-2pm. Students can meet me any other time after requesting for an appointment via email: [meetha.shenoy@pilani.bits-pilani.ac.in](mailto:meetha.shenoy@pilani.bits-pilani.ac.in)

**8. Notices:** All notices regarding the course will be put up in course website.

**9. Make-up Policy:** In-general, Make-up will not be granted without prior permission. If the student is unable to appear for the Mid-Semester Test/ Comprehensive Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up.

**10. Note (if any):** It shall be the responsibility of the individual student to be regular in attending lectures and the lab sessions as per the schedule announced in time table.

**Instructor-in-charge:**  
**Dr. Meetha V Shenoy**  
**Course No. EEE G627**