College of Science and Technology

African Center of Excellence in Internet of Things (ACEIoT)

P.O.BOX BP 3900, Kigali

Master of Science in Internet of Things: Wireless Intelligent Sensor Networking (MSc in IoT:WISeNet)

MODULE DESCRIPTIONS

(August, 2017)

MODULE DESCRIPTION

1. **MODULE CODE** : IOT6161
2. **MODULE TITLE** : **FUNDAMENTALS OF INTERNET OF THINGS**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8
SET READING ETC.		
SELF – DIRECTED STUDY	28	28
ASSIGNMENTS – PREPARATION & WRITING	38	20
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

Most of the other Embedded Computing Systems modules provide students with an understanding on how to build hardware, software, communication protocols and cloud infrastructures that enable the Internet of Things (IoT). This module rather explores a broader perspective of IoT with focus on its applications and the value they create. The module will include studies around business modeling, market segmentation, and applications in trending areas such as agriculture, health, transportation, urbanization, energy and manufacturing. The main objective of this module is to closely examine emerging trends, markets, applications, technologies and skills required by graduate students exploring career opportunities in IoT.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A1, A3, A4, A5)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Advanced concepts, principles and theories of Internet of Things
a2. Theory of IoT protocols and various IoT systems delivery platforms
a3. Networking aspects of IoT
a4. Challenges and Opportunities of IoT systems

a5. Policies and Regulatory aspects of IoT

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE(B1, B3,B4, B7)

Having successfully completed this module the students should be able to:

b1. Identify appropriate technology for the development of IoT system solutions
b2. Understand IoT standards and metrics to apply for innovative designs of IoT systems and components
b3. Apply professional knowledge to develop a complex stakeholder system
b4. Critically analyse IoT case studies
b5. Identify the best IoT solution to issues in business

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS: (C1, C2, C5, C6)

Having successfully completed the module, students should be able to:

c1. Apply the appropriate technology they have learned to review and critically analyse IoT based problems, and to propose and carry appropriate solutions
c2. Identify and describe the core hardware components most commonly used in IoT devices
c3. Demonstrate an awareness of IoT applied in selected case studies
c4. Describe the interactions of IoT systems with the physical world
c5. Demonstrate practical applications of IoT systems

D. GENERAL TRANSFERABLE SKILLS: (D1, D3, D4, D5)

Having successfully completed the module, students should be able to:

d1. Effectively apply IoT technology in different domains
d2. Work effectively as a research team member in the implementation of IoT system
d3. Get enough knowledge of understanding the social impact of IoT
d4. Make effective use of different IoT infrastructures and their applications
d5. Use competently the tools and techniques of information technology (ICT) in the analysis, implementation and monitoring of IoT system

9. INDICATIVE CONTENT :

Overview of IoT:
Vision, Evolution of IoT, Definition, Fundamentals, Characteristics and other enabling factors.

Hardware components in IoT solution:
Sensors, Actuators, Gateway/hub device, Edge node device, Camera/ video capture, LCD display, Touch screen, Audio playback/ speaker

Technical aspects of IoT:
High level requirements, Sensor nodes, Connectivity landscape, IoT on the Cloud, Role of Big data and Data Science, Fog Computing for IoT, Web technology for IoT, IoT delivery platforms, Utility of smartphone as an IoT node, The role of the regulator and policy makers,
Relevance of open source software & hardware.

Cloud platforms of choice for IoT:

Amazon web services, Microsoft azure, Google Cloud Platform

Top IoT concerns:
Security, Interoperability, Connectivity, Integration with hardware

Analysis of IoT case studies:

- Smart Cities, Smart Public Places
- Smart Home, and IoT-based Building Automation
- Smart Agriculture and Water Management
- Smart factories and Industry 4.0
- e-Health, Assisted Living and e-Wellness
- Automotive, Intelligent Transport
- IoT-based Supply Chains
- Smart Grid, Energy Management

Business and Social impact of IoT:

- IoT in fourth Industrial revolution,
- IoT Market place,
- Factory of the future,
- IoT as an appropriate technology
- Urban Dynamics and crowd sourcing services
- Metrics, Measurements, and Evaluation of IoT Market Sustainability and RoI
- Human Role in the IoT, Social Aspects and Services
- Value Chain Analysis and Evolution Aspects
- Social Models and Networks
- Green IoT: Energy Sustainable Design and Technologies

10. LEARNING & TEACHING STRATEGY :

Course materials (handbook, papers, etc.) will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures-based classroom presentation, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies. At the end of the course, an interactive seminar should be held to enable students strengthen their knowledge and understanding by discussing and resolving problems based on real life situations. It is also advised to students to attend in person some IoT–related international events (seminar, workshop or policy making conference). They should then feedback in the interactive session about the event and how it correlates to the learning material provided in this module.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
  For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	Weightage (%)	Learning objectives covered
In-course assessment:	**100**	
Assignment	20	A1, A3-A5, B1, B3, B4, B7, C1, C2, C5, C6, D1, D4, D5
Practise /Tutorial	30	B1, B3, B4, B7, C1, C2, C5, C6
Research seminar	10	B1, B3, B4, B7
Final assessment	40	A1, A3-A5, B1, B3, B4, B7, C1, C2, C5, C6, D1, D4, D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

Alasdair Gilchrist. (2016). *Industry 4.0: The Industrial Internet of Things*. Apress, ISBN 978-1484220467

Maciej Kranz. (2016). Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry. Wiley & Sons, ISBN 978-1119285663

Alec Ross . (2016). The Industries of the Future. Simon & Schuster, ISBN 978-1476753652

Rose, K., Eldridge, S. And Chapin, L., 2015. The internet of things: An overview. The Internet Society (ISOC), pp.1 -50.

ITU Overview Document "Y.2060: Overview of the Internet of Things,"2015, https://www.itu.int/rec/T-REC –Y.2060 -201206-I.

Accenture.com, (2015). Accenture's View on the IoT and the Industrial Internet of Things (IioT), http://www.accenture.com/iot.

15. TEACHING TEAM :

- Prof. Tim Brown
- Mrs. Didacienne

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : IOT6162
2. **MODULE TITLE** : **SMART SENSORS & ACTUATORS**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8
SET READING ETC.		
SELF – DIRECTED STUDY	26	28
ASSIGNMENTS – PREPARATION & WRITING	38	20
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

Smart sensors are tiny, autonomous devices equipped with wireless transmission, sensing capabilities for a huge variety of automation applications, such as healthcare, transportation systems, industrial manufacturing, surveillance, resource discovery, etc. Actuators are also autonomous devices that are responsible for moving or controlling a mechanism or system. An actuator requires a control signal a source of energy. Sensors and actuators can combine to form the skin of IoT. Sensors and actuators provide a link between the physical world and the digital world. This module will focus on the basics of sensors and actuators along with their characteristics, specifications and uses.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A1, A2, A3, A4, A5)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Concepts of sensors and actuators along with their characteristics, specifications and uses
a2. Interconnection and working principle of different components of sensors and actuators
a3. Sensor and actuator technologies
a4. Localization and tracking of sensors

a5. Tasking and control of sensors as well as different connectivity families

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE (B1, B2, B3, B4, B7)

Having successfully completed this module, students should be able to:

b1. Use sensors and actuators for designing small IoTs
b2. Understand different functioning of sensors and actuators
b3. Describe sensors, actuators in IoT environment
b4. Demonstrate a critical understanding of sensor communication protocols
b5. Develop a sense for recognizing irrelevant data and solving related problems

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C2, C3, C5, C6)

Having successfully completed the module, students should be able to:

c1. Build a WSN using sensors and actuators
c2. Demonstrate the practical skills in information sensing and actuating
c3. Design a simple IoT system made up of sensors and actuators
c4. Build and test a complete working IoT system
c5. Condition the sensor electronically and hook it up to a microcomputer, and process the signal for analysis

D. GENERAL TRANSFERABLE SKILLS: (D1, D4, D5)

Having successfully completed the module, students should be able to:

d1. Apply smart sensors and actuators in IoT
d2. Use competently all available case tools
d3. Demonstrate problem solving skills related to sensors and actuators for IoT system
d4. Carry on independently investigation on sensors and actuators in IoT systems of collected data
d5. Effectively retrieve information from a variety of sources

9. INDICATIVE CONTENT :

The Sensor Components: Different components of a sensor (transducers, A-to-D converter, transmitter, receiver, power supply, microprocessor, memory).

Sensors and sensing technologies: Thermocouples, resistive sensors, inductive sensors, capacitive sensors, piezoelectric sensors, encoders and tachometers; sensor performance criteria, Biometric sensors, multimedia sensors.

The Actuator Components: Different components of an actuator (Transmitter, receiver, D-to-A converter, power supply, microprocessor, memory, drivers, mechanical controllers).

Actuators and actuating technologies: electric, fluidic, thermal, mechanical actuators, MEMS sensors and actuators, hydraulic, pneumatic, magnetic actuators; actuator performance criteria.

Sensors for Localization and Tracking: Outdoor and indoor tracking, Cooperative localization centralized and distributed localization, recursive position estimation.

Sensor Tasking and Control: Task based sensing, information based sensing, grouping, sensor resource constraints.

Sensor Communication protocols: RS232, RS422, RS485, Serial peripheral Interface (SPI), Inter – Integrated Circuits (I2c), Universal Serial Bus (USB), AS-i Actuator sensor interface, BSAP Bristol Standards Asynchronous Protocol.

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
  For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	**Weightage (%)**	**Learning objectives covered**
In-course assessment:	**100**	
Assignment	20	A1-A5,B1-B4,B7,C1-C3,C5,C6,D1,D4, D5
Practise /Tutorial	30	B1-B4,B7,C1-C3,C5,C6
Research seminar	10	B1-B4,B7
Final assessment	40	A1-A5,B1-B4,B7,C1-C3,C5,C6,D1,D4, D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work

on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Understanding smart sensors by Randy Frank, Artech House, 2013 - Technology & Engineering - 367 pages.
2. Sensors and Actuators: Engineering System instrumentation, Second edition by Clarence W. de Silva, July 28, 2015 by CRC Press, Textbook - 847 Pages - 456 B/W Illustrations, ISBN 9781466506817.
3. Sensors, Actuators, and Their Interfaces: A Multidisciplinary Introduction by Nathan Ida, ISBN-13: 978-1613530061, ISBN-10: 1613530064.
4. Smart Sensors for Industrial Applications, Krzysztof Iniewski, CRC Press, 29 May 2013 - Technology & Engineering - 598 pages.

TEACHING TEAM :

- Dr Marco Zennaro
- Prof. Santhi Kumaran

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
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4	Signature :	
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Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : IOT6163
2. **MODULE TITLE** : **WIRELESS SENSOR NETWORKS**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	**STUDENT HOURS**	**STAFF HOURS**
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8
SET READING ETC.		
SELF – DIRECTED STUDY	26	28
ASSIGNMENTS – PREPARATION & WRITING	38	20
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

In this module the students will learn about wireless sensor networks. Wireless sensor networks is one of the most important topics in IoT, where all the networking aspects of wireless sensors like introduction to WSN , types of WSNs, protocols and algorithms, WNS applications, WSN platforms, potential synergies etc. are taken care of.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING(A1, A2, A3, A4, A5)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Concepts of WSN
a3. Design and software development principles of WSNs
a4. Principles of WSN performance criteria
a4. Future trends of wireless sensor networks
a5. Various platform used for building a wireless sensor network

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B1, B2, B3, B4, B7)

Having successfully completed this module, the students should be able to:

b1. Suggest and formulate technical solutions WSN
b2. Demonstrate a critical understanding of WSN protocols and algorithm and their use
b3. Show ability to handle new concepts, methods and results in WSN
b4. Use existing platform to build up a wireless sensor network
b5. Design a wireless sensor networks using different sensors and actuators

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C2, C3, C5, C6)

Having successfully completed the module, students should be able to:

c1. Use competently all test and measuring instruments used in WSN
c2. Observe and record accurately collected data in WSN
c3. Critically analyse and describe WSN communication system
c4. Plan the installation and maintenance WSN systems
c5. Demonstrate practical applications of WSN

D. GENERAL TRANSFERABLE SKILLS: (D1, D4, D5)

Having successfully completed the module, students should be able to:

d1. Demonstrate problem solving skills related to WSN
d2. Communicate effectively using block diagrams and network diagrams of wireless sensor networks
d3. Implement WSN for different IoT applications
d4. Work effectively in a team both as a member or leader in a wireless sensor networks for IoT research project
d5. Use competently all available ICT tools and techniques in the deployment and management of WSN for IoT

9. INDICATIVE CONTENT :

Types of WSNs: Terrestrial, Underground, Underwater, Multimedia and Mobile WSN

Tracking: Tracking Scenarios (Sensing Model, Collaborative Localization), Tracking Multiple objects

Protocols and algorithms: Appropriate QoS models, Cooperation in WSNs, WSN deployment, management, and self-reconfigurability, MAC for Sensors (S-Mac)

WNS applications: Body Area Network, Urbanization and Infrastructure (Smart home & cities, Intelligent transportation Systems), Industry & agriculture (Farming and Infrastructure and plant monitoring), environment (animal tracking and disaster management).

WSN platforms: Outdoor and Indoor testbeds (CitySense, Tutornet, Mobile Emulab, w-iLab.t, Sensei-UU) , Berkeley Motes.

Potential synergies: Synergy between mobile robots and WSNs, map-casting from mobile phones to virtual sensor maps, Integration of WSN and RFID, : integrating satellite technology and WSNs.

Future trends of wireless sensor networks: Cross layer design, sensor network application and challenging environments (underwater acoustic sensor networks, terrestrial sensor networks, factors influencing the design of critical environment sensor networks).

Case study projects using Sensor Nodes

- Environment monitoring
- Security implementation
- Home automation
- Industrial control
- Precision Agriculture
- Predictive maintenance
- IoT applications
- Rotating component Health
- Condition-Based Monitoring of Machines
- Health Monitoring of Aircraft, Structures and Vehicles
- Experimental Test and Measurement
- Robotics and Machine Automation
- Condition-based monitoring
- Structural health monitoring
- Test and measurement
- Robotics and machine control
- Remote sensing web-based wireless sensor data acquisition
- Condition-based monitoring

- Equipment performance monitoring, verification, evaluation, and diagnostics
  System control

Laboratory practices

- C based programming
- Exhaustive set of "easy to use" APIs
- Flexible MAC protocol implementation (S-MAC)
- Live data Interface with MATLAB
- Source code of Protocols and open for modification
- Android APP with sample code
- Interface to Cloud access
- Programming sensor devices through their interfaces
- Network topology graph generator for selected protocols (NS-2/NS-3)
- Flexible mac and phy layer with controllable PIB attributes through predefined APIs.
- Complete implementation of protocol stack in C

10. LEARNING & TEACHING STRATEGY :

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11. ASSESSMENT STRATEGY :

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12. ASSESSMENT PATTERN :

Component	Weightage (%)	Learning objectives covered

In-course assessment:	100	
Assignment	20	A1-A5,B1-B4,B7,C1-C3,C5,C6,D1,D4, D5
Practise /Tutorial	30	B1-B4,B7,C1-C3,C5,C6
Research seminar	10	B1-B4,B7
Final assessment	40	A1-A5,B1-B4,B7,C1-C3,C5,C6,D1,D4, D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Introduction to wireless Sensor Networks by Anna Forster, ISBN: 978-1-118-99351-4 186 pages, August 2016, Wiley-IEEE Press
2. Building Wireless Sensor Networks using Arduino by Matthijs Kooijman
3. Wireless Sensor Networks, Principles, Design and Applications, Shuang-Hua Yang, ISBN: 978-1-4471-5504-1 (Print) 978-1-4471-5505-8 (Online)
4. Wireless Sensor Networks: Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli, Taieb Znati, ISBN: 978-0-471-74300-2, 328 pages, May 2007
5. Wireless Sensor Networks: From Theory to Applications, Ibrahiem M. M. El Emary, S. Ramakrishnan, November 16, 2016 by CRC Press, Reference - 799 Pages – 432, B/W Illustrations, ISBN 9781138198821.

15. TEACHING TEAM :

- Prof. Raja Datta
- Prof. Santhi Kumaran

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	

3	Signature :	
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4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : IOT6164
2. **MODULE TITLE** : **DESIGNING AND PROGRAMMING EMBEDDED DEVICES**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	**STUDENT HOURS**	**STAFF HOURS**
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8
SET READING ETC.		
SELF – DIRECTED STUDY	26	28
ASSIGNMENTS – PREPARATION &	38	20

WRITING		
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

There is no inhabited place nowadays that you can step in without being surrounded by embedded computing systems. They are found in personal digital assistants (including smart phones), biomedical devices, networked sensors, mobile robotics, automotive and airlines systems, and smart cards and RFID tags amongst others. With the emergence of the Internet of Things (IoT), embedded systems are going to move viral; they will enter our kitchens, bedrooms and bodies. This module provides an overview of hardware behind embedded computing systems and a deep understanding of software technologies that enable them to operate. Major topics will include software architectures, common design patterns, programming, debugging, and integrating embedded software from smart kitchen appliances to sophisticated fight control for airlines. A series of integrated labs using a Software Development Kit (SDK) for embedded computing systems will enable to reinforce the concepts taught in lectures.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A1, A2, A4, A5, A7)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Advanced principles of embedded system and the components that compose it
a2. Concepts necessary to design and program embedded devices
a3. Principles and practices of software engineering for embedded systems
a4. Design principles of embedded systems software
a5. Programming embedded system using C programming language
a6. Usage and pros of event based programming using interrupts

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE (B1, B2, B3, B5)

Having successfully completed this module, students should be able to:

b1. Develop embedded software of high quality using high level programming
b2. Critically analyse embedded software requirements
b3. Build interrupt-based programs for a concrete microcontroller
b4. Use peripheral components (timer, ADC, EEPROM) to realize complex tasks for embedded systems
b5. Write scheduling algorithms for real time operating systems including their pros and cons

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C2, C3, C5, C6)

Having successfully completed the module, students should be able to:

c1. Interface with external components utilizing serial protocols
c2. Identify compatible software development environment and real-time operating

for various systems

c3. Experience hands-on labs with the development, debugging, and simulation of an embedded system

c4. Develop software on hardware platforms taking limitations such as memory size, processor capacity, and bandwidth into account

c5. Differentiate architectures of embedded software development

D. GENERAL TRANSFERABLE SKILLS: (D1, D2,D4,D5)

Having successfully completed the module, students should be able to:

d1. Integrate hardware and software for embedded systems

d2. Apply software techniques to improve operability

d3. Manage an embedded software development project using SDLC

d4. Carry on independently investigation on embedded systems of their failure

d5. Communicate effectively using sketches block diagrams and wiring diagrams of embedded micro-controllers

9. INDICATIVE CONTENT :

Introduction

Key Definitions, Getting to Know Embedded Hardware, Embedded Design Examples; Getting to Know the Processor, Study the External Peripheral, Initialize the Hardware

Architecture of IoT Devices

- Functional Components (Transceiver, Microcontroller, Memory, Power System)
- Interfaces: SPI
- ARM Cortex-M3/ ARM Cortex-M4, ARM Cortex-M0/ ARM Cortex-M0+/ARM CortexM1, 16-bit MCU, ARM Cortex-M7, 8-bit MCU

System Level Design

- Components Types and Selection
- Integration on PCB

Programming Embedded Microcontrollers

- Compiling, Linking and Debugging
- Advanced embedded programming
    - Memory,
    - Interrupts
    - Drivers for communication with peripherals
- Power Management
- Real-Time OS
- Testing and Debugging

IoT Programming Languages

- Java, C, C++, Python, Javascript, Nodes-js, Assembler, PHP, C#, Lua, R, Go, Ruby, SWIFT, Rust

Programming with Embedded Platforms

- Arduino C Programming
- Raspberry Pi Python Programming
- Micro-Python Programming
- ARM Cotex Programming

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
  For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	**Weightage (%)**	**Learning objectives covered**
In-course assessment:	**100**	
Assignment	20	A1,A2,A4,A5,A7,B1-B3,B5,C1-C3,C5,C6, D1,D2,D4,D5
Practise /Tutorial	30	B1-B3,B5,C1-C3,C5,C6
Research seminar	10	B1-B3,B5
Final assessment	40	A1,A2,A4,A5,A7,B1-B3,B5,C1-C3,C5,C6, D1,D2,D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to

students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Michael Barr, Anthony Massa. (2006).*Programming Embedded Systems: With C and GNU Development Tools*. 2nd Edition. O'Reilly Media, ISBN 9780596009830
2. Ivan Cibrario Bertolotti, Tingting Hu. (2015). *Embedded Software Development: The Open-Source Approach*. CRC Press, ISBN 9781466593923
3. Kai Qian, David Den Haring, Li Cao. (2009). *Embedded Software Development with C*. Springer US, 978-1-4419-0605-2

TEACHING TEAM :

- Dr. Chomora Mikeka
- Dr. Damien

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	

	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : IOT6165
2. **MODULE TITLE** : **IoT ENTERPRENEURSHIP**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	**STUDENT HOURS**	**STAFF HOURS**
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8
SET READING ETC.		
SELF – DIRECTED STUDY	26	28
ASSIGNMENTS – PREPARATION & WRITING	38	20
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

As IoT is now attracted to be used in all aspect of living including business, industries, etc., graduate students in IoT need to have entrepreneurship skills for them to acquire the knowledge of creating and growing a start-up in the settings of the Internet of Things. This module is thought to all students to gain entrepreneurship skills and start-up business. Industrial and consumer IoT markets and products will be discussed.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A1, A2, A3, A7, A8, A10)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Requirements to start an IoT Business
a2. Legal implications
a3. Mistakes must be avoided and how
a4. The intricate differences between an IoT and non-IoT business and
a5. The difference between an industrial IoT and consumer IoT business

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE (B1, B4)

Having successfully completed this module, students should be able to:

b1. Start a small business
b2. Make the right decision between corporate & entrepreneurial worlds
b3. Take the right decisions when growing one's own company
b4. Understand strategies to attract venture capital
b5. Use IoT in the development of solutions to problems in business

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C3, C5, C6)

Having successfully completed the module, students should be able to:

c1. Critically analyse at least 3-4 milestones which need to be met and what they entail from a company transformation point of view.
c2. Apply knowledge of IoT to transforming existing business
c3. Overcome long sales cycles in the IoT
c4. Show ability to start a business with new concepts of use of IoT
c5. Identify and critically analyse mistakes made by IoT entrepreneurs and advise on how to correct them
c6. Secure investment for IoT ventures

D. GENERAL TRANSFERABLE SKILLS: (D1, D3, D4, D5)

Having successfully completed the module, students should be able to:

d1. Start your own businesses
d2. Undertake lifelong learning with active involvement in research and development on IoT business
d3. Carry out independently a sustained investigation and research on IoT business
d4. Work effectively in a team both as a member or leader of the business section in IoT entrepreneurial
d5. Communicate effectively (written, verbal, drafting, sketching etc.) in presenting an IoT business plan, business reports and market analysis reports
d6. Use competently the tools and techniques of information technology (ICT) in making IoT business decisions
d7. Write a company life development plan

9. INDICATIVE CONTENT :

- Basics of entrepreneurship, including business models, business proposals, risk mitigation, business ethics, market assessments, how to get started, hiring strategies, growth milestones, product development & production;
- Entrepreneurial versus Corporate working trajectory, what it implies from a daily routine, sacrifice and potential return point of view;
- Notion of opportunity cost;
- Copyright, trademark and patents
- How to attract Venture Capital
- Entrepreneurial differences of IoT ventures;
- Transforming existing business by applying IoT;
- Differences between industrial and consumer IoT markets and products;
- The stark differences between need and demand in the emerging IoTs;
- Deep-dive on how to overcome long sales cycles in the IoT;
- Deep-dive on business models and business modelling for the IoT;
- Introduction on securing investment for IoT ventures, and discussion on specific exit strategies ;
- Important entrepreneurial and corporate laws and on taxation;
- Discussions on the most typical mistakes made by IoT entrepreneurs, and how to avoid them;

Exercise:
Student should do a business plan and company life development plan for a specific IoT company he/she would like to start (even if only fictional); drafting of patent in IoT.

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used. For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	Weightage (%)	Learning objectives covered
In-course assessment:	**100**	
Assignment	20	A1-A3,A7,A8,A10, B1, B4, C1, C3, C5, C6, D1, D3, D4, D5
Practise /Tutorial	30	B1, B4, C1, C3, C5, C6
Research seminar	10	B1, B4
Final assessment	40	A1-A3,A7,A8,A10, B1, B4, C1, C3, C5, C6, D1, D3, D4, D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. ITU Internet of Things website, consolidating all activities conducted within the ITU which are related to IoT case studies and applications; available online: http://www.itu.int/en/ITU-T/techwatch/Pages/internetofthings.aspx.
2. Harvard Engineering and Entrepreneurship: The Internet of Things; available online: http://crcs.seas.harvard.edu/engineering-and-entrepreneurship-internet-things
3. S.Case, 2016, The Third Wave: An Entrepreneur's Vision of the Future
4. ITU Report "Shaping smarter and more sustainable cities: Striving for sustainable development goals", 2016, http://wftp3.itu.int/pub/epub_shared/TSB/ITUT-Tech-Report-Specs/2016/en/flipviewerxpress.html
5. ITU Report "Implementing ITU-T International Standards to Shape Smart Sustainable Cities: The Case of Dubai", 2016, http://www.itu.int/en/publications/Documents/tsb/2016-DubaiCase/index.html
6. United for Smart Sustainable Cities: Striving for Sustainable Development Goals,2016,http://wftp3.itu.int/pub/epub_shared/TSB/2016-ITUT-SSCBrochure/en/index.html#p=1

TEACHING TEAM :

- Prof. Martin Saint

- Dr. Ngend Luc

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : **IOT6166**
2. **MODULE TITLE** : **RESEARCH METHODOLOGY**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 0
4. **FIRST YEAR OF PRESENTATION** : 2017-2018

5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
LECTURES	36	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY		
STRUCTURED EXERCISES		
SET READING ETC.		
SELF – DIRECTED STUDY	50	
ASSIGNMENTS – PREPARATION & WRITING	64	30
EXAMINATION – REVISION & ATTENDANCE		
OTHER: INVIGILATION END OF MODULE		
TOTAL	150	78

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

This module examines some of the theories and methods associated with educational research methodologies through a consideration of definitions and purposes of research, approaches to framing the enquiry, methods, analysis and writing up the research project. Students are introduced to a range of research methods which are critically assessed. The module aims to give the confidence, critical understanding and skills to enable students to embark on their own educational research project. It also aims to provide a basis for informed judgements about research methods and evidence those members of research-led profession need to make.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: **(A1, A2, A10)**

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Theories of communications, management and methodologies relevant to research and development

a2. General and specific objectives of research related to IoT

a3. Research hypotheses and their importance

a4. Research methodologies (literature review, need of assessment, data collection, data analysis,

validation, verification, and testing)
a5. Budgeting and financing of research projects
a6. Methods of statistical analysis
a7. Qualitative and quantitative research methods within IoT systems

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE : (B1, B2, B9)

Having successfully completed this module the students should be able to:
b1. Develop plans for research on IoT
b2. Develop new techniques and solutions to IoT problems
b3. Create new and innovative designs of IoT systems
b4. Assess R&D work done by self and others
b5. Critically analyse different issues related to failure of IoT Systems
b6. Critically assess and evaluated technical risks due to failure of hardware and software of IoT
b7. Explore commercial and business risks due to system failure
b8. Identify appropriate method to find solution of the environmental risks due to faulty system design and/or implementation

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS: (C1, C2, C6)

Having successfully completed the module, students should be able to:
c1. Design and Develop new projects in IoT
c2. Collect primary and secondary data, critically observe, analyse and report appropriately
c3. Critically analyse data using standard statistical packages or customised software
c4. Design and develop new IoT systems and related ones
c5. Validate Software development /Management strategies based on the requirements specification

D. GENERAL TRANSFERABLE SKILLS: (D1, D4, D5)

Having successfully completed the module, students should be able to:
d1. Organize and conduct research in IoT related research activities
d2. Investigate and formulate reports on IoT research projects
d3. Coordinate with a team in research and also take lead when required
d4. Manage their own learning and development, including time management and organisational skills which add to cost directly or indirectly
d5. Communicate verbally with other individuals and groups, and prepare reports on communications research projects
d6. Demonstrate computational skills and mathematical utility as required
d7. Use all kinds of hardware and software tools appropriate for ICT and research

9. INDICATIVE CONTENT :

- Introduction to research methods, research concepts and methodologies
- Reviewing the literature and data collection: bibliographic methods, sources, archives, information retrieval, keeping records and making notes, critical reading and structuring a literature review

- Academic writing. Scholarly conventions and referencing. Plagiarism.
- Planning the research process
- Research design: types of design, selecting a design, establishing feasibility/access
- Ethical questions in research. Research codes of practice
- Developing the research proposal
- Qualitative research: principles, methods and practice
- Quantitative research: principles and approaches
- Data analysis and presentation of information
- Communicating research progress and results
- Tools for statistical analysis
- Presentation
- Investigating emerging research themes
- Investigating research strategies (approaches and methods) followed
- Investigating theoretical framework used
- Analysing the problem domain addressed (e.g. explorative, develop, evaluation, human, technical etc
- Writing and presenting academic paper
- Research supervision
- Preparing the thesis.

9. LEARNING & TEACHING STRATEGY :

Course materials (handbook, papers, etc.) will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures-based classroom presentation, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies. At the end of the course, an interactive seminar should be held to enable students strengthen their knowledge and understanding by discussing and resolving problems based on real life situations. It is also advised to students to attend in person some IoT–related international events (seminar, workshop or policy making conference). They should then feedback in the interactive session about the event and how it correlates to the learning material provided in this module.

10. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system. 60% based on individual assignments, group works and 40% - a Research proposal.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
- For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

11. ASSESSMENT PATTERN :

Component	Weightage (%)	Learning objectives covered
In-course assessment:	**100**	
Assignments	30	A1,A2,A10,B1,B2,B9,C1,C2,C6,D1,D4,D5
Group work	30	C1,C2,C6,D1,D4,D5
Final Proposal	40	A1,A2,A10,B1,B2,B9,C1,C2,C6,D1,D4,D5

12. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

13. INDICATIVE RESOURCES :

Core Text (include number in library or URL) (Inc. ISBN)

1 Research Methodology by Reddy
   Publisher: APH Publishing Corporation (1 Dec 2004)
   Language English
   ISBN-10: 8176486728
   ISBN-13: 978-8176486729

2 Research Methodology by Khan
   ISBN: 9780761935896
   Publisher SAGE international

3 Research Methodology: Techniques & Trends by V. V. Khanzode
   ISBN: 8170246482ISBN-13: 9788170246480, 978-2008
   Publisher: APH Publishing Corporation

4 Research Methodology by Debashis Chakraborty
   Published: Saurabh Publishing House
   ISBN: 9788189005276

5 Research Methodology: A Step by Step Guide for Beginners by Ranjit Kumar
   Publisher: Sage Publications Ltd (28 Jan 1999)
   ISBN-10: 076196214X

ISBN-13: 978-0761962144

6 Research Methodology by Bhattacharyya D K
Publisher: Excel
ISBN: 8183234972

7 Research Methodology: Methods and Techniques by C. R. Kothari
Publisher: Wiley Eastern Limited (1985)
ASIN: B000KWR1TG

Background Texts (include number in library or URL) (inc ISBN)

1. Management Research Methodology: Integration of Principles, Methods and Techniques by K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan
Prentice Hall, 2009
ISBN: 8177585630
ISBN-13: 9788177585636, 978-8177585636
2. Research Methodology by Thanulingam, N
Himalaya Publishing House
3. Research Methodology by Manoharan
Publisher: APH Publishing Corporation (January 1, 2009)
ISBN-10: 8131305295
ISBN-13: 978-8131305294
4. Research Methodology by Rohilla
Publisher: PHI
ISBN: 8120324528
EAN: 9788120324527

Laboratory space and equipment

For group work sessions a room is required with a level floor with furniture that can be arranged for students to sit in groups. A black or white board is also required. A computer lab with 30 terminals is required for assisting students in research and presentation of seminar.

14. TEACHING TEAM :

- Prof. Santhi Kumaran
- Dr. Bajpai Gaurav

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Masters Coordinator	Date
1	Signature :	
	Print Name :	

2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : WSN6261
2. **MODULE TITLE** : **IoT ARCHITECTURE, PROTOCOLS AND STANDARDS**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 15
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	**STUDENT HOURS**	**STAFF HOURS**
LECTURES	24	48

SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	18	36
STRUCTURED EXERCISES	6	12
SET READING ETC.		
SELF – DIRECTED STUDY	42	42
ASSIGNMENTS – PREPARATION & WRITING	60	30
EXAMINATION – REVISION & ATTENDANCE		44
OTHER: INVIGILATION END OF MODULE		4
TOTAL	150	216

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

The mission of IoT is to enable communication, and computation enabled devices on different networks to be able talk to each other using a common protocol. This will allow new and smart devices to be added to the Internet infrastructure. To offer connectivity between heterogeneous devices, systems and services, there is need of building middleware architectures that support their interoperability. There are several challenges in terms of turning the mission of IoT into reality. This includes architecture, communication, services, computational intelligence, storage, governance apart from core areas of sensor development and material engineering. This module will walk the students through the architecture and protocols that enable next generation Internet and the various middleware designs that are making IoT happen.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A4,A7,A10)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Different architectures of IoT
a2. Principle aspects of Wireless communications
a3. Knowledge of middleware at a specialist level
a4. Protocols used at the various layers of the IoT architecture
a5. Principles of IoT including an awareness of standards of practice

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B3, B4, B5)

Having successfully completed this module, the students should be able to:

b1. Suggest protocols for technical solutions in IoT
b2. Show ability to design a network with new concepts of data exchange protocols for IoT
b3. Use IoT protocols and architecture in the development of solutions to problems in IoT applications
b4. Apply knowledge of IoT protocols and standards to assess impact of IoT system
b5. Use basic principles of wireless communications for planning a wireless sensor network for IoT

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C2,C6)

Having successfully completed the module, students should be able to:

c1. Critically analyse and describe wireless communication technologies

c2. Demonstrate practical applications of wireless communication technologie in IoT

c3. Use competently IoT protocols and standards in the installation of IoT system

c4. Critically analyse different open source and commercial middleware solutions

c5. Instrument different smart applications with IoT sensors

c6. Demonstrate a critical understanding of physical layer, networking layer message protocols, programming frameworks, and an understanding of energy and bandwidth constraints

D. GENERAL TRANSFERABLE SKILLS: (D4,D5)

Having successfully completed the module, students should be able to:

d1. Manage their own learning and development from experience of IoT system

d2. Effective learning of IoT system, with active involvement in research and development of new and efficient IoT architecture and protocols

d3. Carry out independently a sustained investigation and research in IoT architecture and protocols

d4. Demonstrate problem solving skills related to IoT protocols, architecture and standards

d5. Use competently ICT tools in the implementation of IoT system of various architecture and protocols

9. INDICATIVE CONTENT :

Network Design and Architecture:
Various IoT architectures including Three Layers & Five Layers models; ISO layers; Embedded Systems Architectures; Network Planning;

Basic principles of Wireless communications in IoT:
Frequencies, Interference issues, Propagation, Transmission Power, Sensitivity, Antennas.

IoT Protocols and Standards

Physical Layer

Short Range: Zigbee, Z-Wave, RFID, Bluetooth, WiFi, Low-power WiFi (LP -WiFi), visible light communications.

Long Range: LPWAN (LoRA, Sigfox),Weightless Technology

Cellular 3GPP technologies: EC-GSM, GSM/GPRS, NB-IoT, LTE-M

Satellite Communications: Technology overview, coverage, latency and applications

Networking layer

*IPv6***:** Introduction to IP6 and 6LoWPAN;

Content Delivery Network (CDN) and Named Data Networking (NDN) for IoT;

Data exchange protocols:
CoAP, REST, XMPP, MQTT, HTTP, AMQP, DDS etc..

Industrial Protocols:

Modbus, CAN, Industrial Protocol (EtherNet/IP, ControlNet), OPC-UA (IEC 62541), Pratibus, Prafinet, KNX, BACNet,EtherCat, IEC 60870, 61850, DNP3, FOUNDATION fieldbus, Sercos

Software Architecture and Middleware:
Analysis of different open source and commercial middleware solutions, including SCADA, WISeMid, AURA, UBIWARE, HYDRA, Tiny DB; Mobile middleware enabling communication;
Impact of IMS, RCS, RCS-e, EPC, LTE on the evolution of mobile middleware;

Practical:
Instrumenting different smart applications with IoT sensors;
Simulation Tools for IoT (accessible software solutions); MQTT based data exchange;

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
  For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	**Weightage (%)**	**Learning objectives covered**
In-course assessment:	**100**	
Assignment	20	A4,A7,A10,B3,B4,B5,C1,C2,C6,D4,D5
Practise /Tutorial	30	B3,B4,B5,C1,C2,C6
Research seminar	10	B3,B4,B5
Final assessment	40	A4,A7,A10,B3,B4,B5,C1,C2,C6,D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Honbo Zhou (2012). *The Internet of Things in the Cloud: A Middleware Perspective*. CRC Press, ISBN 9781439892992
2. Hervé Chabanne, Pascal Urien, Jean-Ferdinand Susini. (2013). *RFID and the Internet of Things*. John Wiley & Sons, 9781848212985
3. Byrav Ramamurthy, George N. Rouskas, Krishna Moorthy Sivalingam. (2011). *Next-Generation Internet: Architectures and Protocols*. Cambridge University Press, ISBN 978-0521113687

15. TEACHING TEAM :

- Dr. Marco Zenaro
- Prof. Santhi Kumaran

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : WSN6262
2. **MODULE TITLE** : **SECURITY, PRIVACY AND ETHICAL ASPECTS OF IoT**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 15
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	**STUDENT HOURS**	**STAFF HOURS**
LECTURES	24	48
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	18	36
STRUCTURED EXERCISES	6	12
SET READING ETC.		
SELF – DIRECTED STUDY	42	42
ASSIGNMENTS – PREPARATION & WRITING	60	30
EXAMINATION – REVISION & ATTENDANCE		44
OTHER: INVIGILATION END OF MODULE		4
TOTAL	150	216

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

Wireless sensor network is highly vulnerable to attacks because it consists of various devices which have constrained resources such as; low battery power, less memory, and associated low energy. Sensor nodes communicate among themselves via wireless links. However, there are still a lot of unresolved issues in wireless sensor networks of which security is one of them. Sensor networks are deployed in hostile environments. Environmental conditions along with resource-constraints give rise to many types of security threats or attacks. In this module the students will learn about various attacks in IoT, the security design and also different types of infringement on privacy of human beings and also other habitats. This module will also impart knowledge on the ethical aspects while deploying IoT for various applications.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A4,A5)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Concepts of security in IoT
a2. Security design approaches
a3. Design and development principles of authentication and security systems
a4. Professional ethical legal responsibilities of IoT Engineers
a5. Privacy issues in IoT

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B4,B6,B9)

Having successfully completed this module, students should be able to:

b1. Use principles of IoT security in the development of solutions to problems in WSN
b2.Apply known encryption /decryption and authentication algorithms to produce innovative designs of IoT products
b3. Apply knowledge of IoT security to produce technical risk assessment
b4. Apply knowledge gained on security to produce commercial risk assessment
b5. Apply ethical knowledge of IoT to solve ethical implications of data collection and use

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C4, C6)

Having successfully completed the module, students should be able to:

c1. Use competently and safely any IoT security related monitoring instruments
c2. Plan installation and maintenance of IoT security equipment
c3. Demonstrate awareness of privacy issues in IoT
c4. Demonstrate awareness ethical aspects of IoT
c5. Demonstrate practical applications of IoT security system

D. GENERAL TRANSFERABLE SKILLS: (D1,D4,D5)

Having successfully completed the module, students should be able to:

d1. Efficiently manage time and resources in maintaining IoT security systems
d2. Demonstrate problem solving skills specific for IoT security
d3. Apply software techniques to improve security in IoT system

d4. Carry on independently investigation on IoT security equipments and Systems of their failure
d5. Demonstrate problem solving using ICT tools

9. INDICATIVE CONTENT :

Need of IoT Security: Requirement and Basic Properties , Main Challenges, Confidentiality, Integrity, Availability, Non-Repudiation

Security Classification & Access Control: Data classification (Public and Private), Privacy issues in IoT, IoT Authentication and Authorization, IoT Data Integrity

IoT Security Technologies: Communication Security, Data encryption, JSON web token or similar token, public key infrastructure, OAuth &OpenID, Over the air update, Secure boot, Use of hardware Security Module, Use of trusted Platform Modules (TPM)

Web Based Attacks and Implementation in IoT: Denial of Service, Sniffing, Phishing, DNS Hijacking, Pharming, Defacement etc.

Cryptology:

- ✓ **Cipher:** Symmetric Key Algorithms (AES and DES), Asymmetric Key Algorithm(RSA),
- ✓ **Attacks:** Dictionary and Brute Force, Lookup Tables, Reverse Lookup Tables, Rainbow Tables,
- ✓ **Hashing:** MD5, SHA256, SHA512, RipeMD, and WHIRLPOOL, Salt , Best practices

Attack Surface in IoT and Threat Assessment:

- ✓ **Embedded device:** UART, SPI, I2C, JTAG,
- ✓ **Software and Cloud Components:** Firmware of the device, Web Application Dashboard , Mobile Application Used to Control, Configure and Monitor the Devices,
- ✓ **Radio Communication:** WiFi, BLE, Cellular, Zigbee, ZWave, 6LoWPAN.

IoT Protocol Inbuilt Security Features: On Transport Layer: SSL/TLS and DTLS, On Application Layer: MQTT, CoAP, XMPP, AMQP

Security Management: Identity and Access Management, Key Management

IoT security use cases: examples of securing Upstream/downstream and upstream communications for IoT devices.

Privacy issues in IoT: data privacy (privacy in data aggregation and privacy in data query), contextual privacy (location privacy and temporal privacy). Privacy laws (national/international regulations), trust issues in IoT systems.

Ethical aspects of IoT: Ethics, laws and regulations related to deployment of IoT (differences between countries/regions), ethical implications of data collection and use.

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
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Research seminar	10	B4,B6,B9
Final assessment	40	A4,A5,B4,B6,B9,C1,C4,C6, D1,D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
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- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

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2. Handbook on securing cyber-physical critical infrastructure: Chapter 7: by Raja Datta and Ningrinla Marchang (Morgan Kaufmann)

Journal Proceedings

1. Idrees S. Kocher, Chee-Onn Chow, Hiroshi Ishii, and Tanveer A. Zia "Threat Models and Security Issues in Wireless Sensor Networks" International Journal of Computer Theory and Engineering, Vol. 5, No. 5, October 2013
2. John Paul Walters, Zhengqiang Liang, Weisong Shi, and Vipin Chaudhary, "Wireless Sensor Network Security: A Survey", Security in Distributed, Grid, and Pervasive Computing, Chapter 17, Auerbach Publications, CRC Press,2006
3. Kahina CHELLI "Security Issues in Wireless Sensor Networks: Attacks and Countermeasures" Proceedings of the World Congress on Engineering 2015 Vol I, WCE 2015, July 1 - 3, 2015, London, U.K.
4. Jaydip Sen "Security in Wireless Sensor Networks" Department of Computer Science & Engineering, National Institute of Science & Technology, INDIA
5. Teaching Security of Internet of Things in Using RaspberryPi by: Oliver Nichols University of Tennessee at Chattanooga, mpl934@mocs.utc.edu Li Yang University of Tennessee at Chattanooga, lyang03@gmail.com Xiaohong Yuan North Carolina A& T State University, xhyuan@ncat.edu

TEACHING TEAM :

- Prof. Time Brown
- Dr. Richard Musabe

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/coordinator/Staff	Date
1	Signature :	
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Library	Signature:	
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MODULE DESCRIPTION

1. **MODULE CODE** : WSN6263
2. **MODULE TITLE** : **ADVANCED WIRELESS SENSOR NETWORKS (WSN) DESIGN IN 5G**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 15
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
LECTURES	24	48
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	18	36
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ASSIGNMENTS – PREPARATION & WRITING	60	30

EXAMINATION – REVISION & ATTENDANCE		44
OTHER: INVIGILATION END OF MODULE		4
TOTAL	150	216

8.1 BRIEF DESCRIPTION OF AIMS & CONTENT :

Big hope had been placed in the 4G family of wireless communications systems. It was expected that they would significantly address the crisis of spectrum and data rates that the world faces. This was at least before the explosion of mobile devices, cloud technologies, artificial intelligence and networked sensors. Though many countries around the world have now deployed fourth generation wireless infrastructures, the shortage in spectrum and bandwidth has not decreased. With the announced rapid expansion of the Internet of Things (IoT) 5G is expected to address the problems mentioned above. Compared to the 4G networks, 5G systems will achieve 1,000 times the system capacity, 10 times the data rate, and 25 times the cell throughput. The aim of 5G is to provide seamless coverage, connectivity, and high quality of service between heterogeneous devices and under diverse scenarios such as high mobility. This module covers various promising technologies for 5G wireless communication systems, such as massive MIMO, energy-efficient communications, millimeter wave (mmWave) communications, cognitive radio networks, and device-to-device communications. Through mmWave band for example, 5G would support Narrow Band IoT (NB-IoT) which is a good use and business case for the mobile operators and is well supported by ITU-R standards unlike LoRA and related platforms.

8.2 LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A4,A7, A10)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. 5G development roadmap in terms of 3GPP releases.
a2. Concept behind 5G wireless communication networks;
a3. Similarities and differences between the different families of wireless network technologies;
a4. Architectures of key technologies enabling 5G communication systems;
a5. How radio signals can be used to carry digital information in a spectrally efficient manner;
a6. Functioning of cellular connectivity technologies geared towards low complexity and embedded IoT devices.

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B1,B4,B5)

Having successfully completed this module, students should be able to:

b1. Develop abilities to setup experiments and analyse system performance using 5G wireless systems;
b2. Explain LTE-Advanced Pro and 3GPP roadmap to 5G;
b3. Learn about features of Massive MTC, D2D, MIMO, Spectrum and 5G Wireless Propagation Channel Models;
b4. Learn how 5G wireless networks could support up to 1,000-fold gains in capacity.

b5. Critically analyse and design the functioning of cellular connectivity technologies geared towards low complexity and embedded IoT devices.

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C2,C3,C6)

Having successfully completed the module, students should be able to:

c1. Discuss technical standards related to 5G enabling technologies
c2. Illustrate 5G wireless communication networks cellular architecture and key technologies
c3. Deploy 3GPP Licensed-Assisted Access (LAA), Narrowband- Internet of Things (NB-IoT), and Enhanced Device to Device (DD) requirements in IoT system
c4. Describe new 5G Radio Access Technology Interworking with LTE
c5. Design suitable architecture for the IoT system

D. GENERAL TRANSFERABLE SKILLS: (D1,D2,D4,D5)

Having successfully completed the module, students should be able to:

d1. Walk through current and future deployment of 5G scenarios
d2. Describe the operation scenarios of 5G
d3. Describe 3GPP LTE/LTE-A evolution towards 5G
d4. List 5G Wireless Use Cases
d5. List User-Driven 5G Requirements

9. INDICATIVE CONTENT :

Introduction & Historical Background

- Industrial and technological revolution: from steam engines to the Internet
- Mobile communications generations: from 1G to 4G
- From mobile broadband (MBB) to extreme MBB
- IoT: relation to 5G

Key Global Initiatives

- METIS and the 5G-PPP
- China: 5G promotion group
- Korea: 5G Forum
- Japan: ARIB 2020 and Beyond Ad Hoc
- IoT Initiatives

Standardization

- ITU-R
- 3GPP
- IEEE
- NGMN
- BBF
- SCF

5G Network Concept

- Concept overview
- Extreme mobile broadband
- Massive machine-type communication
- Ultra-reliable machine-type communication
- Dynamic radio access network
- Lean system control plane
- Localized contents and traffic flows
- Spectrum toolbox

5G Architecture

- High-level requirements for the 5G architecture
- Functional architecture and 5G flexibility
- Physical architecture and 5G deployment

Machine-Type Communications

- Fundamental techniques for MTC
- Massive MTC
- Ultra-reliable low-latency MTC

Device to Device (D2D) Communications

- D2D: from 4G to 5G
- Radio resource management for mobile broadband D2D
- Multi-hop D2D communications for proximity and emergency services
- Multi-operator D2D communication

The 5G Radio-Access Technologies

- Access design principles for multi-user communications
- Multi-carrier with filtering: a new waveform
- Non-orthogonal schemes for efficient multiple access
- Radio access for dense deployments
- Radio access for V2X communication
- Radio access for massive machine-type communication

Massive Multiple-Input Multiple-Output (MIMO) systems

- Pilot design for massive MIMO (antennas to communication subsystem using FPGA or other testbeds)
- Resource allocation and transceiver algorithms for massive MIMO
- Fundamentals of baseband and RF implementations in massive MIMO
- Channel models

Spectrum

- 5G spectrum landscape and requirements
- Spectrum access modes and sharing scenarios
- 5G spectrum technologies
- Value of spectrum for 5G: a techno-economic perspective

Discussions

- The implementation feasibility of 5G wireless networks in Africa;
- The Suitability of 5G technologies in the African setting.

10. LEARNING & TEACHING STRATEGY :

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11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, quizzes, research seminars, tutorials, practicals, 40% - written examination.

Assessment Criteria:

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12. ASSESSMENT PATTERN :

Component	**Weightage (%)**	**Learning objectives covered**
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Research seminar	10	B1,B4,B5
Final assessment	40	A4,A7,A10,B1,B4,B5,C2,C3,C6, D1,D2,D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
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Journal Proceedings

1. Afif Osseiran et al. (2016). *5G Mobile and Wireless Communications Technology*. Cambridge University Press, ISBN 9781107130098
2. Boccardi, F., Heath, R.W., Lozano, A., Marzetta, T.L. and Popovski, P., (2014). *Five disruptive technology directions for 5G. IEEE Communications Magazine*, 52(2), pp.74-80.
3. Yilmaz, T., Gokkoca, G. and Akan, O.B., (2016). *Millimetre Wave Communication for 5G IoT Applications. In Internet of Things (IoT) in 5G Mobile Technologies* (pp. 37-53). Springer International Publishing.
4. Biral, A., Centenaro, M., Zanella, A., Vangelista, L. and Zorzi, M., 2015. *The challenges of M2M massive access in wireless cellular networks*. Digital Communications and Networks, 1(1), pp.1-19.

15. TEACHING TEAM :

Prof. Santi Kumaran
Dr. Said Ngoga

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
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Library	Signature:	
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MODULE DESCRIPTION

1. **MODULE CODE** : WSN6264
2. **MODULE TITLE** : **CLOUD NETWORKING FOR IoT**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 15
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
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SELF – DIRECTED STUDY	42	42
ASSIGNMENTS – PREPARATION & WRITING	60	30
EXAMINATION – REVISION & ATTENDANCE		44
OTHER: INVIGILATION END OF MODULE		4
TOTAL	150	216

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

Cloud computing is a widely used technology that provides theoretically unlimited computing and storage capabilities, and efficient communication services for transferring terabyte flows between data centers in an easy way. All these features make cloud computing a promising choice for supporting IoT services and applications. This course covers the various aspects of the integration of IoT, Networking and Cloud computing. There are significant benefits in the integration of IoT devices with cloud computing systems and network infrastructures along with different services. Networking solutions specifically designed for the exploitation of Cloud services in IoT scenarios assume a crucial role. Also, virtualization techniques make pools of (virtual) sensors and actuators available as new types of on-demand resources over the Cloud that can be integrated with other resources and exposed as cloud-based services. They allow developers to differentiate circuits aimed at IoT interactions, to increase Cloud scalability and efficiency in service provisioning.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING : **(A1,A8,A10)**

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Advanced concepts for Cloud Computing
a2. Concepts of Software Defined Datacenter
a3. Concepts of virtualization as Cloud Computing
a4. Infrastructure, Platforms and Software of Cloud computing
a5. Challenges and Opportunities in the development of Cloud-based IoT systems
a6. Policies and Regulatory aspects of Cloud-based IoT systems
a7. Infrastructures, platforms, and software for Cloud Networking for IoT

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: **(B1,B3,B7)**

Having successfully completed this module, students should be able to:

b1. Identify the appropriate technology for the development of Cloud Networking for IoT solutions
b2. Apply professional knowledge to develop a complex Cloud Networking for IoT
b3. Explain the role of cloud computing in a typical IoT system
b4. Critically evaluate the strengths and weaknesses of different types of Cloud Computing architecture and show understanding of their key features
b5. Critically analyse, appraise and apply knowledge about legal, social, ethical and professional issues related to the design, development, and implementation of Cloud Computing and IoT technologies and systems
b6. Critically analyse Cloud Networking for IoT case studies

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS: (C1,C4,C6)

Having successfully completed the module, students should be able to:

c1. Effectively deploy tools and equipment for the implementation and documentation of virtualization in elastic computing

c2. Deploy and install Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS) abstractions, and Public and Private Clouds

c3. Critically analyse Infrastructure, Platform and Software as a Service advantages and disadvantages

c4. Describe service oriented architectures that are foundational to the WWW

c5. Build a multi- tiered Cloud-based IoT system

c6. Deploy research methodologies in Internet of Things and Cloud Computing commercial context considering any privacy/security issues associated with such.

D. GENERAL TRANSFERABLE SKILLS : (D3,D4,D5)

Having successfully completed the module, students should be able to:

d1. Apply broad skill in writing a professional report as a vehicle for communicating ideas in research

d2. Illustrate a comprehensive ability for professional presentation on the subject of their research work

d3. Build a basic Internet of Things infrastructure that can access Cloud computing services

d4. Demonstrate the ability and critical understanding of the underlying principles of Cloud Computing and IoT systems, and the commercial and business implications of technical advances in this area

d5. Demonstrate the ability to use appropriate hardware and software platforms that implement cloud networking for IoT

9. INDICATIVE CONTENT :

Cloud Computing Concepts

Cloud Infrastructures & Networking Scenarios, Automatic management, Fog computing paradigm, Edge Computing, Distributed cloud wireless networking,

Cloud services for IoT

Amazon AWS, Microsoft Azure, Google Cloud Platform, Private/On-premise cloud, IBM Bluemix, OpenSTack (On premise), Red hat Open Shift, Cloud Foundry, GEPredix

Software Defined Datacenter

Infrastructure & Architectures, Application Programming Interfaces Protocols & Programming languages, Efficient Network and Cloud Function Virtualization (NFV), Software-Defined Data Centers and Inter-datacenter Networks, Service & Information Orchestration, Chaining and Life Cycle Management, Energy Efficient and Green Software-defined Infrastructures.

Virtualization concepts

Object identity management, discovery services in IoT, Virtualization of objects, devices and IoT infrastructures, Ad-hoc Cloud services

Cloud Networking for IoT
Infrastructures- platforms- and software for CN4IoT scenarios, CN4IoT design, Router Architecture, Control Architecture, Network programming for CN4IoT, Service discovery in CN4IoT- device Discovery, Data Discovery, service Discovery, SLA Management for CN4IoT, Monitoring of CN4IoT Systems, Mobility support in CN4IoT,Security and privacy preservation in CN4IoT Systems, CN4IoT services (Sensing as a Service, Data Analytics as a Service, etc), Utility Models for CN4IoT metering, micro services, CloudLet computing.

Application Use cases
Industrial IoT interacting with Clouds and Virtual Networks, Personal IoT and Physical Analytics in IoT Focusing on Applications Use Case with Small Data, Energy-aware and sustainable computing solutions for CN4IoT applications, Applications for Smart Cities, BigData Applications, ICT devices used in Factory of the Future, HPC, eHealth, Industrial Processes, Energy Efficiency Systems, Social Platforms, etc.

10. LEARNING & TEACHING STRATEGY :

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Final assessment	40	A1,A8,A10,B1,B3,B7,C1,C4,C6, D3,D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Hwang K., Fox G., Dongarra J., 2011, Distributed and Cloud Computing: Parallel Processing to the Internet of Things, Morgan Kaufmann; 0123858801 [CORE]
2. Bahga A., Madisetti V., 2014, Internet of Things – A Hands-on Approach, VPT; 0996025510
3. Chin S., Weaver J., 2015, Raspberry Pi with Java: Programming the Internet of Things (IoT), McGraw-Hill Osborne; 0071842012
4. Tsiatsis V., et al., 2014, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press Inc; 012407684X
5. Internet of Things: Principles and Paradigms, 1st Edition, paperback ISBN: 9780128053959 Imprint: Morgan Kaufmann
6. Internet of Things and Data Analytics Handbook, Hwaiyu Geng, David Y. Fong, Published Online: 23 DEC 2016, DOI: 10.1002/9781119173601, © 2017 John Wiley & Sons, Inc.

15. TEACHING TEAM :

- Dr Idris Rai
- Dr. Gaurav Bajpai

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	

3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
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ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : WSN6265
2. **MODULE TITLE** : **APPLICATIONS OF UAV IN IoT**
3. **LEVEL** : 06 **SEMESTER**: 01 **CREDITS**: 10
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

DESCRIPTION	STUDENT HOURS	STAFF HOURS
LECTURES	18	36
SEMINARS/ WORKSHOPS		
PRACTICAL CLASSES/ LABORATORY	14	24
STRUCTURED EXERCISES	4	8

SET READING ETC.		
SELF – DIRECTED STUDY	26	28
ASSIGNMENTS – PREPARATION & WRITING	38	20
EXAMINATION – REVISION & ATTENDANCE		28
OTHER: INVIGILATION END OF MODULE		2
TOTAL	100	146

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

The demand for connectivity is driving the IoT for drones/UAVs, better and cheaper micro-electromechanical systems sensors – accelerometers, gyros, magnetometers and often pressure sensors – small GPS modules, powerful processors and a number of digital radios have pushed the controversial devices into the mainstream market. In this module the basics of UAVs and their potential applications will be taught. Some uses of these UAVs will be experimented to show that how data can be collected with drones.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A2,A9,A10)

At the end of the program students should be able to demonstrate knowledge and understanding of:

a1. Functioning principles of a UAV
a2. Aerodynamics, how a drone is built and necessary parts to build one
a3. GPS and how accurate position is calculated using various constellations
a4. The latest laws and regulations pertaining UAV, with a particular focus on Rwanda
a5. How UAVs can be used to gather data coming from IoT nodes on the ground

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B1,B3,B10)

Having successfully completed this module, students should be able to:

b1. Identify UAV applications and being able to choose the appropriate drone models for them
b2. Add IoT nodes to a drone and calculate the maximum weight of an IoT node to be used on a drone
b3. Calculate the output power necessary to communicate with a ground gateway
b4. Decide on the parameters to be considered to take pictures from a drone
b5. Calculate the link budget necessary to send data from nodes to drones flying at different heights

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1,C5,C6)

Having successfully completed the module, students should be able to:

c1. Use a drone simulator on a smartphone
c2. Operate a simulated UAV on a smartphone
c3. Identify security measures when flying a drone
c4. Demonstrate the ability to solve UAV problems using IoT

c5. Design IoT devices given a certain set of application requirements

D. GENERAL TRANSFERABLE SKILLS: (D1, D4,D5)

Having successfully completed the module, students should be able to:

d1. Demonstrate some beneficial, societal applications using UAVs
d2. Motivate the construction of UAVs
d3. Generate new optimization techniques for UAVs
d4. Illustrate a comprehensive ability for professional presentation on the subject of their research work
d5. Demonstrate the ability to use ICT tools for UAVs

9. INDICATIVE CONTENT :

- UAV Technology and Operations;
- UAV Aerodynamics and flight stability;
- Drone Construction;
- Autonomous Unmanned Systems;
- GNSS applied to UAVs;
- Applications of UAVs;
- UAV Laws, Regulations, Ethics;
- UAV for remote sensing;
- UAV as data gateway;
- UAV communications technologies and networking;
- Optical measurements with UAVs;

Lab Exercises: learn how to operate a drone using a smartphone; design, build and test your own UAV; gathering data from ground IoT nodes; practical considerations on adding IoT nodes to a UAV.

10. LEARNING & TEACHING STRATEGY :

A course handbook will be provided in advance and this will contain in depth information relating to the course content and give an opportunity to the students to prepare the course. The lecture materials will be posted on the web page that will also contain comprehensive web links for further relevant information. The module will be delivered through lectures, tutorial/practice sessions and group discussions. In addition to the taught element, students will be expected to undertake a range of self-directed learning activities, which will comprise case studies and mini research projects. All supporting documents for the course will be made available on web, as printed copies and also as soft copies.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. As this is much of a theory oriented module requiring familiarity the current standards of practice mostly in documented form, more weight will be given to testing the attainment of analytic skills in the understanding and interpretation of IoT system.
60% based on individual assignments, research seminars, quizzes, tutorials, practicals, 40% - written examination.

Assessment Criteria:

- For the examination setting and marking the UR generic marking criteria will be used.
- For the assessment of the practical exercises, the UR assessment criteria will be used.
  For the assignment, criteria will be drawn up appropriate to the topic, based on the UR generic marking criteria.

12. ASSESSMENT PATTERN :

Component	Weightage (%)	Learning objectives covered
In-course assessment:	**100**	
Assignment	20	A2,A9,A10,B1,B3,B10,C1,C5,C6, D1,D4,D5
Practise /Tutorial	30	B1,B3,B10, C1,C5,C6
Research seminar	10	B1,B3,B10
Final assessment	40	A2,A9,A10,B1,B3,B10,C1,C5,C6, D1, D4,D5

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Interactive lecturing style, with opportunities for questions, and requirement to work on simple practical exercises.
- Marked summative assessments (practical report and assignment) handed back to students, with comments.
- Opportunities to consult Lecturer during working hours

14. INDICATIVE RESOURCES :

1. Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs 1st Edition by John Baichtal (Author)
   https://www.amazon.com/Building-Your-Own-Drones-Beginners/dp/078975598X/ref=sr_1_7?ie=UTF8&qid=1494490179&sr=8-7&keywords=UAV
2. Introduction to UAV Systems 4th Edition, by Paul Fahlstrom (Author), Thomas Gleason (Author)
   https://www.amazon.com/Introduction-UAV-Systems-Paul-Fahlstrom/dp/1119978661/ref=sr_1_11?ie=UTF8&qid=1494490179&sr=8-11&keywords=UAV
3. Drones: Mastering Flight Techniques Paperback – February 3, 2017, by Brian Halliday
   https://www.amazon.com/Drones-Mastering-Techniques-Brian-Halliday/dp/1520410417/ref=sr_1_1?s=books&ie=UTF8&qid=1494490385&sr=1-1&keywords=drone
4. Bergenas, Johan, Rachel Stohl, and Alexander Georgieff. "The other side of drones: saving wildlife in Africa and managing global crime." conflict trends 2013.3 (2013): 3-9.
5. Everaerts, Jurgen. "The use of unmanned aerial vehicles (UAVs) for remote sensing and mapping." The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences 37.2008 (2008): 1187-1192.

6. Olivares-Mendez, Miguel A., et al. "The NOAH project: Giving a chance to threatened species in Africa with UAVs." International Conference on e-Infrastructure and e-Services for Developing Countries. Springer International Publishing, 2013.

TEACHING TEAM :

- Dr. Chomora Mikeka
- Dr. Ngend Luc

15. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/coordinator/Staff	Date
1	Signature :	
	Print Name :	
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3	Signature :	
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4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
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ICT	Signature:	
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Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. **MODULE CODE** : WSN6361
2. **MODULE TITLE** : **FIELD ATTACHMENT**
3. **LEVEL** : 06 **SEMESTER**: 03 **CREDITS**: 20
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

Learning format	**Activity**	**Hours**
Faculty Hours	Faculty-student feedback sessions	**20**
Student Hours	Self-paced learning (mostly online), individual research	80
Student Hours	Industrial Training/real world experiences	100
Total		**200**

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT :

The aim of this module is to develop work-related knowledge, skills and capabilities necessary to complete a field attachment and to pursue further work opportunities in fields of IoT. The internship aims to improve the methodological knowledge and technical skills of the students in relation to IoT research. This training is included in a defined research project which allows learning more on the methodological approach to answer a defined research question. The student is introduced into the techniques and supervised by experienced personal. There are regular discussions of the results. The field attachment is completed by writing a short report focusing on the techniques learned during the course. The field attachment can take 2 to 3 months.

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING :

Having successfully completed the field attachment, students need not have to demonstrate knowledge and understanding of the principles and concepts of computing since this is a practice oriented module involving application

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B1,B2, B4, B8)

Having successfully completed the module, students should be able to:

b1. Select and apply appropriate mathematical methods for modeling and analyzing real world IoT based problems

b2. Use scientific and engineering principles in the development of solutions to problems in the design and development of IoT systems

b3. Display advanced conceptual understanding of Internships, employability and the industrial placement cycle

b4. Critically reflect on the skills, attributes and behaviours required for successful professional conduct in an organizational context to which IoT is relevant

b5. Understand and reflect on the goals, objectives and culture of a specific organization through close first-hand experience and guidance

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1,C2,C3,C5)

Having successfully completed the module, students should be able to:

c1. Select appropriate methods for answering a research question in IoT field

c2. Get practical knowledge and experience on selected methods including a critical assessment of limitations

c3. Observe and record accurately data and experimental evidence both in the laboratory and in the IoT industrial environment

c4. Critically analyse, evaluate and interpret measured or observed data in the shop floor

c5. Plan the installation and maintenance of IoT systems and equipment in practical work environments

c6. Demonstrate an awareness of practical computing skills in terms of Hardware and Software required in IoT Industrial Practice

c7. Use computational tools and packages appropriate to the area of production or Manufacturing

D. GENERAL TRANSFERABLE SKILLS : (D1, D2, D3, D4)

Having successfully completed the module, students should be able to:

d1. Work effectively in a team both as a member or leader in the work environment

d2. Efficiently manage both time and resources observing deadlines etc.

d3. Communicate effectively the solutions arrived with the help of IoT design symbols

d4. Demonstrate numerical skills and problem solving skills pertaining to real world IoT problems

9. INDICATIVE CONTENT

List of activities:

Since this is a practical module, it involves the application of technical knowledge on a specific area

1. Shop Floor Training

Real world applications already developed in the industry to be practiced. Final report must be submitted for the skills Examination.

2. Revision of the Concepts already learnt over the semesters and their application in the IoT Industry
3. Work on real world applications
4. Based on the Survey of Contemporary Developments already made in the work area develop a new system or improvement.
5. Learning about work Schedules, Production strategies etc.
6. Analysis of Time and Materials management etc.
7. Design and Development Prototypes of IoT
8. Exploitation , Testing and Evaluation of IoT systems
9. Improve skills through constant Training

The above list is only comprehensive and more or different work can be done depending on the industry selected and the availability of facilities.

10. LEARNING & TEACHING STRATEGY :

The module will be delivered solely through Experimentation and practice with instructions from the floor supervisor. Periodic Discussions with the supervisor will be required to do the work in a periodic manner. Organized discussions, presentations and teamwork will help students to get the required cognitive, intellectual and key (transferable) skills. Each learner will get trained individually and submit a report at the end of the Training for the final skill examination.

11. ASSESSMENT STRATEGY :

The assessment strategies are aimed at testing the achievement of the learners in different aspects of IoT. The students will have to submit an internship report similar to a project report and it will be assessed as follows: presentation 40% and field attachment report 60%.

12. ASSESSMENT PATTERN :

Component	**Weightage (%)**	**Learning objectives covered**
In-course assessment:		
Practical exercises and report	60	B1,B2,B4,B8,C1,C2,C3,C5,D1,D2, D3,D4
Presentation	40	B1,B2,B4,B8,C1,C2,C3,C5,D1,D2, D3,D4
Final assessment:		
Practical examination		

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

- Field Attachment Internal guide consultation
- Field Attachment external/industry guide consultation

14. INDICATIVE RESOURCES :

Field Attachment guidelines and ACM Professional ethics guidelines

15. TEACHING TEAM :

All Senior staff and Partners of ACEIoT

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
	Print Name :	
2	Signature :	
	Print Name :	
3	Signature :	
	Print Name :	
4	Signature :	
	Print Name :	

Seen and agreed

Library	Signature:	
	Print Name:	
ICT	Signature:	
	Print Name:	
Quality Office	Signature:	
	Print Name:	

MODULE DESCRIPTION

1. MODULE CODE : WSN 6461

2. **MODULE TITLE** : **MASTER'S DISSERTATION**
3. **LEVEL** : 06 **SEMESTER**: 03 **CREDITS**: 100
4. **FIRST YEAR OF PRESENTATION** : 2017-2018
5. **ADMINISTERING SCHOOL**: **AFRICAN CENTER OF EXCELLENCE OF INTERNET OF THINGS (ACEIoT)**
6. **CORE**: Core Module
7. **PRE-REQUISITE OR CO-REQUISITE MODULE, EXCLUDED COMBINATIONS** : NA
8. **ALLOCATION OF STUDY & TEACHING HOURS :**

Learning format	**Activity**	**Hours**
Faculty Hours	Faculty-student feedback sessions	200
Student Hours	Self-paced learning (mostly online), individual research and project execution	800
Total		**1000**

8.1. BRIEF DESCRIPTION OF AIMS & CONTENT:

This project work/dissertation is aimed at creating confidence in the learners to do independent ICT project development and management / research work by applying the knowledge they have gained over the previous two trimesters. The learners have the option to choose either a project work or Dissertation individually of his/her choice in consultation with the allotted supervisor. The outcome of the project will be the solution to a real world problem or a prototype or a research publication in an international journal

8.2. LEARNING OUTCOMES :

A. KNOWLEDGE & UNDERSTANDING: (A1, A2, A4, A6,A7, A10)

At the end of the programme students should be able to demonstrate knowledge and understanding of

a1. Concepts of communications and management at an advanced level
a2. The advanced concepts, principles and theories of communication
a3. Design and development of communication software and management systems at a specialist level
a4. The awareness of standards of practice
a5. The professional, legal and ethical responsibilities of an IoT expert
a6. Quality and benchmarks in IoT project development

B. COGNITIVE/ INTELLECTUAL SKILLS/ APPLICATION OF KNOWLEDGE: (B1, B2, B3, B4, B9)

Having successfully completed the module, students should be able to:

b1. Select and apply appropriate mathematical methods for modelling and analysing IoT based systems
b2. Use scientific and engineering principles in the development of solutions to problems using IoT
b3. Apply computing standards, software metrics and bench marks to produce innovative designs of IoT systems and components
b4. Critically assess IoT systems developed by others

C. COMMUNICATION/ ICT/ NUMERACY/ ANALYTIC TECHNIQUES/ PRACTICAL SKILLS (C1, C2, C3, C5, C6)

Having successfully completed the module, students should be able to:
c1. Specify, plan, manage, conduct and report on development and research projects
c2. Prepare technical reports and deliver technical presentations at an advanced level
c3. Use competently and safely standard laboratory instrumentation and systems
c4. Observe and record skilfully and accurately data as well as experimental evidence in development or research work
c5. Analyse, evaluate and interpret data and apply them to the solution of development problems
c6. Plan the installation of IoT based systems.
c7. Demonstrate an awareness of advanced and practical skills especially in analysis and design IoT systems
c8. Use competently all computational tools and packages appropriate to development and research

D. GENERAL TRANSFERABLE SKILLS: (D1, D2, D4, D5)

Having successfully completed the module, students should be able to:
d1. Have the capacity for self-learning
d2. Undertake lifelong learning with active involvement in research and development
d3. Carry out independently a sustained investigation and research in the relevant areas
d4. Communicate the development documentation/research findings effectively (written, verbal, drafting, sketching etc.)
d5. Demonstrate general problem solving skills
d6. Use competently all available forms of information technology

9. INDICATIVE CONTENT

The problem to be addressed will require the student to draw from theories and techniques studied in the course.
The module will also cover the following project work topics:

- Information search, retrieval and evaluation
- Project definition and planning
- Use of conceptual models and frameworks
- Research methodology
- Problem solving
- Prototyping
- Action planning

- Report writing
- Oral presentation
- Project management
- Evaluation

10. LEARNING & TEACHING STRATEGY:

360 hours of learning by practical work includes field survey, analysis and design after passing all the previous modules, as the project to be done shall involve the software engineering aspects like requirement / design / analysis / testing / maintenance /etc. along with communications management and covers the application of all the modules taught in semesters I & II and the knowledge gained during internship to link up to a particular working project at the end of this module.

Teaching is affected by way of coaching, guidance, facilitation and supervision.
Note*
(The meaning is the student shall be provided tentatively a research project after Research Methodology module which has to be carried forward with all other modules as a mini project depending on the nature of the modules)

11. ASSESSMENT STRATEGY :

100% based on individual research and dissertation work done on the project with special emphasis on the contribution to knowledge.
The final projects/dissertations will be evaluated for quality and contribution to knowledge based on the written project report/dissertation, presentation and oral examination by the external examiner(s) during the VIVA-VOCE.

Assessment Criteria:

For the dissertation, criteria will be drawn up appropriate to the topic, based on the hardware/software/ system developed and or contribution to knowledge as presented in the project report/dissertation thesis and examined by an external examiner through a final defense (viva voce) examination

12. ASSESSMENT PATTERN :

Component	Weighting (%)	Learning objectives covered
In-course assessment:	**100**	A1, A2, A4, A6,A7, A10, B1, B2, B3, B4, B9, C1, C2, C3, C5, C6,D1, D2, D4, D5
1. Practical defence:	**50**	A1, A2, A4, A6,A7, A10, B1, B2, B3, B4, B9, C1, C2, C3, C5, C6,D1, D2, D4, D5
Internal examiner	25 project implementation	
External examiner	25 project implementation	

2.Final assessment:	**50**	A1, A2, A4, A6,A7, A10, B1, B2, B3, B4, B9, C1, C2, C3, C5, C6,D1, D2, D4, D5
Internal examiner	20 viva	
External examiner 1	15 dissertation	
External examiner 2	15 dissertation	

13. STRATEGY FOR FEEDBACK AND STUDENT SUPPORT DURING MODULE :

Student Feedback:

Feedback to students shall be in form of report prepared after each assessment strategy. It shall also refer and indicate any changes required to be done for the presentation etc.

Student feedback forms shall be provided to evaluate the process, and module as a whole.

Student Support:

Each supervisor shall individually assist the student with their project/ dissertations etc. the student and concerned supervisor shall both keep record of their meeting and record discussions as required.

Students shall be provided with relevant computer equipment reference books journal and other resources as required

14. INDICATIVE RESOURCES :

As determined by the supervisor

- Journals
- All publications relevant to the area of research
- Key websites and on-line resources

Teaching/Technical Assistance

15. TEACHING TEAM :

- Prof. Santhi Kumaran
- Dr. Gaurav Bajpai
- Dr. Richard Musabe
- Dr. Damien Hanyurwimfura
- Dr. Luc Ngend
- Dr. Said Ngoga Rutabayiro
- Dr. Marco Zennaro
- Prof. Raja Datta
- Prof. Martin Saint
- Dr. Chomora Mikeka
- Dr. Jimmy Nsenga
- Prof. Idris Rai
- Prof. Tim Browm

16. UNIT APPROVAL :

Director and Senior staff contributing to the Program to confirm agreement

Department	Director/Coordinator/Staff	Date
1	Signature :	
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Library	Signature:	
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