1	**Course title**	**Internet of Things Applications**
2	**Course number**	**0907725**
3	**Credit hours (theory, practical)**	3,0
	Contact hours (theory, practical)	3,0
4	**Prerequisites/corequisites**	None
5	**Program title**	**Artificial Intelligence and Robotics**
6	**Program code**	0907
7	**Awarding institution**	The University of Jordan
8	**School**	Engineering
9	**Department**	Computer Engineering
10	**Level of course**	First/Second Year
11	**Year of study and semester (s)**	First Year, Second Semester *or* Second Year, First/Second Semester
12	**Final Qualification**	Passing the exams and delivering a project
13	**Other department (s) involved in teaching the course**	None
14	**Language of Instruction**	English
15	**Teaching methodology**	☒Regular (Physical) ☐Blended ☐Online
16	**Electronic platform(s)**	☐Moodle ☒Microsoft Teams ☐Skype ☐Zoom ☐Others…………
17-A	**Course Time**	To be defined
17-B	**Date of production/revision**	September 2023

18. Course Coordinator:

Instructor: Prof. Khalid A. Darabkh
Office#: CPE 342,
Office hours: Monday, Tuesday, and Thursday: 12:30 pm - 1:30 pm, or by appointment
E-mail address: k.darabkeh@ju.edu.jo

19. Other instructors:

None

20. Course Description:

The course starts by reviewing networks and TCP/IP protocol stack. Then, the course will focus on concepts related to IoT including: Defining IoT, Characteristics of IoT, 5G communication and its relation to IoT, Physical design of IoT, Logical design of IoT, Machine to Machine, Industry applications, Surveillance applications, Body Area Networks, Smart Homes, Smart City, and other IoT applications. The course uses active learning techniques to guarantee better engagement from the students. Also, experts from the industry are invited to talk about the practical applications in this domain. This course includes assignments and a practical term project.

21. Course aims and outcomes:

A- Aims:

- Getting familiar with the network layer of TCP/IP stack including IP addressing, routing protocols, and constructing IP networks.

- Getting a deep understanding of IoT stack and technologies from the ground up.

- Getting a deep understanding of the key enabling technology (infrastructure) of IoT, namely, wireless sensor networks.

- Getting familiar with constructing some of IoT applications.

- Incorporating the concept of computational intelligence into the clustering/routing of IoT domains.

- Getting a deep understanding of the Routing Protocol for Low Power and Lossy Networks over Internet of Things (RPL-IoT).

- Getting familiar with IoT device programming (Arduino and Raspberry Pi), sensing and actuating technologies, and IoT protocol stacks (Zigbee, 5G, NFC, MQTT, etc).

B- Upon successful completion of this course, students will be able to

I.   Master the TCP/IP stack and particularly its network layer.
II.   Master the IoT stack and technologies from the ground up.
III. Be familiar with contemporary issues in IoT technologies.
IV.   Understand the key enabling technology (infrastructure) of IoT, namely, wireless sensor networks.
V.   Understand the construction of necessary IoT applications.
VI.   Incorporate the concept of computational intelligence into the clustering/routing of IoT domains.
VII. Master the Routing Protocol for Low Power and Lossy Networks over Internet of Things (RPL-IoT).
VIII. Master the IoT device programming.

22. Topic Outline and Schedule:

Topic	Week	Instructor	Teaching Methods*/platform	Evaluation Methods
Reviewing TCP/IP Stack with Focus on Network Layer	1	Khalid A. Darabkh	Regular/Physical	Exams
IoT Architectures, Protocols, and Applications	3	Khalid A. Darabkh	Regular/Physical	Exams
IoT Recent Advances, Future Directions, and Recommendations	5	Khalid A. Darabkh	Regular/Physical	Exams
IoT Sensor Networks	6	Khalid A. Darabkh	Regular/Physical	Exams
Construction of IoT Applications	8	Khalid A. Darabkh	Regular/Physical	Exams
Computational Intelligence and IoT Clustering/Routing	10	Khalid A. Darabkh	Regular/Physical	Exams
RPL-IoT: Deep dive, Recent Advances, Recommendations, and Future Directions	12	Khalid A. Darabkh	Regular/Physical	Exams
Computational Intelligence and RPL-IoT	13	Khalid A. Darabkh	Regular/Physical	Exams
IoT Device Programming	15	Khalid A. Darabkh	Regular/Physical	Exams

23. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:
- The student attends the class presentations and participates in the discussions.
- The student studies online video recordings along with references and research papers.

24. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:
- Quizzes and Exams
- Project Proposal and Final Report

25. Course Policies:

A. Attendance policies:
- Attendance is mandatory and highly encouraged. To that end, attendance will be taken every lecture. All exams (including the final exam) should be considered cumulative.

B- Absences from exams and handing in assignments on time:
- A makeup exam can be arranged for students with acceptable absence causes.

C- Health and safety procedures:

- All health and safety procedure of the university and school should be followed.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

- The homeworks and exams are expected to be individual work (have to be done by your own) and completed without any help of your classmates. Handing in work that was jointly prepared and/or copied will be considered plagiarism and will be handled according to the University regulations.

E- Grading policy:
- Mid-term Exam (35%)
- Quizzes (5%)
- Project Presentation and Discussion (10%)
- Project Final Report (10%)
- Final Exam (40%)

F- Available university services that support achievement in the course:

- Course Website: http://eacademic.ju.edu.jo/k.darabkeh/Material
- **Documents will be posted over Microsoft Teams**

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26. Required equipment: (Facilities, Tools, Labs, Training….)

None

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27. References:

The following research papers will be so valuable and helpful to understand the material covered in class:

[1] Wafa'a Kassab and Khalid A. Darabkh, "A-Z Survey of Internet of Things: Architectures, Protocols, Applications, Recent Advances, Future Directions and Recommendations," *Journal of Network and Computer Applications* (WoS/JCR, 2020 IF = 6.281), Elsevier, vol. 163, p.102663, August 2020.

[2] Khalid A. Darabkh, Wafa'a K. Kassab, and Ala' F. Khalifeh, "LiM-AHP-G-C: Life Time Maximizing Based on Analytical Hierarchal Process and Genetic Clustering Protocol for the Internet of Things Environment," *Computer Networks* (WoS/JCR, 2020 IF = 4.474), Elsevier, vol.176, p. 107253, July 2020.

[3] Khalid A. Darabkh, Asma'a B. Amareen, Muna Al-Akhras, and Wafa'a K. Kassab, "An Innovative Cluster-based Power-aware Protocol for Internet of Things Sensors Utilizing Mobile Sink and Particle Swarm Optimization," to appear in *Neural Computing and Applications*, (WoS/JCR, 2022 IF = 5.102), Springer, vol. 35, pp. 19365–19408, 2023.

QF-AQAC-03.02.1.2

[4] Khalid A. Darabkh, Muna Al-Akhras, Mohammed Atiquzzaman, and Jumana Zomot, "Routing Protocol for Low Power and Lossy Networks over Internet of Things (RPL-IoT): A Comprehensive Survey, Recent Advances, Recommendations, and Future Directions," to appear in *Journal of Network and Computer Applications,* (WoS/JCR, 2020 IF = 6.281), Elsevier, vol. 207, p. 103476, November 2022.

[5] Khalid A. Darabkh, Jumana N. Zomot, Zouhair Al-qudah, and Ala' F. Khalifeh, "Impairments-Aware Time Slot Allocation Model for Energy-constrained Multi-Hop Clustered IoT Nodes Considering TDMA and DSSS MAC Protocols," *Journal of Industrial Information Integration* (WoS/JCR, 2020 IF = 10.615), Elsevier, vol. 25, p. 100243, January 2022.

[6] Khalid A. Darabkh, Jumana N. Zomot, Zouhair Al-qudah, "EDB-CHS-BOF: Energy and Distance Based Cluster Head Selection with Balanced Objective Function Protocol," *IET Communications*, *Special Issue: Future of Intelligent Wireless LANs*, (WoS/JCR, 2018 IF = 1.779), IET, vo. 13, no. 19, p. 3168 – 3180, November 2019.

[7] Khalid A. Darabkh, Muna Al-Akhras, Ala' F. Khalifeh, Iyad F. Jafar, and Fahed Jubair, "An Innovative RPL Objective Function for Broad Range of IoT Domains Utilizing Fuzzy Logic and Multiple Metrics," Expert Systems with Applications*,* (WoS/JCR, 2020 IF = 6.945), Elsevier, vol. 205, p.117593, November 2022.

28. Additional information:

Students are assumed to have sufficient knowledge pertaining to probability theory.

Name of Course Coordinator: **Prof. Khalid A. Darabkh**

Signature:

Date: **22-9-2023**