K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

CONTENTS

K. S. SCHOOL OF ENGINEERING AND MANAGEMENT

VISION

To impart quality education in engineering and management to meet technological, business and societal needs through holistic education and research.

MISSION

K.S. School of Engineering and Management shall,

- Establish state-of-art infrastructure to facilitate effective dissemination of technical and Managerial knowledge.
- Provide comprehensive educational experience through a combination of curricular and Experiential learning, strengthened by industry-institute-interaction.
- Pursue socially relevant research and disseminate knowledge.
- Inculcate leadership skills and foster entrepreneurial spirit among students.

Department of Computer Science and Engineering

VISION

To produce quality Computer Science professional, possessing excellent technical knowledge, skills, personality through education and research.

MISSION

Department of Computer Science and Engineering shall,

- Provide good infrastructure and facilitate learning to become competent engineers who meet global challenges.
- Encourages industry institute interaction to give an edge to the students.
- Facilitates experimental learning through interdisciplinary projects.
- Strengthen soft skill to address global challenges.

INTERNET OF THINGS (Effective from the academic year 2018 -2019) SEMESTER – VIII			
Course Code	**18CS81**	**CIE Marks**	40
Number of Contact Hours/Week	3:0:0	**SEE Marks**	60
Total Number of Contact Hours	40	**Exam Hours**	03
CREDITS –3			

Course Learning Objectives: This course (18CS81) will enable students to:

- Assess the genesis and impact of IoT applications, architectures in real world.
- Illustrate diverse methods of deploying smart objects and connect them to network.
- Compare different Application protocols for IoT.
- Infer the role of Data Analytics and Security in IoT.
- Identifysensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

Module 1	Contact Hours
What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. **Textbook 1: Ch.1, 2** **RBT: L1, L2, L3**	08
Module 2	
Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. **Textbook 1: Ch.3, 4** **RBT: L1, L2, L3**	08
Module 3	
IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. **Textbook 1: Ch.5, 6** **RBT: L1, L2, L3**	08
Module 4	
Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment **Textbook 1: Ch.7, 8** **RBT: L1, L2, L3**	08
Module 5	
IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT	08

Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

Textbook 1: Ch.12

Textbook 2: Ch.7.1 to 7.4, Ch.8.1 to 8.4, 8.6

RBT: L1, L2, L3

Course Outcomes: The student will be able to :

- Interpret the impact and challenges posed by IoT networks leading to new architectural models.
- Compare and contrast the deployment of smart objects and the technologies to connect them to network.
- Appraise the role of IoT protocols for efficient network communication.
- Elaborate the need for Data Analytics and Security in IoT.
- Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.

Question Paper Pattern:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbooks:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"**IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things**", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (**ISBN:** 978-9386873743)
2. Srinivasa K G, "**Internet of Things**",CENGAGE Leaning India, 2017

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "**Internet of Things (A Hands-on-Approach)**", 1st Edition, VPT, 2014. (**ISBN:** 978-8173719547)
2. Raj Kamal, "**Internet of Things: Architecture and Design Principles**", 1st Edition, McGraw Hill Education, 2017. (**ISBN:** 978-9352605224)

Mandatory Note:

Distribution of CIE Marks is a follows (Total 40 Marks):

- 20 Marks through IA Tests
- 20 Marks through practical assessment

Maintain a copy of the report for verification during LIC visit.

Posssible list of practicals:

1. Transmit a string using UART
2. Point-to-Point communication of two Motes over the radio frequency.
3. Multi-point to single point communication of Motes over the radio frequency.LAN (Sub-netting).
4. I2C protocol study
5. Reading Temperature and Relative Humidity value from the sensor

K. S. SCHOOL OF ENGINEERING AND MANAGEMENT

BENGALURU-560109

TENTATIVE CALENDAR OF EVENTS EVEN SEM - VIII SEMESTER (2021-2022)

SESSION: APR 2022 - JUNE 2022

Week No.	Month	Mon	Tue	Wed	Thu	Fri	Sat	Days	Activities
		Day							
1	APR	4*	5	6	7	8	9DH	5	4* Commencement of VIII Semester
2	APR	11	12	13	[redacted]	[redacted]	16 DH	3	14- Dr. B R Ambedkar Jayanthi / Mahaveera Jayanthi 15- Good Friday
3	APR	18	19	20	21	22	23DH	5	
4	APR	25	26	27	28	29	30	6	30 -Wednesday Time Table
5	MAY	2	[redacted]	4	5 TA	6	7	5	3- Basava Jayanthi/ Akshaya Tritiya, Khutub-E-Ramzan 7 -Tuesday Time Table
6	MAY	9	10	11	12 BV	13* FFB1	14 T1	6	14 -Thursday Time Table 13* - First Faculty Feed back
7	MAY	16	17	18	19	20	21DH	5	
8	MAY	23	24	25	26	27	28	6	28 -Tuesday Time Table
9	MAY/JUN	30	31	1	2TA	3 T2	4DH	5	
10	JUN	6	7	8 BV	9	10* FFB2	11	6	10* -Second Faculty Feed back 11 -Monday Time Table
11	JUN	13	14	15	16	17 TF	18DH	5	17 - Technical Fest
12	JUN	20	21	22 TA	23 NC	24 NC	25 PE	6	25 -Wednesday Time Table NC - National Conference PE - Project Exhibition
13	JUNE	27	28	29T3	30*			4	30 - * Last Woking Day
					Total No of Working Days : 67				

Total Number of working days (Excluding holidays and Tests)=64

H	Holiday
BV	Blue Book Verification
T1,T2,T3	Tests 1,2, 3
ASD	Attendance & Sessional Display
DH	Declared Holiday
TA	Test attendance
FFB	Faculty Feed Back
TF	Technical Fest

Monday	13
Tuesday	12
Wednesday	12
Thursday	12
Friday	9
Saturday	6
Total	**64**

K. Rama
28/4/22

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Management
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ACADEMIC YEAR : 2021-22 (EVEN SEMESTER)

(w.e.f. 8th April 2022)

CLASS TIME TABLE

CLASS : IV 'B' & VIII 'A'&'B'

Mrs.Geethanjali R S

DAY	8.40-9.35	9.35-10.30	10.30-10.45	10.45-11.40	11.40-12.35	12.35-1.20	1.20-2.10	2.10-3.00	3.00-3.50
MONDAY			BREAK	IOT (A)	IOT (A)	Lunch Break	Project Work Phase II (G1/G4) (18CSP83)		
TUESDAY	IOT (A)	IOT (A)					Project Work Phase II (G1/G4) (18CSP83)		
WEDNESDAY	TECHNICAL SEMINAR						Project Work Phase II (G1/G4) (18CSP83)		
THURSDAY	IOT LAB (G1/G2/G3)						IOT LAB (G4/G5/G6)		
FRIDAY									
SATURDAY									

CODE	SUBJECT	HOURS /WEEK	STAFF
18CS81	Internet of Things	4	Mrs.Geethanjali R S
18CSP83	Project Work Phase-II	4.5	
18CSS84	Technical Seminar	2	
18CSL81	Internet of Things Lab	3	
18CS85	Internship	1	

Time Table Co-ordinator

HOD 19/5/22

Dept. of Computer Science & Engineering

K.S. School of Engineering & Management

PRINCIPAL

Principal/Director

K S School of Engineering and Management

K. S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU -560 019

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

VIII- A Semester Student List

Sl. No.	USN	Name of the Student
1	1KG16CS103	Sujay H S
2	1KG17CS003	Adithya U
3	1KG17CS008	Atul thakur
4	1KG18CS001	A Harika
5	1KG18CS002	Adarsh p
6	1KG18CS003	Adithi M C
7	1KG18CS004	Adithi.N
8	1KG18CS005	Aishwarya S
9	1KG18CS006	Akshatha K A
10	1KG18CS007	Amith
11	1KG18CS008	Amitha S M
12	1KG18CS009	Amulya D M
13	1KG18CS011	Anirudh A
14	1KG18CS012	Anusha H
15	1KG18CS013	Anusha N
16	1KG18CS014	Anusha Ramnath
17	1KG18CS015	Ashish Kumar
18	1KG18CS016	Athmika
19	1KG18CS018	Bhashyam Keerthikumar
20	1KG18CS019	Bhavitha D
21	1KG18CS020	Brundha P
22	1KG18CS021	C Amruta Gayatri
23	1KG18CS022	Chandana M
24	1KG18CS023	CHANDANA R K
25	1KG18CS025	Chinmye H H
26	1KG18CS026	Deekshitha V Reddy
27	1KG18CS027	Deepak t n
28	1KG18CS028	DEEPTHI T E
29	1KG18CS029	Devapoojitaa
30	1KG18CS030	Dhanushree D.B
31	1KG18CS032	Dravid Balakrishna
32	1KG18CS033	D sai rohit
33	1KG18CS034	Eesha B S
34	1KG18CS036	Gayana H G
35	1KG18CS038	Goutham RP
36	1KG18CS039	Guru Prasad K A
37	1KG18CS040	Hamsaveena S

38	1KG18CS041	Jayanth J
39	1KG18CS042	Jayanth N
40	1KG18CS043	Jeevan sai G
41	1KG18CS044	Kalyan Venkatesh B S
42	1KG18CS045	Karthik Gowda D
43	1KG18CS046	kotapati Sushma chowdary
44	1KG18CS047	Kruthi M
45	1KG18CS048	Kruthika B
46	1KG18CS049	Lakshmi J
47	1KG18CS050	Madhumathi
48	1KG18CS051	Malavika
49	1KG18CS052	Manisha Rai
50	1KG18CS053	Mayurjit Borkakoty
51	1KG18CS054	Megha ML
52	1KG18CS055	Meghana A S
53	1KG18CS056	Meghana K V
54	1KG18CS057	Mithun M
55	1KG18CS059	Monica V
56	1KG18CS060	Nafeesa Banu
57	1KG19CS400	Ashwini.T
58	1KG19CS401	Bharath P
59	1KG19CS402	Durgi sobha
60	1KG19CS403	Nethravathi

R.S Geethanjali

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-22 (EVEN SEMESTER)

LESSON PLAN

NAME OF THE STAFF : R S Geethanjali

COURSE CODE/TITLE : 18CS81/ INTERNET OF THINGS

SEMESTER/YEAR : VIII/IV

Sl. No.	Topic to be covered	Mode of Delivery	Teaching Aid	No. of Periods	Cumulative No. of Periods	Proposed Date	Engaged Date
	MODULE 1:Introduction						
1	What is IoT, Genesis of IoT	L+D	BB	1	1	08/04/2022	8/4/22
2	IoT and Digitization, IoT Impact	L+D	BB	1	2	08/04/2022	8/4/22
3	Convergence of IT and IoT, IoT Challenges	L+D	BB	1	3	09/04/2022	9/4/22
4	IoT Network Architecture and Design Drivers Behind New Network Architectures	L+D	BB	1	4	09/04/2022	9/4/22
5	Comparing IoT Architectures	L+D	BB	1	5	25/04/2022	9/4/22
6	A Simplified IoT Architecture	L+D	BB	1	6	25/04/2022	9/4/22
7	The Core IoT Functional Stack	L+D	BB+LCD	1	7	26/04/2022	25/4/22
8	IoT Data Management and Compute Stack	L+D	BB+LCD	1	8	26/04/2022	25/4/22

	MODULE 2:Smart Objects						
9	The "Things" in IoT, Sensors, Actuators	L+D	BB	1	9	02/05/2022	26/4/22
10	Smart Objects, Sensor Networks	L+D	BB	1	10	02/05/2022	26/4/22
11	**Assignment-1**: Written Assignment	Offline	Assignment Book	0	10	04/05/2022	4/5/22
12	Connecting Smart Objects	L+D	BB	1	11	09/05/2022	9/5/22
13	Communications Criteria	L+D	BB+LCD	1	12	09/05/2022	9/5/22
14	IEEE 802.15.4, Standardization and Alliances Physical Layer,MAC Layer Topology, Security	L+D	BB+LCD	1	13	10/05/2022	10/5/22
15	IEEE 802.15.4g and 802.15.4e, Conclusions IEEE 1901.2a, Standardization and Alliances,Physical Layer , MAC Layer Topology ,Security	L+D	BB+LCD	1	14	10/05/2022	10/5/22
16	IEEE 802.11ah ,Standardization and Alliances Physical Layer, MAC Layer, Topology, Security	L+D	BB+LCD	1	15	16/05/2022	16/5/22
17	LoRa WAN, Standardization and Alliances Physical Layer, MAC Layer, Topology, Security	L+D	BB	1	16	16/05/2022	16/5/22
	MODULE 3:IP as the IoT Network Layer						
18	The Business Case for IP	L+D	BB	1	17	17/05/2022	17/5/22
19	The need for Optimization	L+D	BB	1	18	17/05/2022	17/5/22
20	Optimizing IP for IoT	L+D	BB	1	19	23/05/2022	23/5/22
21	Profiles and Compliances	L+D	BB	1	20	23/05/2022	23/5/22
22	Application Protocols for IoT	L+D	BB	1	21	24/05/2022	23/5/22

23	The Transport Layer, Application Layer Protocol Not Present, SCADA, A Little Background on SCADA	L+D	BB	1	22	24/05/2022	23/5/22
24	Assignment 2: Written Assignment	Offline	Assignment Book	0	22	25/05/2022	24/5/22
25	Adapting SCADA for IP,Tunneling Legacy SCADA over IP Networks,SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T	L+D	BB+LCD	1	23	30/05/2022	24/5/22
26	Generic Web-Based Protocols, IoT Application Layer Protocols, CoAP, Message Queuing Telemetry Transport (MQTT)	L+D	BB+LCD	1	24	30/05/2022	24/5/22
MODULE 4: Data and Analytics for IoT							
27	An Introduction to Data Analytics for IoT, Machine Learning	L+D	BB	1	25	31/05/2022	24/5/22
28	Big Data Analytics Tools and Technology, Edge Streaming Analytics	L+D	BB	1	26	31/05/2022	06/6/22
29	Network Analytics, Securing IoT	L+D	BB	1	27	06/06/2022	06/6/22
30	A Brief History of OT Security	L+D	BB	1	28	06/06/2022	13/6/22
31	Common Challenges in OT Security	L+D	BB+LCD	1	29	07/06/2022	13/6/22
32	How IT and OT Security Practices and Systems Vary	L+D	BB+LCD	1	30	07/06/2022	14/6/22
33	Formal Risk Analysis Structures: OCTAVE and FAIR	L+D	BB+LCD	1	31	13/06/2022	14/6/22
34	The Phased Application of Security in an Operational Environment	L+D	BB	1	32	13/06/2022	17/6/22

	MODULE 5 : IoT Physical Devices and Endpoints						
35	Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming	L+D	BB+LCD	1	33	14/06/2022	17/6/22
36	IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi	L+D	BB+LCD	1	34	14/06/2022	20/6/22
37	**Assignment-3**: Written Assignment	Offline	Assignment Book	0	34	17/06/2022	20/6/22
38	About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi,	L+D	BB+LCD	1	35	20/06/2022	27/6/22
39	Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi	L+D	BB+LCD	1	36	20/06/2022	27/6/22
40	DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH,Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi	L+D	BB	1	37	21/06/2022	28/6/22
41	Smart and Connected Cities, An IoT Strategy for Smarter Cities	L+D	BB	1	38	21/06/2022	28/6/22
42	Smart City IoT Architecture	L+D	BB	1	39	27/06/2022	28/6/22
43	Smart City Use-Case Examples	L+D	BB+LCD	1	40	27/06/2022	28/6/22
44	Revision	L+D	BB+LCD	0	40	28/06/2022	28/6/22
45	Revision	L+D	BB+LCD	0	40	28/06/2022	28/6/22

Total No. of Lecture Hours = 40

Total No. of Revision Hours = 02

	Mode of Assignment and Instructions	Date
Assignment 1	Written Assignment - Module 1 and Module 2 • Genesis of IoT • IoT Challenges • A Simplified IoT Architecture • IoT Data Management and Compute Stack • Smart Objects, Sensor Networks, Connecting Smart Objects **Note:** students need to answer Assignment -1 for 15 marks and should submit assignment on or before submission date.	04/05/2022
Assignment 2	Written Assignment - Module 2 and Module 3 • IEEE 802.15.4, Standardization and Alliances Physical Layer,MAC Layer Topology, Security • Application Protocols for IoT • Adapting SCADA for IP • CoAP, MQTT **Note:** students need to answer Assignment -1 for 15 marks and should submit assignment on or before submission date.	25/05/2022

Assignment 3	Written Assignment - Module 4 and Module 5 • An Introduction to Data Analytics for IoT • Network Analytics, Securing IoT • Introduction to Arduino UNO • RaspberryPi Board • Smart City Use-Case Examples **Note:** students need to answer Assignment -3 for 20 marks and should submit assignment on or before submission date	17/06/2022

R.S. Geethayal.
Course in charge

Head of the Department
HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Principal
Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Management
Bengaluru - 560 109

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

Question Bank-1

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Sl. No.	MODULE 1	K Level	CO
1.	**Explain** oneM2M IoT standardized architecture with a neat diagram.	Understanding K2	CO1
2	**Explain** the impact of "IoT" in real world with an example of connected factories.	Understanding K2	CO1
3.	**Define** Internet of Things (IoT). **Explain** in detail the genesis of IoT.	Understanding K2	CO1
4.	**Illustrate** The IoT world forum (IoTWF) standardized architecture with a neat block diagram.	Understanding K2	CO1
5.	**Illustrate** the extended simplified IoT architecture with the help of a diagram.	Understanding K2	CO1
6.	**Explain** IoT data management and compute stack.	Understanding K2	CO1
7.	**Explain** the core IoT functional stack.	Understanding K2	CO1
8.	**Explain** few of the most significant challenges and problems that IoT is currently facing.	Understanding K2	CO1
9.	**Define** IoT. **Explain** the evolutionary phases of IoT.	Understanding K2	CO1
10.	**Illustrate** some of the differences between IT and OT networks and their	Understanding	CO1

	various challenges	K2	
11	**Explain** the access network sub layer with a neat diagram	Understanding K2	CO1
12	**Explain** the following in terms of IoT i) Connected roadways ii) Smart connected buildings	Understanding K2	CO1
13	**Explain** briefly about connecting smart objects.	Understanding K2	CO1
14	**Explain** the drivers behind IoT Architecture	Understanding K2	CO1
	MODULE 2		
15	**Explain** briefly about Wireless Sensor Networks (WSN)	Understanding K2	CO2
16.	**Define** sensor and smart objects. **Explain** their characteristics	Understanding K2	CO2
17.	**Explain** the different types of sensors.	Understanding K2	CO2
18.	**Define** actuator. **Explain** how sensors and actuators Interact with the physical world.	Understanding K2	CO2
19.	**Explain** IoT access technologies of IEEE 802.15.4	Understanding K2	CO2
20.	**Explain** about data aggregation in wireless sensor networks.	Understanding K2	CO2

Course Incharge

Head of the Department

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

Question Bank-2

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Sl. No.	MODULE 2	K Level	CO
1.	**Explain** IEEE 802.15.4 PHY Format with neat diagram.	**Understanding** K2	CO2
2	**Explain** the Protocol Stacks utilizing IEEE 802.15.4	**Understanding** K2	CO2
3.	**Explain** LoRaWAN layers and its physical layer	**Understanding** K2	CO2
4.	**Illustrate** ZigBee IP protocol stack with a neat diagram.	**Understanding** K2	CO2
5.	**Explain** IEEE 802.15.4 MAC Format with neat diagram.	**Understanding** K2	CO2
6.	**Explain** the frame format of auxillary security header field for 802.15.4-2006.	**Understanding** K2	CO2
7.	**Explain** the general MAC frame format for IEEE 1901.2.	**Understanding** K2	CO2
	MODULE 3		
8.	**Differentiate** between COAP and MQTT.	**Understanding** K2	CO3
9.	**Outline** the concept of tunneling legacy SCADA over IP networks.	**Understanding** K2	CO3

10.	**Explain** the header stacks of 6LoWPAN.	Understanding K2	CO3
11.	**Explain** CoAP communication in IoT infrastructure with an example of reliable transmission.	Understanding K2	CO3
12.	**Explain** MQTT message format	Understanding K2	CO3
13.	**Explain** SCADA protocol translation using DNP3 protocol.	Understanding K2	CO3
14.	**Explain** with neat diagram the concept of MQTT QoS flows.	Understanding K2	CO3
15.	**Explain** the RPL routing metrics in RPL header.	Understanding K2	CO3
16.	**Illustrate** the framework for MOTT publish/subscribe.	Understanding K2	CO3
17.	**Explain** the CoAP message format with an example of reliable transmission and	Understanding K2	CO3
18	**Explain** with a neat diagram DNP3 protocol over 6LoWPAN networks with MAP-T.	Understanding K2	CO3
19	**Elaborate** the concept of IoT data broker in application transport methods.	Understanding K2	CO3
20	**Summarize** the need for optimization.	Understanding K2	CO3
21	**Outline** the key advantages of Internet Protocol.	Understanding K2	CO3
22	**Explain** the scheduling and forwarding mechanisms of 6TiSCH.	Understanding K2	CO3

Course Incharge

Head of the Department 3/6/22

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering and Management
Bengaluru

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
Question Bank-3

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Sl. No.	MODULE 4	K Level	CO
1.	**Discuss** Big data analytics tools and technologies.	**Understanding K2**	**CO4**
2	**Explain** the elements of Hadoop with a neat diagram.	**Understanding K2**	**CO4**
3.	**Discuss** the following: a) Supervised learning b) Unsupervised learning c) Neural networks	**Understanding K2**	**CO4**
4.	**Explain** in detail the core functions of edge analytics with a neat diagram.	**Understanding K2**	**CO4**
5.	**Explain** the different steps and phases of OCTAVE allegro methodology.	**Understanding K2**	**CO4**
6.	**Explain** formal risk analysis structures.	**Understanding K2**	**CO4**
7.	**Explain** Lambda architecture with a neat diagram.	**Understanding K2**	**CO4**
8.	**Explain** the different components of Flexible Network Flow architecture (FNF).	**Understanding K2**	**CO4**
9.	**Explain** Secured Network Infrastructure by using process control hierarchy model.	**Understanding K2**	**CO4**
10.	**Explain** the data and analytics of IOT.	**Understanding K2**	**CO4**
	MODULE 5		
11.	**Explain** the different pins/parts of Arduino Uno Board.	**Understanding K2**	**CO5**
12.	**Explain** the following with respect to Arduino programming. a) Structure b) Functions c) Variables d) Flow control statements e) Data type f) Constants	**Understanding K2**	**CO5**
13.	**Explain** Raspberry Pi learning board.	**Understanding K2**	**CO5**
14.	**Develop** a program to measure the humidity and temperature using Arduino Uno board.	**Applying K3**	**CO5**
15.	**Define** Arduino. **Explain** the advantages of Arduino.	**Understanding K2**	**CO5**

16.	**Explain** smart city security architecture.	**Understanding K2**	**CO5**
17.	**Explain** wireless temperature monitoring system using Raspberry P_i.	**Understanding K2**	**CO5**
18.	**Distinguish** between Raspberry P_i and Arduino.	**Understanding K2**	**CO5**
19.	**Explain** the steps to install Arduino software for the windows PCs.	**Understanding K2**	**CO5**
20.	**Explain** smart parking architecture with advantages and disadvantages.	**Understanding K2**	**CO5**

Course Incharge

Head of the Department

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062.

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CO-PO Mapping

Course: Internet of Things			
Type: Core		Course Code: 17CS81/15CS81	
No of Hours			
Theory (Lecture Class)	Practical/Field Work/Allied Activities	Total/Week	Total teaching hours
4	3	4	40
Marks			
Internal Assessment	Examination	Total	Credits
40	60	100	4

Aim/Objectives of the Course

1. To assess the genesis and impact of IoT applications and architectures in real world.
2. To illustrate diverse methods of deploying smart objects and connecting them to network.
3. To compare different Application protocols for IoT.
4. To infer the role of Data Analytics and Security in IoT.
5. To identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

Course Learning Outcomes

After completing the course, the students will be able to

CO1	**Interpret** the impact and challenges posed by IoT networks leading to new architectural models.	**Understanding (K2)**
CO2	**Outline** the deployment of smart objects and access technologies to frame network.	**Understanding (K2)**
CO3	**Describe** the role of IoT protocols for efficient network communication.	**Understanding (K2)**
CO4	**Exhibit** the need for Data Analytics, Big Data Analytics and Tools & Security in IoT.	**Applying (K3)**
CO5	**Illustrate** different sensor technologies for sensing real world entities and **Identify** the applications of IoT in Industry.	**Applying (K3)**

Syllabus Content

Module 1: What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute. **LO:** At the end of this session the student will be able to 1. What is mean by IOT? 2. What are the difference between IOT and Digitization? 3. Write a short note IOT network architecture designs.	CO1 08 hours PO1-3 PO4-1 PO5-1 PO6-1 PO7-3 PO12-1

4. Explain the the drivers behind new network architecture 5. Explain IoT Data Management and Compute Stack 6. Explain Core IoT Functional Stack	PSO1-3 PSO2-1
Module 2: Smart Objects. The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies **LO**: At the end of this session the student will be able to 1. Explain the IOT with help of Sensors and actuators 2. Explain the smart objects 3. Explain connecting smart objects 4. Explain IoT Access Technologies.	**CO2** 08 hrs. PO1-3 PO4-1 PO5-1 PO6-1 PO7-2 PO9-1 PO12-1 PSO1-3 PSO2-1
Module 3: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. **LO**: At the end of this session the student will be able to 1. Explain IOT network layer 2. Explain the business case for IP 3. What is the need for Optimization? 4. Explain the IoT Application Transport Methods	**CO3** 08 hrs PO1-3 PO5-1 PO6-1 PO7-2 PO9-1 PO12-1 PSO1-3 PSO2-1
Module 4 Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment **LO**: At the end of this session the student will be able to 1. Demonstrate the need for Data Analytics in IoT 2. Explain Big Data Analytics Tools and Technology 3. Write a Brief History of OT Security. 4. What are Common Challenges in OT Security. 5. Explain Formal Risk Analysis Structures: OCTAVE and FAIR	**CO4** 08 hrs PO1-3 PO5-1 PO6-1 PO7-2 PO9-1 PO12-1 PSO1-3 PSO2-1

Module 5: IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples. **LO:** At the end of this session the student will be able to 1. Develop programs using Arduino UNO. 2. Explain Physical Devices and Endpoints. 3. Explain remote access to RaspberryPi. 4. Develop steps required for Configuring RaspberryPi. 5. Show use case examples for temperature sensors and smart city.	CO5 08 hrs PO1-3 PO5-1 PO6-1 PO7-2 PO9-1 PO12-1 PSO1-3 PSO2-1

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978- 9386873743)
2. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017.

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

Useful Websites

1. https://www.goodfirms.co/internet-of-things
2. https://builtin.com/internet-things/iot-examples
3. https://new.siemens.com/
4. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-cs66/
5. https://nptel.ac.in/courses/106/105/106105166/

Useful Journals

1. International Journal of Computers and Applications on IOT.
2. International Journal of Computer Techniques Internet of Things Technologies.

Teaching and Learning Methods

1. Lecture class: 40hrs

CO to PO Mapping

PO1: Science and engineering Knowledge **PO2:** Problem Analysis **PO3:** Design & Development **PO4:**Investigations of Complex Problems **PO5:** Modern Tool Usage **PO6:** Engineer & Society	**PO7:**Environment and Society **PO8:**Ethics **PO9:**Individual& Team Work **PO10:** Communication **PO11:**ProjectMngmt& Finance **PO12:**Lifelong Learning

PSO1: Understand fundamental and advanced concepts in the core areas of Computer Science and Engineering to analyze, design and implement the solutions for the real world problems.

PSO2: Utilize modern technological innovations efficiently in various applications to work towards the betterment of society and solve engineering problems.

CO	PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
18CS 81	K-level														
CO1	K2	3	-	-	1	1	1	3	-	-	-	-	1	3	1
CO2	K2	3	-	-	1	1	1	2	-	1	-	-	1	3	1
CO3	K2	3	-	-	-	1	1	2	-	1	-	-	1	3	1
CO4	K3	3	1	1	-	1	1	2	-	1	-	-	1	3	1
CO5	K3	3	1	1	-	1	1	2	-	1	-	-	1	3	1

Course in charge

Head of the Department

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bengaluru-560062

Principal

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Management
Bengaluru - 560 109

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
ASSIGNMENT 1

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Assignment No: 1
Date of Issue: 3/5/2022

Total marks:15
Date of Submission: 13/5/2022

Sl. No.	Assignment Questions	K Level	CO	Marks
1.	Define IOT. **Explain** the evolutionary phases of IOT.	Understanding K2	CO1	2
2	**List and explain** some of the differences between IT and OT networks and their various challenges.	Understanding K2	CO1	2
3.	**Explain** the oneM2M IoT standardized architecture with a neat diagram.	Understanding K2	CO1	2
4.	**Explain** IoT Data Management and Compute Stack with Fog Computing.	Understanding K2	CO1	2
5.	**Illustrate** The IoT World Forum (IoTWF) standardized architecture with a neat block diagram. (explain every layer)	Understanding K2	CO1	2
6.	**Define** actuator. **Explain** how sensors and actuators Interact with the physical world.	Understanding K2	CO2	1
7.	**List** and **explain** different types of sensors.	Understanding K2	CO2	1
8.	**Explain** IOT access technologies.	Understanding K2	CO2	1
9.	**Explain** briefly the Wireless Sensor Networks (WSN).	Understanding K2	CO2	1
10.	**Define** sensor and smart objects. **Explain** their characteristics.	Understanding K2	CO2	1

Course Incharge

Head of the Department 3/5/22

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

ASSIGNMENT 2

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Assignment No: 2
Date of Issue: 27/5/2022

Total marks:15
Date of Submission: 2/6/2022

Sl. No.	Assignment Questions	K Level	CO	Marks
1.	**Explain** all the Protocol Stacks Utilizing IEEE 802.15.4.	Understanding K2	CO2	1
2	**Explain** IEEE 802.15.4 PHY Format with neat diagram.	Understanding K2	CO2	1
3.	**Explain** IEEE 802.15.4 MAC Format with neat diagram.	Understanding K2	CO2	1
4.	**Explain** High-Level ZigBee and Zigbee IP Protocol Stack with neat diagram.	Understanding K2	CO2	1
5.	Explain the main topologies used for IOT connecting devices.	Understanding K2	CO2	1
6.	**Explain** the working of IP as the IOT Network layer.	Understanding K2	CO3	2
7.	Discuss need for optimization.	Understanding K2	CO3	2
8.	**Describe** application protocols of IOT.	Understanding K2	CO3	2
9.	**Compare** between COAP and MQTT.	Understanding K2	CO3	2
10.	**Explain** in detail the 6LOWPAN.	Understanding K2	CO3	2

Course Incharge

3/6/22
Head of the Department

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

K S SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

ASSIGNMENT 3

Batch	2018
Year/Semester/Section	IV/VIII/A&B
Course Code/Title	18CS81/Internet Of Things
Name of the Course In charge	Mrs. R S Geethanjali & Mrs. Gargi N

Assignment No: 3
Date of Issue: 15/6/2022

Total marks:20
Date of Submission: 25/6/2022

Sl. No.	Assignment Questions	K Level	CO	Marks
1.	**Discuss** Big data analytics tools and technologies.	Understanding K2	CO4	2
2.	**Explain** the elements of Hadoop with a neat diagram	Understanding K2	CO4	2
3.	**Discuss** the following: a) Supervised learning b) Unsupervised learning c) Neural networks	Understanding K2	CO4	2
4.	**Explain** in detail the core functions of edge analytics with a neat diagram	Understanding K2	CO4	2
5.	**Explain** the different steps and phases of OCTAVE allegro methodology	Understanding K2	CO4	2
6.	**Explain** the different pins/parts of Arduino Uno Board.	Understanding K2	CO5	2
7.	**Explain** the following with respect to Arduino programming a) Structure b) Functions c) Variables d) Flow control statements e) Data type f) Constants	Understanding K2	CO5	2
8.	**Explain** Raspberry Pi learning board.	Understanding K2	CO5	2
9.	**Develop** a program to measure the humidity and temperature using Arduino Uno board.	Applying K3	CO5	2
10.	**Define** Arduino. **Explain** the advantages of Arduino.	Understanding K2	CO5	2

Course Incharge

Head of the Department

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bengaluru

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
I SESSIONAL TEST QUESTION PAPER
SET-A

USN

Degree	: B.E		Semester :	VIII A&B
Branch	: Computer Science and Engineering		Course Code :	18CS81/17CS81/15CS81
Course Title	: Internet of Things		Date :	14/05/2022
Duration	: 90 Minutes		Max Marks :	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Explain** oneM2M IoT standardized architecture with a neat diagram.	5	Understanding K2	CO1
(b)	**Explain** the impact of "IoT" in real world with an example of connected factories.	5	Understanding K2	CO1
(c)	**Define** actuator. **Explain** how sensors and actuators Interact with the physical world.	5	Understanding K2	CO2
	OR			
2(a)	**Define** Internet of Things (IoT). **Explain** in detail the genesis of IoT.	5	Understanding K2	CO1
(b)	**Illustrate** The IoT world forum (IoTWF) standardized architecture with a neat block diagram.	5	Understanding K2	CO1
(c)	**Explain** the different types of sensors.	5	Understanding K2	CO2
	PART-B			
3(a)	**Illustrate** the extended simplified IoT architecture with the help of a diagram.	5	Understanding K2	CO1
(b)	**Explain** IoT data management and compute stack.	5	Understanding K2	CO1
(c)	**Define** sensor and smart objects. **Explain** their characteristics.	5	Understanding K2	CO2
	OR			
4(a)	**Explain** the core IoT functional stack.	5	Understanding K2	CO1
(b)	**Explain** few of the most significant challenges and problems that IoT is currently facing.	5	Understanding K2	CO1
(c)	**Explain** briefly about Wireless Sensor Networks (WSN).	5	Understanding K2	CO2

Course Incharge | HOD CSE | IQAC- Coordinator | Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Managem
Bengaluru - 560 1..

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

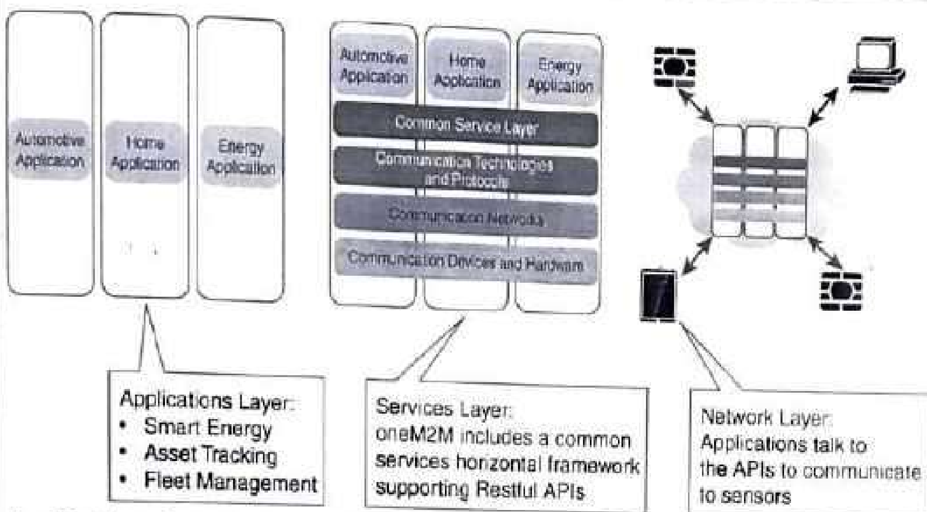
SESSION: 2021-2022 (EVEN SEMESTER)

I SESSIONAL TEST SCHEME & SOLUTION

SET-A

Degree	: B.E	**Semester**	: VIII A&B
Branch	: Computer Science & Engineering	**Date**	: 14-05-2022
Course Title	: Internet of Things	**Course Code**	: 18CS81/17CS81/15CS81
Duration	: 90 Minutes	**Max Marks**	: 30

Note: Answer ONE full question from each part

Q. No.	Scheme & Solution	Marks
	PART-A	
1(a)	 **Applications layer:** The oneM2M architecture gives major attention to connectivity between devices and their applications. This domain includes the application-layer protocols and attempts to standardize northbound API definitions for interaction with business intelligence (BI) systems. Applications tend to be industry-specific and have their own sets of data models, and thus they are shown as vertical entities. **Services layer:** This layer is shown as a horizontal framework across the vertical industry applications. At this layer, horizontal modules include the physical network that the IoT applications run on, the underlying management protocols, and the hardware. Examples include backhaul communications via cellular, MPLS networks, VPNs, and so on. Riding on top is the common services layer. **Network layer:** This is the communication domain for the IoT devices and endpoints. It includes the devices themselves and the communications network that links them. Embodiments of this communications infrastructure include wireless mesh technologies, such as IEEE 802.15.4, and wireless point-to-multipoint systems, such as IEEE 801.11ah.	**2M-Diagram** **3M-Explanation**

(b)	Traditional factories have been operating at a disadvantage, impeded by production environments that are "disconnected" or, at the very least, "strictly gated" to corporate business systems, supply chains, and customers and partners. Managers of these traditional factories are essentially "flying blind" and lack visibility into their operations. These operations are composed of plant floors, front officers, and suppliers operating in independent silos. Ex: Smelting factories, industries and mining companies.	Explanation- 5M
(c)	Actuators are natural complements to sensors. Sensors are designed to sense and measure practically any measurable variable in the physical world. They convert their measurements (typically analog) into electric signals or digital representations that can be consumed by an intelligent agent (a device or a human).	**Definition- 1M** **Table- 4M**

Type	Examples
Mechanical actuators	Lever, screw jack, hand crank
Electrical actuators	Thyristor, biopolar transistor, diode
Electromechanical actuators	AC motor, DC motor, step motor
Electromagnetic actuators	Electromagnet, linear solenoid
Hydraulic and pneumatic actuators	Hydraulic cylinder, pneumatic cylinder, piston, pressure control valves, air motors
Smart material actuators (includes thermal and magnetic actuators)	Shape memory alloy (SMA), ion exchange fluid, magnetorestrictive material, bimetallic strip, piezoelectric bimorph
Micro- and nanoactuators	Electrostatic motor, microvalve, comb drive

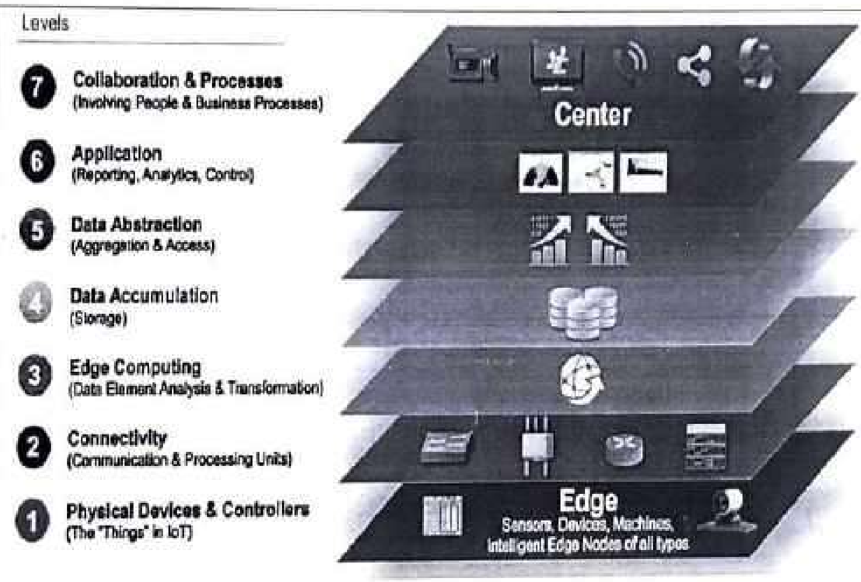
OR

2(a)	The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables to collect and exchange data. Genesis of IoT The age of IoT is often said to have started between the years 2008 and 2009. During this time period, the number of devices connected to the Internet eclipsed the world's population. With more "things" connected to the Internet than people in the world, a new age was upon us, and the Internet of Things was born. Kevin Ashton is the person who created the term "Internet of Things". Kevin has subsequently explained that IoT now involves the addition of senses to computers. In the Twentieth century, Computers depended on humans to input data and knowledge through typing, bar codes, and so on.	**Definition-1M** **Phases- 4M**

Internet Phase	Definition
Connectivity (Digitize access)	This phase connected people to email, web services, and search so that information is easily accessed.
Networked Economy (Digitize business)	This phase enabled e-commerce and supply chain enhancements along with collaborative engagement to drive increased efficiency in business processes.
Immersive Experiences (Digitize interactions)	This phase extended the Internet experience to encompass widespread video and social media while always being connected through mobility. More and more applications are moved into the cloud.
Internet of Things (Digitize the world)	This phase is adding connectivity to objects and machines in the world around us to enable new services and experiences. It is connecting the unconnected.

Table 1-1 *Evolutionary Phases of the Internet*

(b)



Architecture- 2M

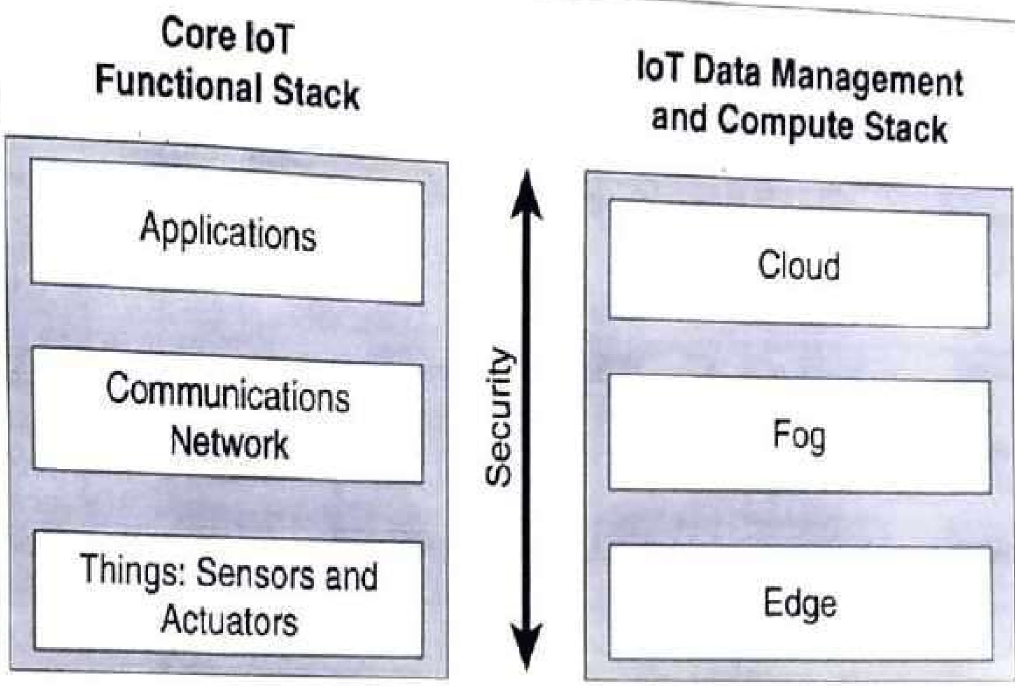
Explanation- 3M

IoT Reference Model Layer	Functions
Layer 4: Data accumulation layer	Captures data and stores it so it is usable by applications when necessary. Converts event-based data to query-based processing.
Layer 5: Data abstraction layer	Reconciles multiple data formats and ensures consistent semantics from various sources. Confirms that the data set is complete and consolidates data into one place or multiple data stores using virtualization.
Layer 6: Applications layer	Interprets data using software applications. Applications may monitor, control, and provide reports based on the analysis of the data.
Layer 7: Collaboration and processes layer	Consumes and shares the application information. Collaborating on and communicating IoT information often requires multiple steps, and it is what makes IoT useful. This layer can change business processes and delivers the benefits of IoT.

(c)	Categories under which the sensors and actuators ate clustered. There are a number of ways to group and cluster sensors into different categories, including the following: • **Active or passive:** Sensors can be categorized based on whether theyproduce an energy output and typically require an external power supply(active) or whether they simply receive energy and typically require noexternal power supply (passive). • **Invasive or non-invasive:** Sensors can be categorized based on whether a sensor is part of the environment it is measuring (invasive) or external to it (non-invasive). • **Contact or no-contact:** Sensors can be categorized based on whether they require physical contact with what they are measuring (contact) or not (nocontact). • **Absolute or relative:** Sensors can be categorized based on whether they measure on an absolute scale (absolute) or based on a difference with a fixed or variable reference value (relative). • **Area of application:** Sensors can be categorized based on the specific industry or vertical where they are being used. • **How sensors measure:** Sensors can be categorized based on the physical mechanism used to measure sensory input (for example, thermoelectric, electrochemical, piezoresistive, optic, electric, fluid mechanic, photoelastic). **What sensors measure:** Sensors can be categorized based on their applications or what physical variables they measure. Actuators also vary greatly in function, size, design, and soon. Some common ways that they can be classified include the following: • **Type of motion:** Actuators can be classified based on the type of motion they produce (for example, linear, rotary, one/two/three-axes). • **Power:** Actuators can be classified based on their power output (forexample, high power, low power, micro power) • **Binary or continuous:** Actuators can be classified based on the number of stable-state outputs. • **Area of application:** Actuators can be classified based on the specificindustry or vertical where they are used. • **Type of energy:** Actuators can be classified based on their energy type like mechanical electrical, hydraulic powers.	**Definition- 1M** **Types- 4M**

PART-B

3(a)



Intention is to simplify the IoT architecture into its most basic building blocks and then to use it as a foundation to understand key design and deployment principles that are applied to industry-specific use cases. All the layers of more complex models are still covered, but they are grouped here in functional blocks that are easy to understand.

Diagram-3M

Explanation-2M

(b)

IoT Data Management and Compute Stack

The data generated by IoT sensors is one of the single biggest challenges in building an IoT system. In the case of modern IT networks, the data sourced by a computer or server is typically generated by the client/server communications model, and it serves the needs of the application. The best-known embodiment of edge services in IoT is fog computing. Any device with computing, storage, and network connectivity can be a fog node.

Examples include industrial controllers, switches, routers, embedded servers, and IoT gateways. Analyzing IoT data close to where it is collected minimizes latency, offloads gigabytes of network traffic from the core network, and keeps sensitive data inside the local network.

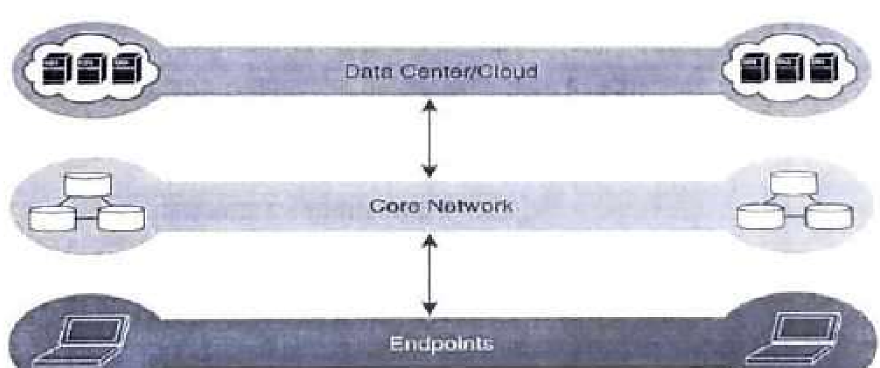
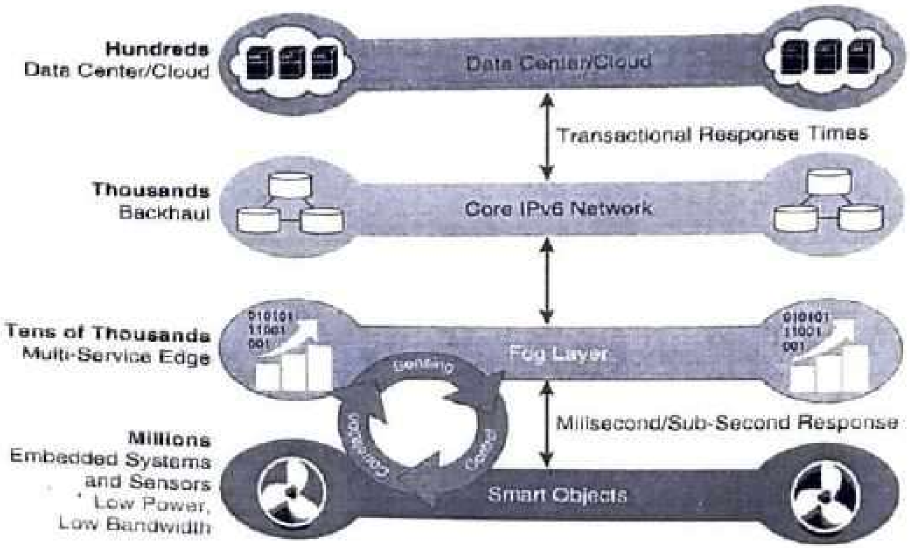


Diagram- 2M

Explanation-3M



(c)

Characteristics.

Processing Unit: A smart object has some type of processing unit for acquiring data, processing and analyzing sensing information received by the sensor(s), coordinating control signals to any actuators, and controlling a variety of functions on the smart object, including the communication and power systems.

- **Sensor(s) and /or actuator(s):** A smart object is capable of interacting with the physical world through sensors and actuators. A smart object does not need to contain both sensors and actuators. In fact, a smart object can contain one or multiple sensors and/or actuators, depending upon the application.
- **Communication Device:** The communication unit is responsible for connecting a smart object with other smart objects and the outside world (via the network). Communication devices for smart objects can be either wired or wireless.
- **Power Source:** Smart objects have components that need to be powered. Interestingly, the most significant power consumption usually comes from the communication unit of a smart object.

Characteristics- 5M

OR

4(a)

Things Layer and Applications Layer of The Core IoT Functional Stack.
Most IoT networks start from the object, or "thing," that needs to be connected.
There are myriad ways to classify smart objects.

1. **Battery-powered or power-connected:** This classification is based on whether the object carries its own energy supply or receives continuous power from an external power source.
2. **Mobile or static:** This classification is based on whether the "thing"should move or always stay at the same location. A sensor may be mobile because it is moved from one object to another.
3. **Low or high reporting frequency:** This classification is based on how often the object should report monitored parameters. A rust sensor may report values once a months
4. **Simple or rich data:** This classification is based on the quantity of data exchanged at each report cycle. A humidity sensor in a field may report a

Explanation- 5M

simple daily index value, while an engine sensor may report hundreds of parameters, from temperature to pressure, gas velocity, compression speed, carbon index, and many others. Richer data typically drives higher power consumption.

5. Report range: This classification is based on the distance at which the gateway is located.

Object density per cell: This classification is based on the number ofsmart objects over a given area, connected to the same gateway. An oil pipeline may utilize a single sensor at key locations every few miles.

Applications and Analytics Layer

Once connected to a network, your smart objects exchange information with other systems. As soon as your IoT network spans more than a few sensors, the power of the Internet of Things appears in the applications that make use of the information exchanged with the smart objects.

Analytics Versus Control Applications

- **Analytics application:** This type of application collects data frommultiple smart objects, processes the collected data, and displays information resulting from the data that was processed. The display can be about any aspect of the IoT network, from historical reports, statistics, or trends to individual system states.
- **Control application:** This type of application controls the behavior of the smart object or the behavior of an object related to the smart object

(b) **Challenges - 5M**

Challenge	Description
Scale	While the scale of IT networks can be large, the scale of OT can be several orders of magnitude larger. For example, one large electrical utility in Asia recently began deploying IPv6-based smart meters on its electrical grid. While this utility company has tens of thousands of employees (which can be considered IP nodes in the network), the number of meters in the service area is tens of millions. This means the scale of the network the utility is managing has increased by more than 1,000-fold! Chapter 5, "IP as the IoT Network Layer," explores how new design approaches are being developed to scale IPv6 networks into the millions of devices.
Security	With more "things" becoming connected with other "things" and people, security is an increasingly complex issue for IoT. Your threat surface is now greatly expanded, and if a device gets hacked, its connectivity is a major concern. A compromised device can serve as a launching point to attack other devices and systems. IoT security is also pervasive across just about every facet of IoT. For more information on IoT security, see Chapter 8, "Securing IoT."

Privacy	As sensors become more prolific in our everyday lives, much of the data they gather will be specific to individuals and their activities. This data can range from health information to shopping patterns and transactions at a retail establishment. For businesses, this data has monetary value. Organizations are now discussing who owns this data and how individuals can control whether it is shared and with whom.
Big data and data analytics	IoT and its large number of sensors is going to trigger a deluge of data that must be handled. This data will provide critical information and insights if it can be processed in an efficient manner. The challenge, however, is evaluating massive amounts of data arriving from different sources in various forms and doing so in a timely manner. See Chapter 7 for more information on IoT and the challenges it faces from a big data perspective.
Interoperability	As with any other nascent technology, various protocols and architectures are jockeying for market share and standardization within IoT. Some of these protocols and architectures are based on proprietary elements, and others are open. Recent IoT standards are helping minimize this problem, but there are often various protocols and implementations available for IoT networks. The prominent protocols and architectures—especially open, standards-based implementations—are the subject of this book. For more information on IoT architectures, see Chapter 2, "IoT Network Architecture and Design," Chapter 4, "Connecting Smart Objects," Chapter 5, "IP as the IoT Network Layer," and Chapter 6, "Application Protocols for IoT," take a more in-depth look at the protocols that make up IoT.

Wireless Sensor Networks (WSNs)

Wireless sensor networks are made up of wirelessly connected smart objects, which are sometimes referred to as *motes*. These data aggregation techniques are helpful in reducing the amount of overall traffic (and energy) in WSNs with very large numbers of deployed smart objects.

(c)

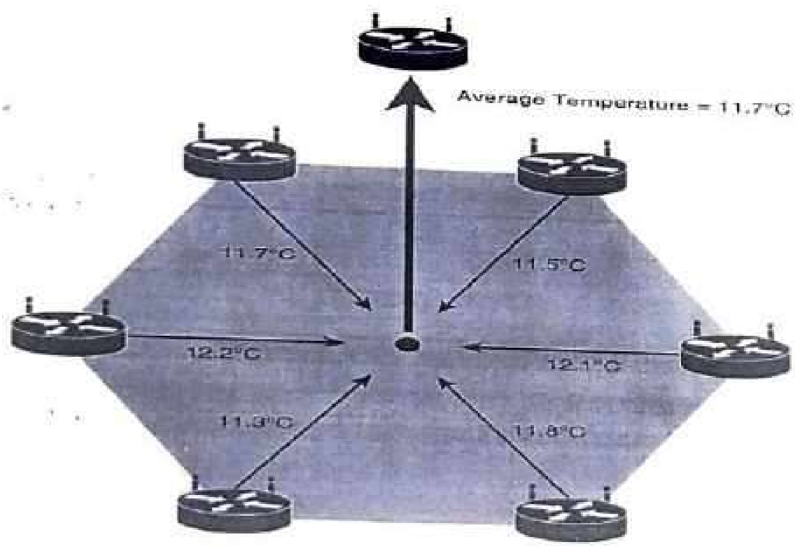


Diagram- 3M

Explanation- 2M

Wirelessly connected smart objects generally have one of the following two communication patterns:

- **Event-driven:** Transmission of sensory information is triggered only when a smart object detects,a particular event or predetermined threshold.
- **Periodic:** Transmission of sensory information occurs only at periodic intervals

Communication Protocols for Wireless Sensor Networks:

- Any communication protocol must be able to scale to a large number of nodes.
- Likewise, when selecting a communication protocol, you must carefully take into account the requirements of the specific application.

Also consider any trade-offs the communication protocol offers between power consumption, maximum transmission speed, range, tolerance for packet loss, topology optimization, security, and so on.

- Sensors often produce large amounts of sensing and measurement data that needs to be processed.
- This data can be processed locally by the nodes of a WSN or across zero or more hierarchical levels in IoT networks.
- IoT is one of those rare technologies that impacts all verticals and industries, which means standardization of communication protocols is a complicated task, requiring protocol definition across multiple layers of the stack, as well as a great deal of coordination across multiple standards development organizations.

Course Incharge

HOD CSE 10/5/22

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

IQAC- Coordinator

Principal

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Manage
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
I SESSIONAL TEST QUESTION PAPER
SET-B

USN: | | | | | | | | | | |

Degree	: B.E	Semester :	VIII A&B
Branch	: Computer Science and Engineering	Course Code :	18CS81/17CS81/15CS81
Course Title	: Internet of Things	Date :	14/05/2022
Duration	: 90 Minutes	Max Marks :	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Define** IoT. **Explain** the evolutionary phases of IoT.	5	Understanding K2	CO1
(b)	**Illustrate** some of the differences between IT and OT networks and their various challenges.	5	Understanding K2	CO1
(c)	**Explain** the different types of sensors.	5	Understanding K2	CO2
	OR			
2(a)	**Explain** the access network sub layer with a neat diagram.	5	Understanding K2	CO1
(b)	**Explain** the following in terms of IoT. i) Connected roadways ii) Smart connected buildings.	5	Understanding K2	CO1
(c)	**Explain** IoT access technologies of IEEE 802.15.4	5	Understanding K2	CO2
	PART-B			
3(a)	**Illustrate** the simplified IoT architecture with a neat diagram.	5	Understanding K2	CO1
(b)	**Explain** briefly about connecting smart objects.	5	Understanding K2	CO1
(c)	**Explain** how sensors and actuators Interact with the physical world.	5	Understanding K2	CO2
	OR			
4(a)	**Explain** the drivers behind IoT Architecture.	5	Understanding K2	CO1
(b)	**Explain** the challenges faced in IoT.	5	Understanding K2	CO1
(c)	**Explain** about data aggregation in wireless sensor networks.	5	Understanding K2	CO2

Course Incharge | HOD CSE | IQAC- Coordinator | Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Managem
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

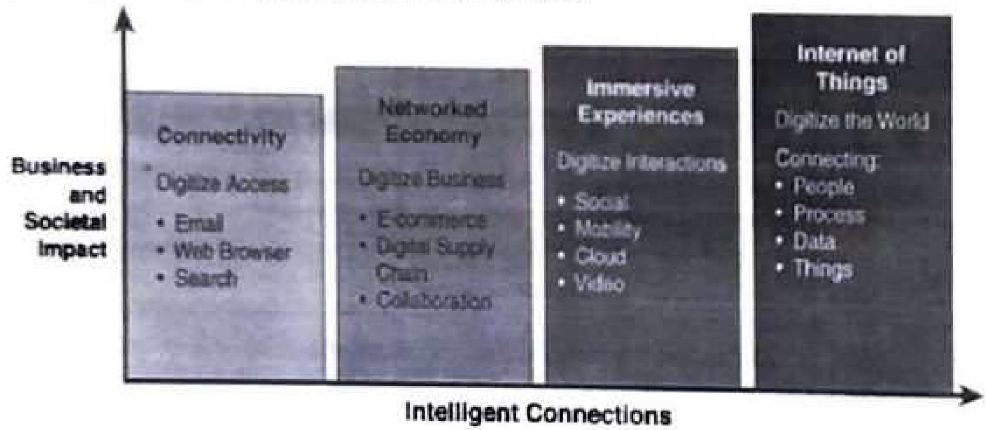
SESSION: 2021-2022 (EVEN SEMESTER)

I SESSIONAL TEST SCHEME & SOLUTION

SET-B

Degree	: B.E		Semester	:	VIII A&B
Branch	: Computer Science & Engineering		Date	:	14-5-2022
Course Title	: Internet of Things		Course Code	:	18CS81/17CS81/15CS81
Duration	: 90 Minutes		Max Marks	:	30

Note: Answer ONE full question from each part

Q. No.	Scheme & Solution	Marks
	PART-A	
1(a)	Evolutionary phases of the Internet of Things. The age of IoT is often said to have started between the years 2008 and 2009. During this time period, the number of devices connected to the Internet eclipsed the world's population. With more "things" connected to the Internet than people in the world, a new age was upon us, and the Internet of Things was born.  Figure 1.1 *Evolutionary Phases of the Internet*	Diagram- 3M Explanation- 2M
(b)	Operational Technology (OT) with Information Technology (IT) in terms of IoT. IoT focuses on connecting "things", such as objects and machines, to a computer network, such as the Internet. IoT is a well-understood term used across the industry as a whole. The whole photography industry has been digitized. Pretty much everyone has digital cameras these days, either standalone devices or built into their mobile phones. Almost no one buys film and takes it to a retailer to get it developed. The digitization of photography has completely changed our experience when it comes to capturing images. Example: Video rental industry, Transportation industry.	Differences between OT and IT- 5M

Criterion	Industrial OT Network	Enterprise IT Network
Operational focus	Keep the business operating 24x7	Manage the computers, data, and employee communication system in a secure way
Priorities	1. Availability 2. Integrity 3. Security	1. Security 2. Integrity 3. Availability
Types of data	Monitoring, control, and supervisory data	Voice, video, transactional, and bulk data
Security	Controlled physical access to devices	Devices and users authenticated to the network
Implication of failure	OT network disruption directly impacts business	Can be business impacting, depending on industry, but workarounds may be possible
Network upgrades (software or hardware)	Only during operational maintenance windows	Often requires an outage window when workers are not onsite; impact can be mitigated
Security vulnerability	Low: OT networks are isolated and often use proprietary protocols	High: continual patching of hosts is required, and the network is connected to Internet and requires vigilant protection

Source: Maciej Kranz, *IT Is from Venus, OT Is from Mars*, blogs.cisco.com/digital/it-is-from-venus-ot-is-from-mars, July 14, 2015.

(c)

There are a number of ways to group and cluster sensors into different categories, including the following:

- **Active or passive:** Sensors can be categorized based on whether theyproduce an energy output and typically require an external power supply(active) or whether they simply receive energy and typically require noexternal power supply (passive).
- **Invasive or non-invasive:** Sensors can be categorized based on whether a sensor is part of the environment it is measuring (invasive) or external to it (non-invasive).
- **Contact or no-contact:** Sensors can be categorized based on whether they require physical contact with what they are measuring (contact) or not (nocontact).
- **Absolute or relative:** Sensors can be categorized based on whether they measure on an absolute scale (absolute) or based on a difference with a fixed or variable reference value (relative).
- **Area of application:** Sensors can be categorized based on the specificindustry or vertical where they are being used.

Types of sensors - 5M

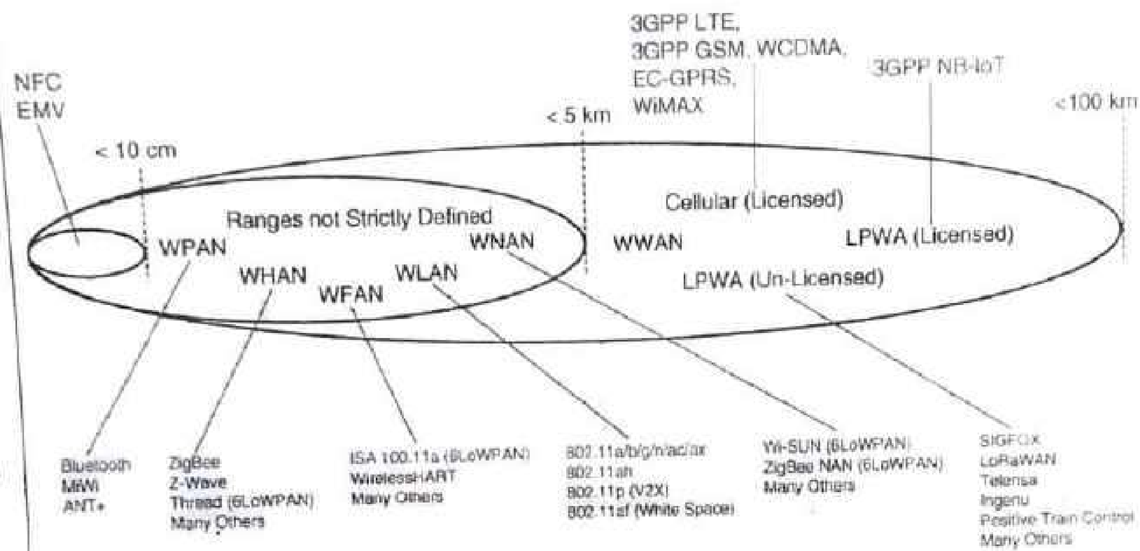
OR

Access Network Sublayer

There is a direct relationship between the IoT network technology you choose and the type of connectivity topology this technology allows. Each technology was designed with a certain number of use cases in mind (what to connect, where to connect, how much data to transport at what interval and over what distance). These use cases determined the frequency band that was expected to be most suitable, the frame structure matching the expected data pattern (packet size and communication intervals), and the possible topologies that these use cases illustrate.

One key parameter determining the choice of access technology is the range between the smart object and the information collector

2(a)



WPAN: Wireless Personal Area Network
WHAN: Wireless Home Area Network
WFAN: Wireless Field (or Factory) Area Network
WLAN: Wireless Local Area Network

WNAN: Wireless Neighborhood Area Network
WWAN: Wireless Wide Area Network
LPWA: Low Power Wide Area

Diagram- 3M

Explanation- 2M

PAN (personal area network): Scale of a few meters. This is the personal space around a person. A common wireless technology for this scale is Bluetooth.

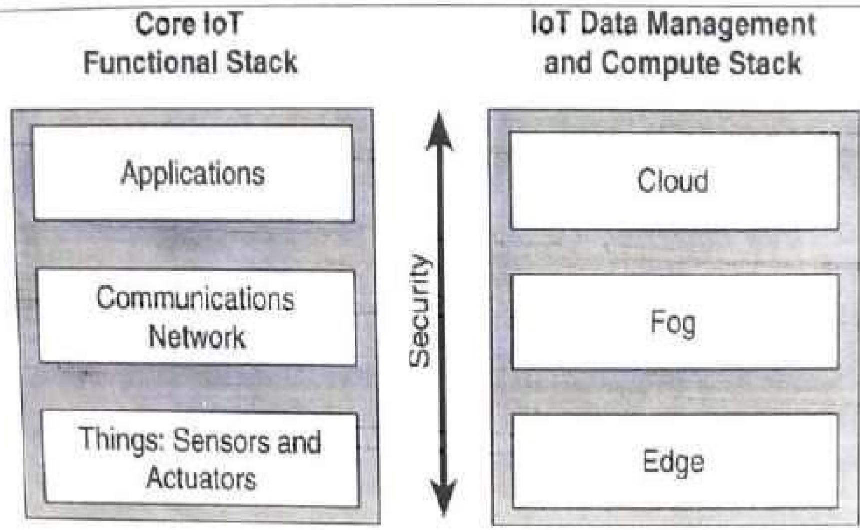
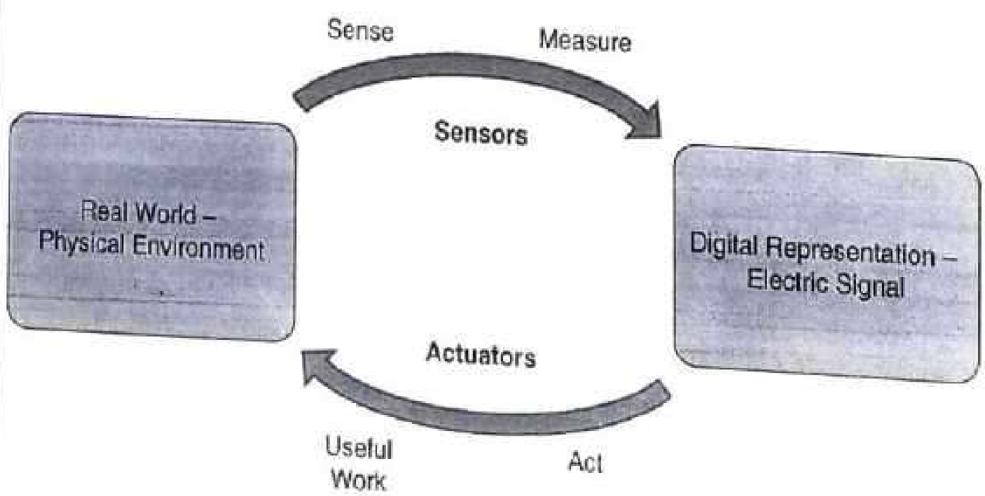
HAN (home area network): Scale of a few tens of meters. At this scale, common wireless technologies for IoT include ZigBee and Bluetooth Low Energy (BLE).

NAN (neighborhood area network): Scale of a few hundreds of meters. The term NAN is often used to refer to a group of house units from which data is collected.

FAN (field area network): Scale of several tens of meters to several hundred meters. The FAN typically refers to an outdoor area larger than a single group of house units. The FAN is often seen as "open space" (and therefore not secured and not controlled).

LAN (local area network): Scale of up to 100 m. This term is very common in networking, and it is therefore also commonly used in the IoT space when standard networking technologies (such as Ethernet or IEEE 802.11) are used.

(b)	i) Connected roadways ii) Smart connected buildings. **1. Connected Roadways** IoT is going to allow self-driving vehicles to better interact with the transportation system around them through bidirectional data exchanges while also providing important data to the riders. Connected roadways is the term associated with both the driver and driverless cars fully integrating with the surrounding transportation infrastructure. Most connected roadways solutions focus on resolving today's transportation challenges such as 1. Safety 2. Mobility 3. Environment 2. **Smart connected buildings.** The function of a building is to provide a work environment that keeps the workers comfortable, efficient, and safe. Work areas need to be well lit and kept at a comfortable temperature. To keep workers safe, the fire alarm and suppression system needs to be carefully managed, as do the door and physical security alarm systems. While intelligent systems for modern buildings are being deployed and improved for each of these functions. Sensors are often used to control the heating, ventilation, and air-conditioning (HVAC) system.	**Connected roadway- 2.5M** **Smart connected buildings- 2.5M**
(c)	**IoT Access Technologies** IEEE 802.15.4: ☛ IEEE 802.15.4 is a wireless access technology for low-cost and low-data-rate devices that are powered or run on batteries. ☛ This access technology enables easy installation using a compact protocol stack while remaining both simple and flexible. ☛ IEEE 802.15.4 is commonly found in the following types of deployments: o Home and building automation o Automotive networks o Industrial wireless sensor networks o Interactive toys and remote controls ☛ Criticisms of IEEE 802.15.4 often focus on its MAC reliability, unbounded latency, and susceptibility to interference and multipath fading. ☛ Interference and multipath fading occur with IEEE 802.15.4 because it lacks a frequency-hopping technique.	**Explanation - 5M**
	PART-B	
3(a)	Intention is to simplify the IoT architecture into its most basic building blocks and then to use it as a foundation to understand key design and deployment principles that are applied to industry-specific use cases. All the layers of more complex models are still covered, but they are grouped here in functional blocks that are easy to understand.	**Diagram- 2M** **Explanation- 3M**

		
(b)	Connecting Smart Objects. IoT devices and sensors must be connected to the network for their data to be utilized. In addition to the wide range of sensors, actuators, and smart objects that make up IoT, there are also a number of different protocols used to connect them. This chapter takes a look at the characteristics and communications criteria that are important for the technologies that smart objects employ for their connectivity, along with a deeper dive into some of the major technologies being deployed today. The various technologies used for connecting sensors can differ greatly depending on the criteria used to analyze them.The following subsections look closely at communication criteria: short range medium range and long range also explain frequency bands, topology, constrained nodes and networks.	**Explanation-** **5M**
(c)		**Diagram- 2M** **Explanation-3M**

Sensors are designed to sense and measure practically any measurable variable in the physical world.

- They convert their measurements (typically analog) into electric signals or digital representations that can be consumed by an intelligent agent (a device or a human)
- Actuators, on the others hand, receive some type of control signal (commonly an electric signal or digital command) that triggers a physical effect, usually some type of motion, force, and so on.

Type	Examples
Mechanical actuators	Lever, screw jack, hand crank
Electrical actuators	Thyristor, biopolar transistor, diode
Electromechanical actuators	AC motor, DC motor, step motor
Electromagnetic actuators	Electromagnet, linear solenoid
Hydraulic and pneumatic actuators	Hydraulic cylinder, pneumatic cylinder, piston, pressure control valves, air motors
Smart material actuators (includes thermal and magnetic actuators)	Shape memory alloy (SMA), ion exchange fluid, magnetorestrictive material, bimetallic strip, piezoelectric bimorph
Micro- and nanoactuators	Electrostatic motor, microvalve, comb drive

OR

4(a)

Drivers behind IoT Architectures

Challenge	Description	IoT Architectural Change Required
Scale	The massive scale of IoT endpoints (sensors) is far beyond that of typical IT networks.	The IPv4 address space has reached exhaustion and is unable to meet IoT's scalability requirements. Scale can be met only by using IPv6. IT networks continue to use IPv4 through features like Network Address Translation (NAT).
Security	IoT devices, especially those on wireless sensor networks (WSNs), are often physically exposed to the world.	Security is required at every level of the IoT network. Every IoT endpoint node on the network must be part of the overall security strategy and must support device-level authentication and link encryption. It must also be easy to deploy with some type of a zero-touch deployment model.
Devices and networks constrained by power, CPU, memory, and link speed	Due to the massive scale and longer distances, the networks are often constrained, lossy, and capable of supporting only minimal data rates (tens of bps to hundreds of Kbps).	New last-mile wireless technologies are needed to support constrained IoT devices over long distances. The network is also constrained, meaning modifications need to be made to traditional network-layer transport mechanisms.

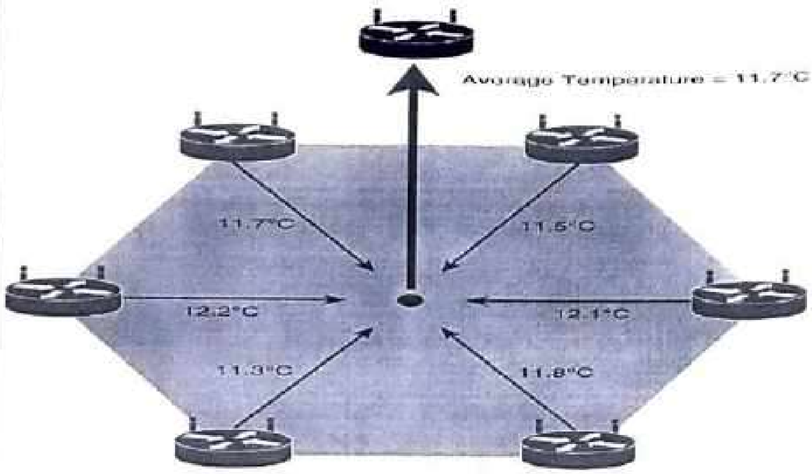
Explanation - 5M

The massive volume of data generated	The sensors generate a massive amount of data on a daily basis, causing network bottlenecks and slow analytics in the cloud.	Data analytics capabilities need to be distributed throughout the IoT network, from the edge to the cloud. In traditional IT networks, analytics and applications typically run only in the cloud.
Support for legacy devices	An IoT network often comprises a collection of modern, IP-capable endpoints as well as legacy, non-IP devices that rely on serial or proprietary protocols.	Digital transformation is a long process that may take many years, and IoT networks need to support protocol translation and/or tunneling mechanisms to support legacy protocols over standards-based protocols, such as Ethernet and IP.
The need for data to be analyzed in real time	Whereas traditional IT networks perform scheduled batch processing of data, IoT data needs to be analyzed and responded to in real-time.	Analytics software needs to be positioned closer to the edge and should support real-time streaming analytics. Traditional IT analytics software (such as relational databases or even Hadoop), are better suited to batch-level analytics that occur after the fact.

(b)

Challenge	Description
Scale	While the scale of IT networks can be large, the scale of OT can be several orders of magnitude larger. For example, one large electrical utility in Asia recently began deploying IPv6-based smart meters on its electrical grid. While this utility company has tens of thousands of employees (which can be considered IP nodes in the network), the number of meters in the service area is tens of millions. This means the scale of the network the utility is managing has increased by more than 1,000-fold! Chapter 5, "IP as the IoT Network Layer," explores how new design approaches are being developed to scale IPv6 networks into the millions of devices.
Security	With more "things" becoming connected with other "things" and people, security is an increasingly complex issue for IoT. Your threat surface is now greatly expanded, and if a device gets hacked, its connectivity is a major concern. A compromised device can serve as a launching point to attack other devices and systems. IoT security is also pervasive across just about every facet of IoT. For more information on IoT security, see Chapter 8, "Securing IoT."
Privacy	As sensors become more prolific in our everyday lives, much of the data they gather will be specific to individuals and their activities. This data can range from health information to shopping patterns and transactions at a retail establishment. For businesses, this data has monetary value. Organizations are now discussing who owns this data and how individuals can control whether it is shared and with whom.
Big data and data analytics	IoT and its large number of sensors is going to trigger a deluge of data that must be handled. This data will provide critical information and insights if it can be processed in an efficient manner. The challenge, however, is evaluating massive amounts of data arriving from different sources in various forms and doing so in a timely manner. See Chapter 7 for more information on IoT and the challenges it faces from a big data perspective.
Interoperability	As with any other nascent technology, various protocols and architectures are jockeying for market share and standardization within IoT. Some of these protocols and architectures are based on proprietary elements, and others are open. Recent IoT standards are helping minimize this problem, but there are often various protocols and implementations available for IoT networks. The prominent protocols and architectures—especially open, standards-based implementations—are the subject of this book. For more information on IoT architectures, see Chapter 2, "IoT Network Architecture and Design," Chapter 4, "Connecting Smart Objects," Chapter 5, "IP as the IoT Network Layer," and Chapter 6, "Application Protocols for IoT," take a more in-depth look at the protocols that make up IoT.

Explanation - 5M



(c)	Wireless sensor networks are made up of wirelessly connected smart objects, which are sometimes referred to as motes. The following are some of the most significant limitations of the smart objects in WSNs: - Limited processing power - Limited memory - Lossy communication - Limited transmission speeds - Limited power These limitations greatly influence how WSNs are designed, deployed, and utilized. Figure below shows an example of such a data aggregation function in a WSN where temperature readings from a logical grouping of temperature sensors are aggregated as an average temperature reading. These data aggregation techniques are helpful in reducing the amount of overall traffic (and energy) in WSNs with very large numbers of deployed smart objects. Wirelessly connected smart objects generally have one of the following two communication patterns: - **Event-driven:** Transmission of sensory information is triggered only when a smart object detects a particular event or predetermined threshold. - **Periodic:** Transmission of sensory information occurs only at periodic intervals.	Diagram- 3M Explanation - 2M

Course Incharge | HOD CSE | IQAC- Coordinator | Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Manag...
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
II SESSIONAL TEST QUESTION PAPER
SET-A

USN [| | | | | | | | | |]

Degree	:	B.E	Semester	:	VIII A&B
Branch	:	Computer Science and Engineering	Course Code	:	18CS81/17CS81/15CS81
Course Title	:	Internet of Things	Date	:	07/06/2022
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Explain** IEEE 802.15.4 PHY Format with neat diagram.	5	Understanding K2	CO2
(b)	**Differentiate** between COAP and MQTT.	5	Understanding K2	CO3
(c)	**Outline** the concept of tunneling legacy SCADA over IP networks.	5	Understanding K2	CO3
	OR			
2(a)	**Explain** the Protocol Stacks utilizing IEEE 802.15.4.	5	Understanding K2	CO2
(b)	**Explain** the header stacks of 6LoWPAN.	5	Understanding K2	CO3
(c)	**Explain** CoAP communication in IoT infrastructure with an example of reliable transmission.	5	Understanding K2	CO3
	PART-B			
3(a)	**Explain** LoRaWAN layers and its physical layer	5	Understanding K2	CO2
(b)	**Explain** MQTT message format	5	Understanding K2	CO3
(c)	**Explain** SCADA protocol translation using DNP3 protocol.	5	Understanding K2	CO3
	OR			
4(a)	**Illustrate** ZigBee IP protocol stack with a neat diagram.	5	Understanding K2	CO2
(b)	**Explain** with neat diagram the concept of MQTT QoS flows.	5	Understanding K2	CO3
(c)	**Explain** the RPL routing metrics in RPL header.	5	Understanding K2	CO3

Course Incharge | HOD CSE | IQAC- Coordinator | Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Managem
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

II SESSIONAL TEST SCHEME & SOLUTION

SET-A

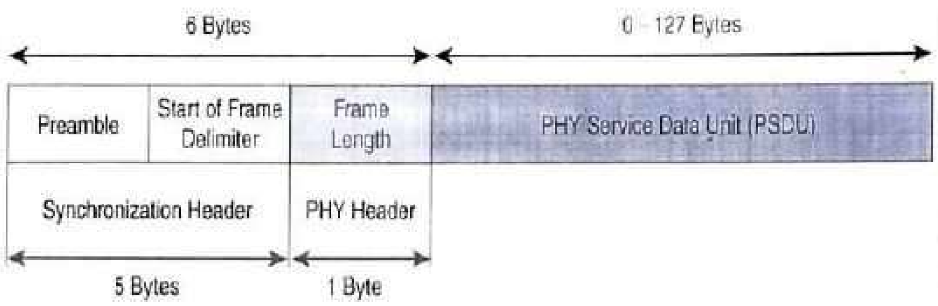
Degree	: B.E	**Semester**	: VIII A&B
Branch	: Computer Science & Engineering	**Date**	: 07-06-2022
Course Title	: Internet of Things	**Course Code**	: 18CS81/17CS81/15CS81
Duration	: 90 Minutes	**Max Marks**	: 30

Note: Answer ONE full question from each part

Q. No.	Scheme & Solution	Marks

PART-A

1(a)



The 802.15.4 standard supports an extensive number of PHY options that range from 2.4 GHz to sub-GHz frequencies in ISM bands. The original IEEE 802.15.4-2003 standard specified only three PHY options based on direct sequence spread spectrum (DSSS) modulation.

The original physical layer transmission options were as follows:

- o 2.4 GHz, 16 channels, with a data rate of 250 kbps
- o 915 MHz, 10 channels, with a data rate of 40 kbps
- o 868 MHz, 1 channel, with a data rate of 20 kbps

The PHY Header portion of the PHY frame is shown in Figure is simply a frame length value.

- It lets the receiver know how much total data to expect in the PHY service data unit (PSDU) portion of the 802.4.15 PHY. The PSDU is the data field or payload.
- The IEEE 802.15.4 MAC layer manages access to the PHY channel by defining how devices in the same area will share the frequencies allocated.
- At this layer, the scheduling and routing of data frames are also coordinated.

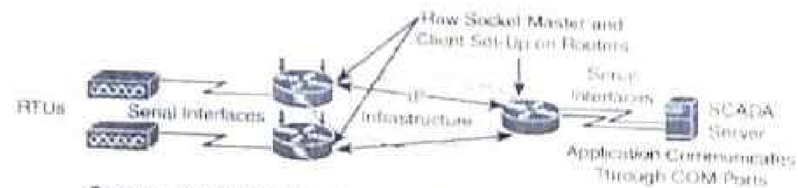
Marks: 2M-Diagram; 3M-Explanation

(b)

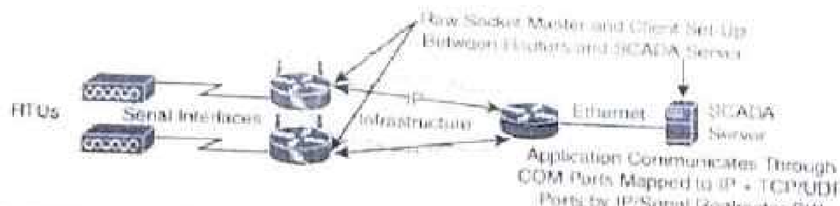
Factor	CoAP	MQTT
Main transport protocol	UDP	TCP
Typical messaging	Request/response	Publish/subscribe
Effectiveness in LLNs	Excellent	Low/fair (Implementations pairing UDP with MQTT are better for LLNs.)
Security	DTLS	SSL/TLS
Communication model	One-to-one	many-to-many
Strengths	Lightweight and fast, with low overhead, and suitable for constrained networks; uses a RESTful model that is easy to code to; easy to parse and process for constrained devices; support for multicasting; asynchronous and synchronous messages	TCP and multiple QoS options provide robust communications; simple management and scalability using a broker architecture
Weaknesses	Not as reliable as TCP-based MQTT, so the application must ensure reliability	Higher overhead for constrained devices and networks; TCP connections can drain low-power devices; no multicasting support

Differences- 5M

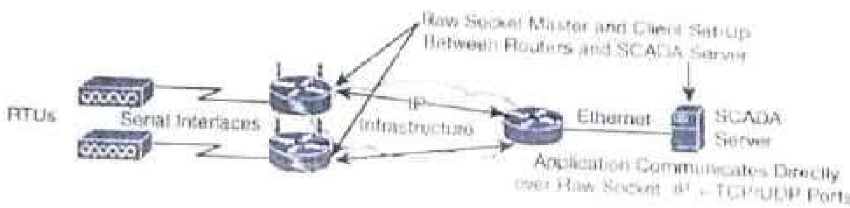
(c)



Scenario A: Raw Socket between Routers – no change on SCADA server



Scenario B: Raw Socket between Router and SCADA Server – no SCADA application change on server but IP/Serial Redirector software and Ethernet interface to be added



Scenario C: Raw Socket between Router and SCADA Server – SCADA application knows how to directly communicate over a Raw Socket and Ethernet interface

Diagram- 3M

Explanation- 2M

- In Scenario A in Figure, both the SCADA server and the RTUs have a direct serial connection to their respective routers. The routers terminate the serial connections at both
- Scenario B has a small change on the SCADA server side. A piece of software is installed on the SCADA server that maps the serial COM ports to IP ports. This software is commonly referred to as an IP/serial redirector. The IP/serial redirector in essence terminates the serial connection of the SCADA server and converts it to a TCP/IP port using a raw socket connection.
- In Scenario C in Figure, the SCADA server supports native raw socket capability. Unlike in Scenarios A and B, where a router or IP/serial redirector software has to map the SCADA server's serial ports to IP ports, in Scenario C the SCADA server has full IP support for raw socket connections.

OR

2(a)

Protocol	Description
ZigBee	Promoted through the ZigBee Alliance. ZigBee defines upper-layer components (network through application) as well as application profiles. Common profiles include building automarion, home automation, and healthcare. ZigBee also defines device object functions, such as device role, device discovery, network join, and security. For more information on ZigBee, see the ZigBee Alliance webpage, at www.zigbee.org. ZigBee is also discussed in more detail later in the next Section.
6LoWPAN	6LoWPAN is an IPv6 adaptation layer defined by the IETF 6LoWPAN working group that describes how to transport IPv6 packets over IEEE 802.15.4 layers. RFCs document header compression and IPv6 enhancements to cope with the specific details of IEEE 802.15.4. (For more information on 6LoWPAN, see Chapter 5.)
ZigBee IP	An evolution of the ZigBee protocol stack, ZigBee IP adopts the 6LoWPAN adaptation layer, IPv6 network layer, and RPL routing protocol. In addition, it offers improvements to IP security. ZigBee IP is discussed in more detail later in this chapter.

Protocol Stack-5M

	ISA100.11a	ISA100.11a is developed by the International Society of Automation (ISA) as "Wireless Systems for Industrial Automation: Process Control and Related Applications." It is based on IEEE 802.15.4-2006, and specifications were published in 2010 and then as IEC 62734. The network and transport layers are based on IETF 6LoWPAN, IPv6, and UDP standards.	
	WirelessHART	WirelessHART, promoted by the HART Communication Foundation, is a protocol stack that offers a time-synchronized, self-organizing, and self-healing mesh architecture, leveraging IEEE 802.15.4-2006 over the 2.4 GHz frequency band. A good white paper on WirelessHART can be found at http://www.emerson.com/resource/blob/system-engineering-guidelines-iec-62591-wirelesshart--data-79900.pdf	
	Thread	Constructed on top of IETF 6LoWPAN/IPv6, Thread is a protocol stack for a secure and reliable mesh network to connect and control products in the home. Specifications are defined and published by the Thread Group at www.threadgroup.org.	

(b)

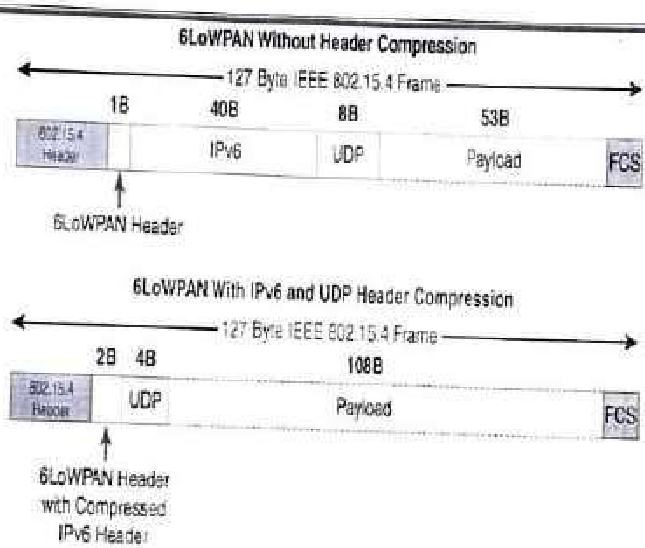


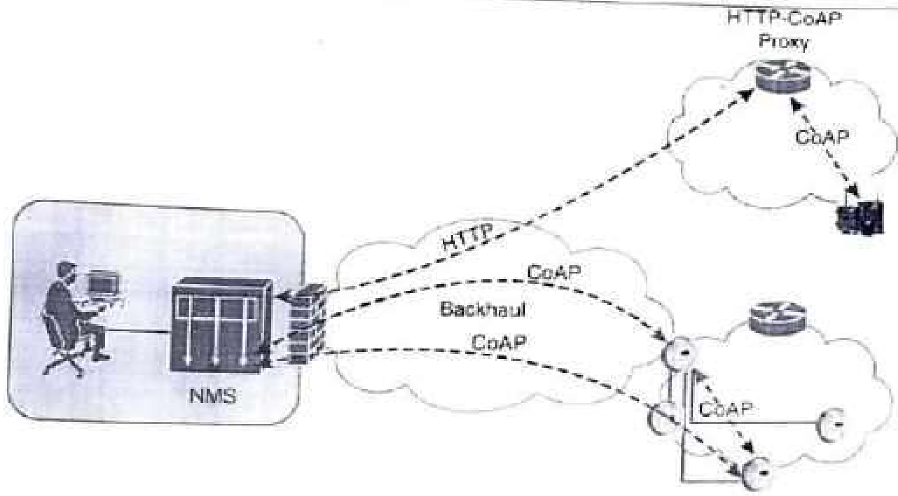
Diagram- 2M

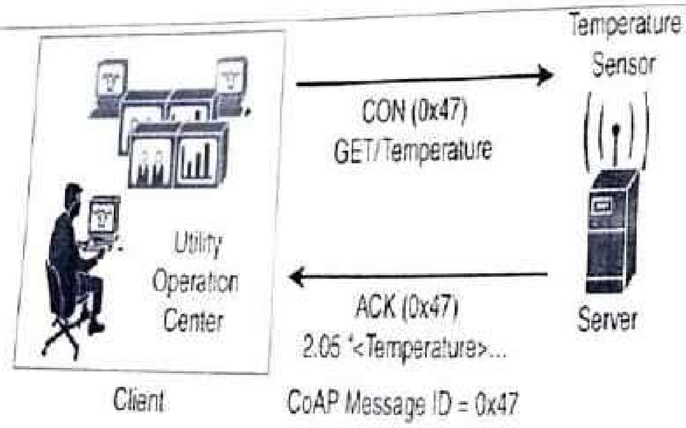
Explanation- 3M

Header Compression

- IPv6 header compression for 6LoWPAN was defined initially in RFC 4944 and subsequently updated by RFC 6282.

Header compression for 6LoWPAN is only defined for an IPv6 header and not IPv4. The 6LoWPAN protocol does not support IPv4, and, in fact, there is no standardized IPv4 adaptation layer for IEEE 802.15.4. 6LoWPAN header compression is stateless, and conceptually it is not too complicated. At a high level, 6LoWPAN works by taking advantage of shared information known by all nodes from their participation in the local network. In addition, it omits some standard header fields by assuming commonly used

	values. At the top of Figure, you see a 6LoWPAN frame without any header compression enabled: The full 40-byte IPv6 header and 8-byte UDP header are visible. The 6LoWPAN header is only a single byte in this case. The bottom half of Figure shows a frame where header compression has been enabled for a best-case scenario.	
(c)	 ➢ Like HTTP, CoAP is based on the REST architecture, but with a —thing‖ acting as both the client and the server. Through the exchange of asynchronous messages, a client requests an action via a method code on a server resource. ➢ A uniform resource identifier (URI) localized on the server identifies this resource. The server responds with a response code that may include a resource representation. ➢ The CoAP request/response semantics include the methods GET, POST, PUT, and DELETE. ➢ CoAP defines four types of messages: confirmable, non-confirmable, acknowledgement, and reset. ➢ If a request or response is tagged as confirmable, the recipient must explicitly either acknowledge or reject the message, using the same message ID, as shown in Figure 6-9. If a recipient can't process a non-confirmable message, a reset message is sent. ➢ Figure shows a utility operations center on the left, acting as the CoAP client, with the CoAP server being a temperature sensor on the right of the figure.	**Diagram- 2M** **Explanation- 3M**



- The communication between the client and server uses a CoAP message ID of 0x47. The CoAP Message ID ensures reliability and is used to detect duplicate messages.
- The client in Figure sends a GET message to get the temperature from the sensor. Notice that the 0x47 message ID is present for this GET message and that the message is also marked with CON.
- A CON, or confirmable, marking in a CoAP message means the message will be retransmitted until the recipient sends an acknowledgement (or ACK) with the same message ID.

PART-B

3(a)

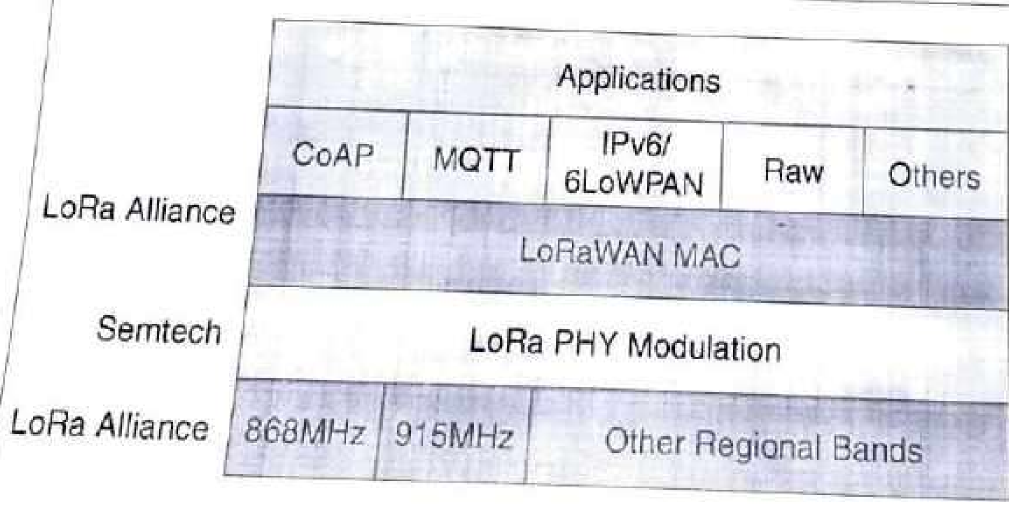


Diagram-3M

Explanation-2M

LoRaWAN 1.0.2 regional specifications describe the use of the main unlicensed sub-GHz frequency bands of 433 MHz, 779–787 MHz, 863–870 MHz, and 902–928 MHz, as well as regional profiles for a subset of the 902–928 MHz bandwidth.

- For example, Australia utilizes 915–928 MHz frequency bands, while South Korea uses 920–923 MHz and Japan uses 920–928 MHz.
- A LoRa gateway is deployed as the center hub of a star network architecture.
- It uses multiple transceivers and channels and can demodulate multiple channels at once or even demodulate multiple signals on the same channel simultaneously.
- LoRa gateways serve as a transparent bridge relaying data between endpoints, and the endpoints use a single-hop wireless connection to communicate with one or many gateways.
- The data rate in LoRaWAN varies depending on the frequency bands and adaptive data rate (ADR).
- ADR is an algorithm that manages the data rate and radio signal for each endpoint.

(b)

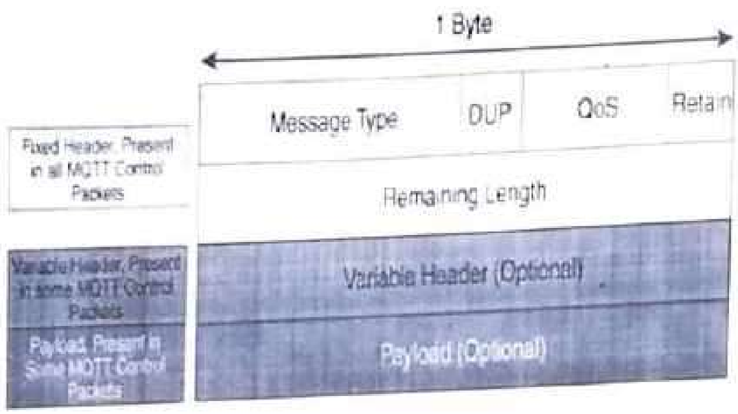
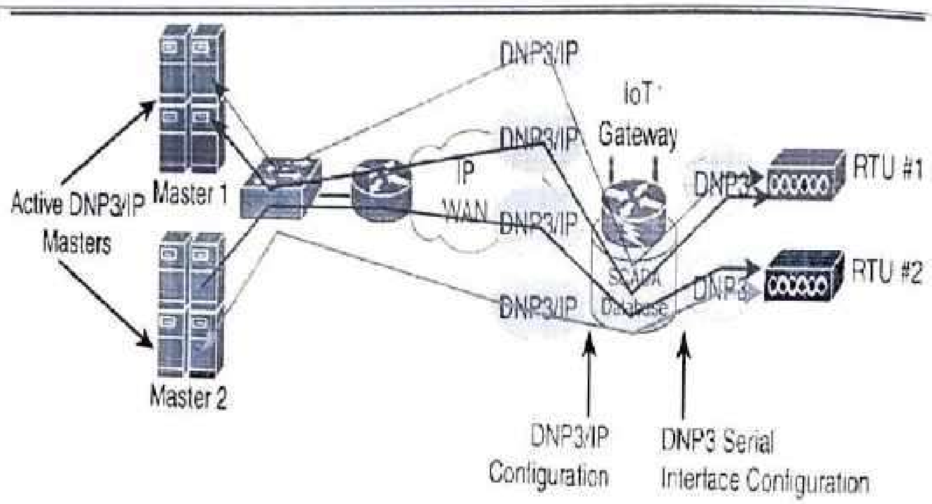


Diagram- 2M

Explanation- 3M

- The next field in the MQTT header is DUP (Duplication Flag). This flag, when set, allows the client to notate that the packet has been sent previously, but an acknowledgement was not received.
- The QoS header field allows for the selection of three different QoS levels.
- The next field is the Retain flag. Only found in a PUBLISH message . the Retain flag notifies the server to hold onto the message data. This allows new subscribers to instantly receive the last known value without having to wait for the next update from the publisher.
- The last mandatory field in the MQTT message header is Remaining Length. This field specifies the number of bytes in the MQTT packet following this field. MQTT sessions between each client and server consist of four phases: session establishment, authentication, data exchange, and session termination.



(c)

- With protocol translation, the legacy serial protocol is translated to a corresponding IP version.
- For example, Figure shows two serially connected DNP3 RTUs and two master applications supporting DNP3 over IP that control and pull data from the RTUs.
- By running protocol translation, the IoT gateway connected to the RTUs in Figure is implementing a computing function close to the edge of the network.
- Adding computing functions close to the edge helps scale distributed intelligence in IoT networks.
- This can be accomplished by offering computing resources on IoT gateways or routers, as shown in this protocol translation example.
- Alternatively, this can also be performed directly on a node connecting multiple sensors. In either case, this is referred to as fog computing.

Diagram- 2M

Explanation- 3M

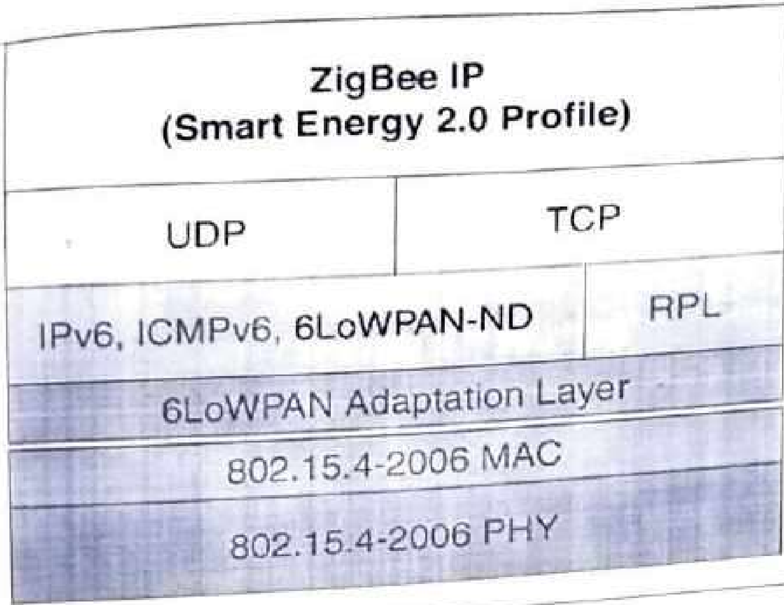
OR

4(a)

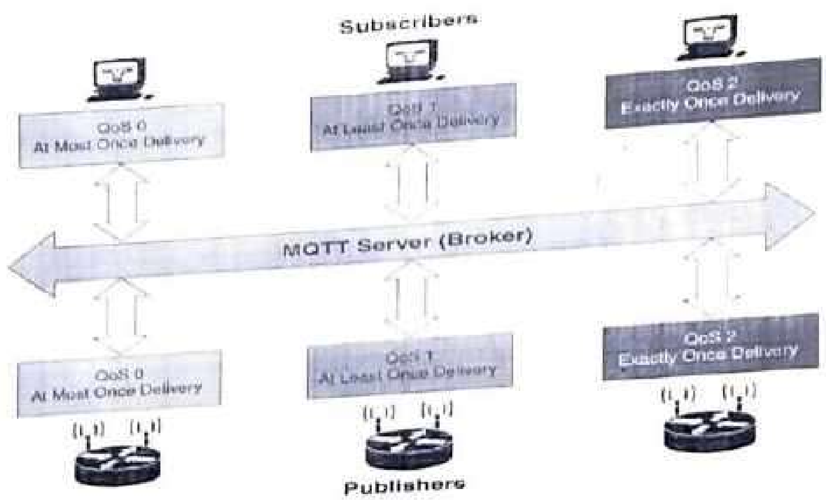
- ZigBee IP requires the support of 6LoWPAN's fragmentation and header compression schemes.
- At the network layer, all ZigBee IP nodes support IPv6, ICMPv6, and 6LoWPAN Neighbor Discovery (ND), and utilize RPL for the routing of packets across the mesh network.

Diagram- 2M

Explanation- 3M



(b)



QoS 0: This is a best-effort and unacknowledged data service referred to as —at most oncel delivery. The publisher sends its message one time to a server, which transmits it once to the subscribers. No response is sent by the receiver, and no retry is performed by the sender. The message arrives at the receiver either once or not at all.

QoS 1: This QoS level ensures that the message delivery between the publisher and server and then between the server and subscribers occurs at least once. In PUBLISH and PUBACK packets, a packet identifier is included in the variable header. If the message is not acknowledged by a PUBACK packet, it is sent again. This level guarantees —at least oncel delivery.

Diagram- 2M

QoS levels- 3M

	QoS 2: This is the highest QoS level, used when neither loss nor duplication of messages is acceptable. There is an increased overhead associated with this QoS level because each packet contains an optional variable header with a packet identifier. Confirming the receipt of a PUBLISH message requires a two-step acknowledgement process.	
(c)	Expected Transmission Count (ETX): Assigns a discrete value to the number of transmissions a node expects to make to deliver a packet. Hop Count: Tracks the number of nodes traversed in a path. Typically, a path with a lower hop count is chosen over a path with a higher hop count. Latency: Varies depending on power conservation. Paths with a lower latency are preferred. Link Quality Level: Measures the reliability of a link by taking into account packet error rates caused by factors such as signal attenuation and interference. Link Color: Allows manual influence of routing by administratively setting values to make a link more or less desirable. These values can be either statically or dynamically adjusted for specific traffic types. Node State and Attribute: Identifies nodes that function as traffic aggregators and nodes that are being impacted by high workloads. High workloads could be indicative of nodes that have incurred high CPU or low memory states. Node Energy: Avoids nodes with low power, so a battery-powered node that is running out of energy can be avoided and the life of that node and the network can be prolonged. Throughput: Provides the amount of throughput for a node link. Often, nodes conserving power use lower throughput. This metric allows the prioritization of paths with higher throughput.	Explanation-5M

Course Incharge **HOD CSE** **IQAC- Coordinator** **Principal**

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Management
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
II SESSIONAL TEST QUESTION PAPER
SET-B

USN: | | | | | | | | | | |

Degree	:	B.E	Semester	:	VIII A&B
Branch	:	Computer Science and Engineering	Course Code	:	18CS81/17CS81/15CS81
Course Title	:	Internet of Things	Date	:	07/06/2022
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Explain** the protocol stacks utilizing IEEE 802.15.4.	5	Understanding K2	CO2
(b)	**Illustrate** the framework for MOTT publish/subscribe.	5	Understanding K2	CO3
(c)	**Explain** the CoAP message format with an example of reliable transmission and	5	Understanding K2	CO3
	OR			
2(a)	**Explain** IEEE 802.15.4 MAC Format with neat diagram.	5	Understanding K2	CO2
(b)	**Explain** with a neat diagram DNP3 protocol over 6LoWPAN networks with MAP-T.	5	Understanding K2	CO3
(c)	**Elaborate** the concept of IoT data broker in application transport methods.	5	Understanding K2	CO3
	PART-B			
3(a)	**Explain** the frame format of auxillary security header field for 802.15.4-2006.	5	Understanding K2	CO2
(b)	**Summarize** the need for optimization.	5	Understanding K2	CO3
(c)	**Differentiate** between COAP and MQTT.	5	Understanding K2	CO3
	OR			
4(a)	**Explain** the general MAC frame format for IEEE 1901.2.	5	Understanding K2	CO2
(b)	**Outline** the key advantages of Internet Protocol.	5	Understanding K2	CO3
(c)	**Explain** the scheduling and forwarding mechanisms of 6TiSCH.	5	Understanding K2	CO3

Course Incharge | HOD CSE | IQAC- Coordinator | Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Manage
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

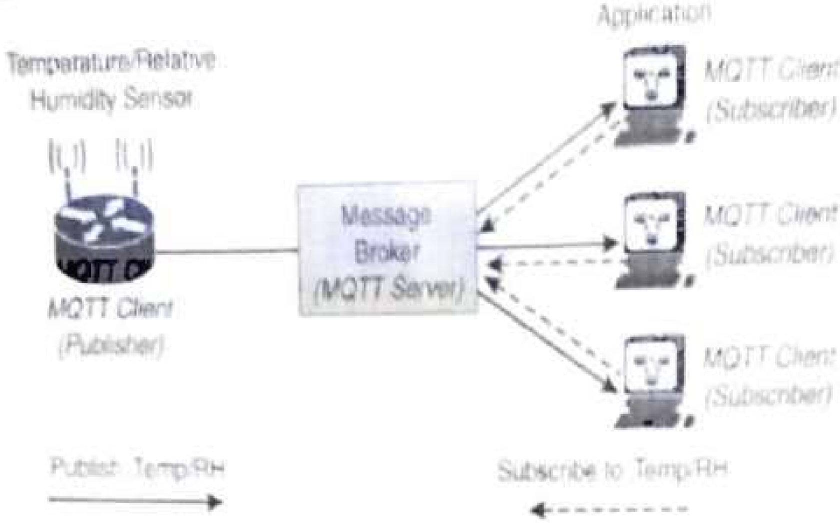
II SESSIONAL TEST SCHEME & SOLUTION

SET-B

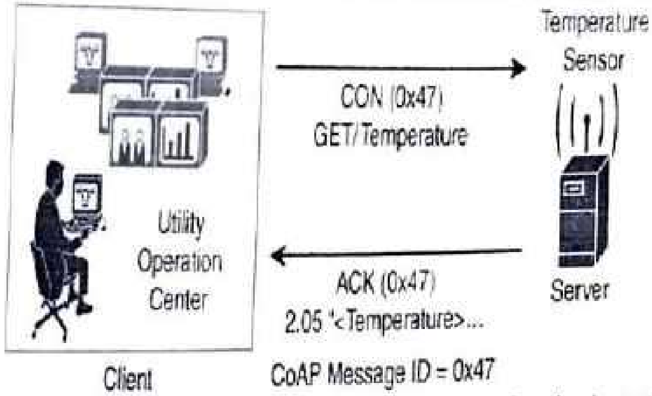
Degree	:	**B.E**	**Semester**	:	**VIII A&B**
Branch	:	**Computer Science & Engineering**	**Date**	:	**07-6-2022**
Course Title	:	**Internet of Things**	**Course Code**	:	**18CS81/17CS81/15CS81**
Duration	:	**90 Minutes**	**Max Marks**	:	**30**

Note: Answer ONE full question from each part

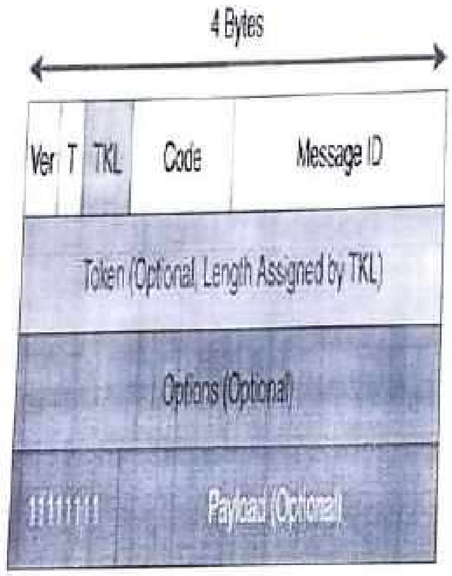
<table>
<tr><th>Q. No.</th><th>Scheme & Solution</th><th>Marks</th></tr>
<tr><td colspan="3">PART-A</td></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Protocol</th><th>Description</th></tr>
<tr><td>ZigBee</td><td>Promoted through the ZigBee Alliance, ZigBee defines upper-layer components (network through application) as well as application profiles. Common profiles include building automation, home automation, and healthcare. ZigBee also defines device object functions, such as device role, device discovery, network join, and security. For more information on ZigBee, see the ZigBee Alliance webpage, at www.zigbee.org. ZigBee is also discussed in more detail later in the next Section.</td></tr>
<tr><td>6LoWPAN</td><td>6LoWPAN is an IPv6 adaptation layer defined by the IETF 6LoWPAN working group that describes how to transport IPv6 packets over IEEE 802.15.4 layers. RFCs document header compression and IPv6 enhancements to cope with the specific details of IEEE 802.15.4. (For more information on 6LoWPAN, see Chapter 5.)</td></tr>
<tr><td>ZigBee IP</td><td>An evolution of the ZigBee protocol stack, ZigBee IP adopts the 6LoWPAN adaptation layer, IPv6 network layer, and RPL routing protocol. In addition, it offers improvements to IP security. ZigBee IP is discussed in more detail later in this chapter.</td></tr>
<tr><td>ISA100.11a</td><td>ISA100.11a is developed by the International Society of Automation (ISA) as "Wireless Systems for Industrial Automation: Process Control and Related Applications." It is based on IEEE 802.15.4-2006, and specifications were published in 2010 and then as IEC 62734. The network and transport layers are based on IETF 6LoWPAN, IPv6, and UDP standards.</td></tr>
<tr><td>WirelessHART</td><td>WirelessHART, promoted by the HART Communication Foundation, is a protocol stack that offers a time-synchronized, self-organizing, and self-healing mesh architecture, leveraging IEEE 802.15.4-2006 over the 2.4 GHz frequency band. A good white paper on WirelessHART can be found at http://www.emerson.com/resource/blob/system-engineering-guidelines-iec-62591-wirelesshart--data-79900.pdf</td></tr>
<tr><td>Thread</td><td>Constructed on top of IETF 6LoWPAN/IPv6, Thread is a protocol stack for a secure and reliable mesh network to connect and control products in the home. Specifications are defined and published by the Thread Group at www.threadgroup.org.</td></tr>
</table>
</td><td>Protocol Stack-
5M</td></tr>
</table>



(b)	➤ The application on the right side of Figure is an MQTT client that is a subscriber to the Temp-RH data being generated by the publisher or sensor on the left. This model, where subscribers express a desire to receive information from publishers, is well known. ➤ A great example is the collaboration and social networking application Twitter. With MQTT, clients can subscribe to all data (using a wildcard character) or specific data from the information tree of a publisher. In addition, the presence of a message broker in MQTT decouples the data transmission between clients acting as publishers and subscribers. ➤ In fact, publishers and subscribers do not even know (or need to know) about each other. A benefit of having this decoupling is that the MQTT message broker ensures that information can be buffered and cached in case of network failures.	Diagram- 2M Explanation- 3M
(c)	From a formatting perspective, a CoAP message is composed of a short fixed-length Header field (4 bytes), a variable-length but mandatory Token field (0–8 bytes), Options fields if necessary, and the Payload field. Figure details the CoAP message format, which delivers low overhead while decreasing parsing complexity. The client in Figure sends a GET message to get the temperature from the sensor. Notice that the 0x47 message ID is present for this GET message and that the message is also marked with CON. A CON, or confirmable, marking in a CoAP message means the message will be retransmitted until the recipient sends an acknowledgement (or ACK) with the same message ID. In Figure, the temperature sensor does reply with an ACK message referencing the	Diagram- 3M Explanation- 2M

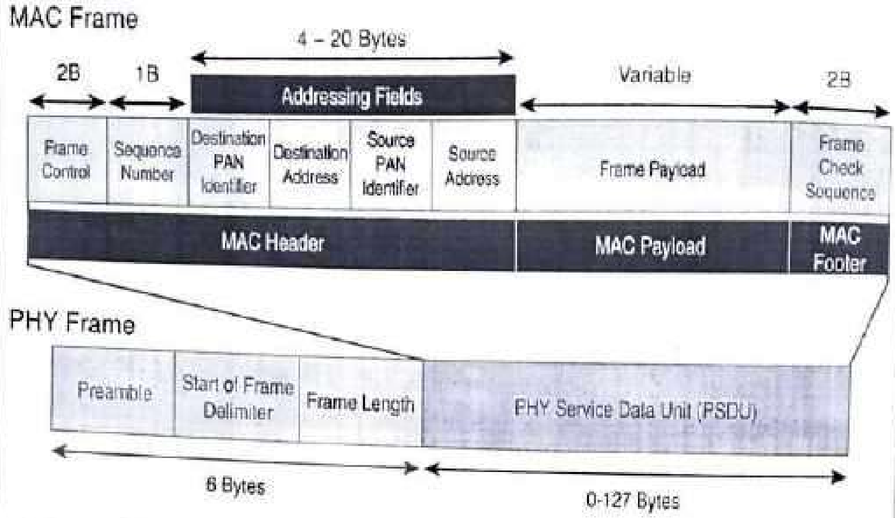


correct message ID of 0x47. In addition, this ACK message piggybacks a successful response to the GET request itself. This is indicated by the 2.05 response code followed by the requested data.

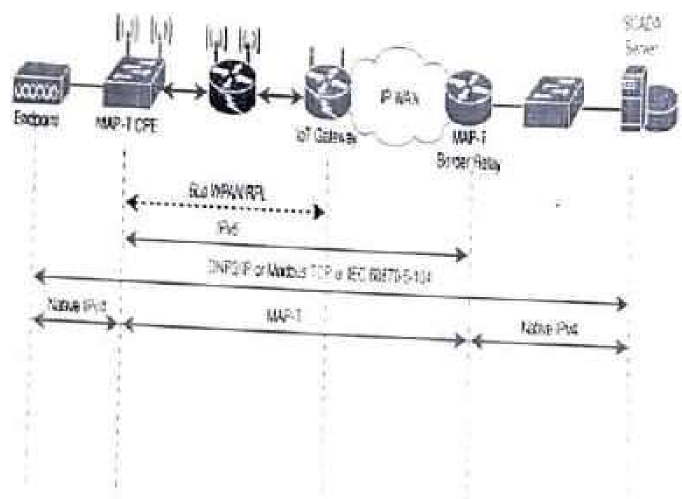


OR

2(a)	The MAC Header field is composed of the Frame Control, Sequence Number and the Addressing fields. ▪ The Frame Control field defines attributes such as frame type, addressing modes, and other control flags. Sequence Number field indicates the sequence identifier for the frame. The Addressing field specifies the Source and Destination PAN Identifier fields as well as the Source and Destination Address fields. ▪ The MAC Payload field varies by individual frame type. ▪ The MAC Footer field is nothing more than a frame check sequence (FCS). ▪ An FCS is a calculation based on the data in the frame that is used by the receiving side to confirm the integrity of the data in the frame.	**Diagram- 2M** **Explanation- 3M**



(b)



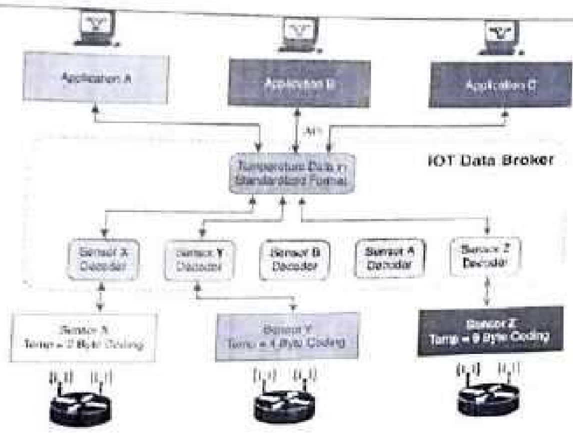
In the IPv4 endpoint on the left side is connected to a Customer Premise Equipment (CPE) device. The MAP-T CPE device has an IPv6 connection to the RPL mesh.

On the right side, a SCADA server with native IPv4 support connects to a MAP-T border gateway. The MAP-T CPE device and MAP-T border gateway are thus responsible for the MAP-T conversion from IPv4 to IPv6.

In this situation, the end devices, the endpoints, and the SCADA server support only IPv4, but the network in the middle supports only IPv6. The solution to this problem is to use the protocol known as MAP-T MAP-T makes the appropriate mappings between IPv4 and the IPv6 protocols. This allows legacy IPv4 traffic to be forwarded across IPv6 networks.

Diagram- 2M

Explanation- 3M



(c)

- In Figure, Sensors X, Y, and Z are all temperature sensors, but their output is encoded differently.
- The IoT data broker understands the different formats in which the temperature is encoded and is therefore able to decode this data into a common, standardized format.
- Applications A, B, and C in Figure can access this temperature data without having to deal with decoding multiple temperature data formats.
- You should note that IoT data brokers are also utilized from a commercial perspective to distribute and sell IoT data to third parties.
- Companies can provide access to their data broker from another company's application for a fee. This makes an IoT data broker a possible revenue stream, depending on the value of the data it contains.

Diagram- 2M

Explanation- 3M

PART-B

3(a)

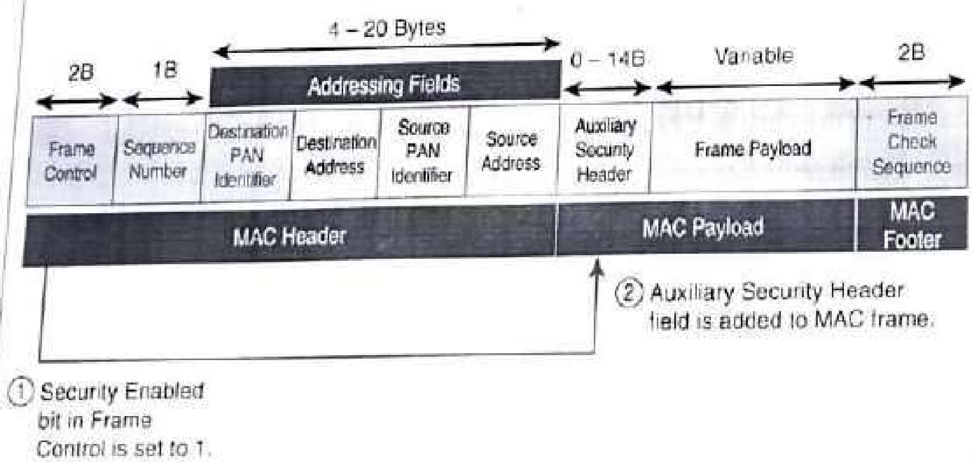


Diagram- 2M

Explanation- 3M

	The IEEE 802.15.4 specification uses Advanced Encryption Standard (AES) with a 128-bit key length as the base encryption algorithm for securing its data. In addition to encrypting the data, AES in 802.15.4 also validates the data that is sent. This is accomplished by a message integrity code (MIC), which is calculated for the entire frame using the same AES key that is used for encryption. The figure below shows the IEEE 802.15.4 frame format at a high level, with the Security Enabled bit set and the Auxiliary Security Header field present.	
(b)	Constrained Nodes ➢ Power consumption is a key characteristic of constrained nodes. Many IoT devices are battery powered, with lifetime battery requirements varying from a few months to 10+ years. ➢ Power consumption is much less of a concern on nodes that do not require batteries as an energy source. ➢ We should also be aware that power consumption requirements on battery-powered nodes impact communication intervals. Constrained Networks ➢ Evolution constraints of networking have seen the emergence of high-speed infrastructures. High-speed connections are not usable by some IoT devices in the last mile. The reasons include the implementation of technologies with low bandwidth, limited distance and bandwidth due to regulated transmit power, and lack of or limited network services. ➢ Constrained networks have unique characteristics and requirements. In contrast with typical IP networks, where highly stable and fast links are available, constrained networks are ➢ limited by low-power, low-bandwidth links (wireless and wired). They operate between a few kbps and a few hundred kbps and may utilize a star, mesh, or combined network topologies, ensuring proper operations.	**Explanation-** 5M

(c)

Factor	CoAP	MQTT
Main transport protocol	UDP	TCP
Typical messaging	Request/response	Publish/subscribe
Effectiveness in LLNs	Excellent	Low/fair (Implementations pairing UDP with MQTT are better for LLNs.)
Security	DTLS	SSL/TLS
Communication model	One-to-one	many-to-many
Strengths	Lightweight and fast, with low overhead, and suitable for constrained networks; uses a RESTful model that is easy to code to; easy to parse and process for constrained devices; support for multicasting; asynchronous and synchronous messages	TCP and multiple QoS options provide robust communications; simple management and scalability using a broker architecture
Weaknesses	Not as reliable as TCP-based MQTT, so the application must ensure reliability.	Higher overhead for constrained devices and networks; TCP connections can drain low-power devices; no multicasting support

Differences- 5M

OR

4(a)

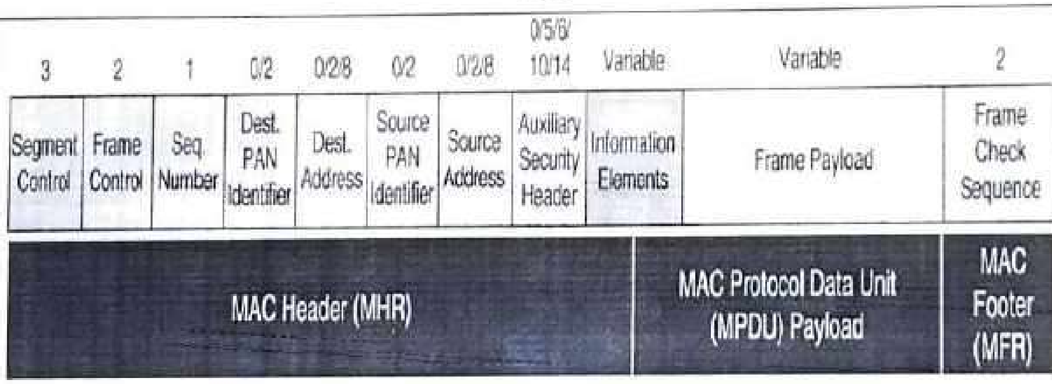


Diagram- 2M

The MAC frame format of IEEE 1901.2a is based on the IEEE 802.15.4 MAC frame but integrates the latest IEEE 802.15.4e-2012 amendment, which enables key features to be supported.

- One of the key components brought from 802.15.4e to IEEE 1901.2a is information elements.
- Figure provides a overview of the general MAC frame format for IEEE 1901.2.
- This field handles the segmentation or fragmentation of upper-layer packets with sizes larger than what can be carried in the MAC protocol data unit (MPDU).

Explanation- 3M

(b)	a) Open and standards-based: ➢ Operational technologies have often been delivered as turnkey features by vendors who may have optimized the communications through closed and proprietary networking solutions. b) Versatile: ➢ A large spectrum of access technologies is available to offer connectivity of —thingsǁ in the last mile. Additional protocols and technologies are also used to transport IoT data through backhaul links and in the data center. c) Ubiquitous: ➢ All recent operating system releases, from generalpurpose computers and servers to lightweight embedded systems (TinyOS, Contiki, and so on), have an integrated dual (IPv4 and IPv6) IP stack that gets enhanced over time. d) Scalable: ➢ As the common protocol of the Internet, IP has been massively deployed and tested for robust scalability. e) Manageable and highly secure: ➢ Communications infrastructure requires appropriate management and security capabilities for proper operations. f) Stable and resilient: ➢ IP has been around for 30 years, and it is clear that IP is a workable solution. ➢ IP has a large and well-established knowledge base and, more importantly, it has been used for years in critical infrastructures, such as financial and defense networks. g) Consumers' market adoption: ➢ When developing IoT solutions and products targeting the	Explanation - 5M

(c)	▪ Static scheduling: All nodes in the constrained network share a fixed schedule. Cells are shared, and nodes contend for slot access in a slotted aloha manner. Slotted aloha is a basic protocol for sending data using time slot boundaries when communicating over a shared medium. ▪ Neighbor-to-neighbor scheduling: A schedule is established that correlates with the observed number of transmissions between nodes. Cells in this schedule ▪ Remote monitoring and scheduling management: Time slots and other resource allocation are handled by a management entity that can be multiple hops away. ▪ Hop-by-hop scheduling: A node reserves a path to a destination node multiple hops away by requesting. In addition to schedule management functions, the 6TiSCH architecture also defines three different forwarding models. o Track Forwarding (TF): This is the simplest and fastest forwarding model. A —trackl in this model is a unidirectional path between a source and a destination. 6LoWPAN fragmentation to build a Layer 2 forwarding table. Fragmentation within the 6LoWPAN protocol is covered earlier in this chapter, in the section information can further contribute to the need for fragmentation o IPv6 Forwarding (6F): This model forwards traffic based on its IPv6 routing table. Flows of packets should be prioritized by traditional QoS (quality of service) and RED (random early detection) operations. QoS is a classification scheme for flows based on their priority, and RED is a common congestion avoidance mechanism.	**Explanation - 5M**

Course Incharge **HOD CSE** **IQAC- Coordinator** **Principal**

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Dr. K. RAMA NARASIMHA
Principal/Director
K S School of Engineering and Mana
Bengaluru - 560 109

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SESSION: 2021-2022 (EVEN SEMESTER)
III SESSIONAL TEST QUESTION PAPER
SET-A

USN

Degree	:	B.E	Semester	:	VIII A&B
Branch	:	Computer Science and Engineering	Course Code	:	18CS81/17CS81/15CS81
Course Title	:	Internet of Things	Date	:	29/06/2022
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Explain** the edge analytics core functions with a neat diagram.	5	Understanding K2	CO4
(b)	**Illustrate** the different steps and phases of OCTAVE allegro methodology.	5	Understanding K2	CO4
(c)	**Explain** the different pins/parts of Arduino Uno Board.	5	Understanding K2	CO5
	OR			
2(a)	**Give main idea** about the common challenges in OT security.	5	Understanding K2	CO4
(b)	**Illustrate** the FAIR formal risk analysis Structures.	5	Understanding K2	CO4
(c)	**Explain** the fundamentals of Arduino programming.	5	Understanding K2	CO5
	PART-B			
3(a)	**Explain** Massively Parallel Processing Databases with a neat diagram.	5	Understanding K2	CO4
(b)	**Explain** Lambda Architecture with a neat diagram.	5	Understanding K2	CO4
(c)	**Develop** a program to print "Hello World" using Arduino Programming.	5	Applying K3	CO5
	OR			
4(a)	**Explain** Flexible NetFlow with a neat diagram.	5	Understanding K2	CO4
(b)	**Explain** Distributed Hadoop Cluster with a neat diagram.	5	Understanding K2	CO4
(c)	**Develop** a program to display message in LCD with I2C using Arduino Programming.	5	Applying K3	CO5

Course Incharge **HOD CSE** **IQAC- Coordinator** **Principal**

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Principal / Director
K.S School of Engineering & Management
Bangalore-560 062

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

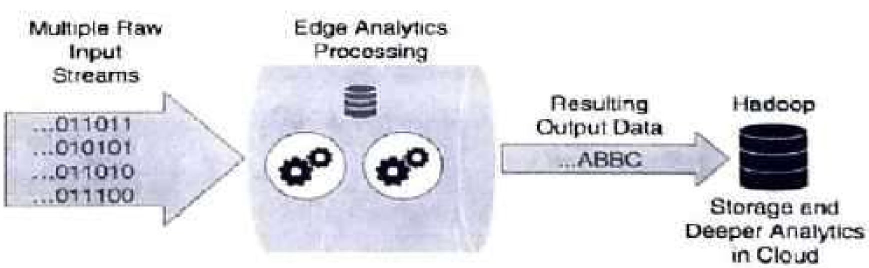
SESSION: 2021-2022 (EVEN SEMESTER)

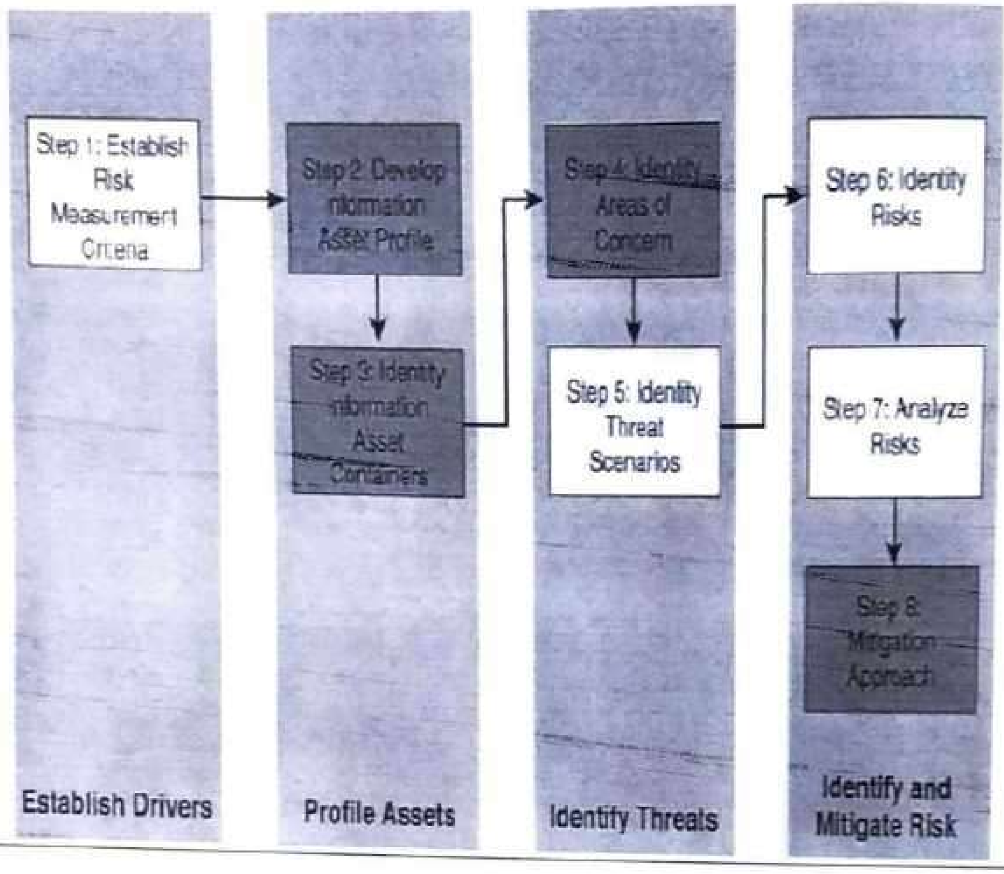
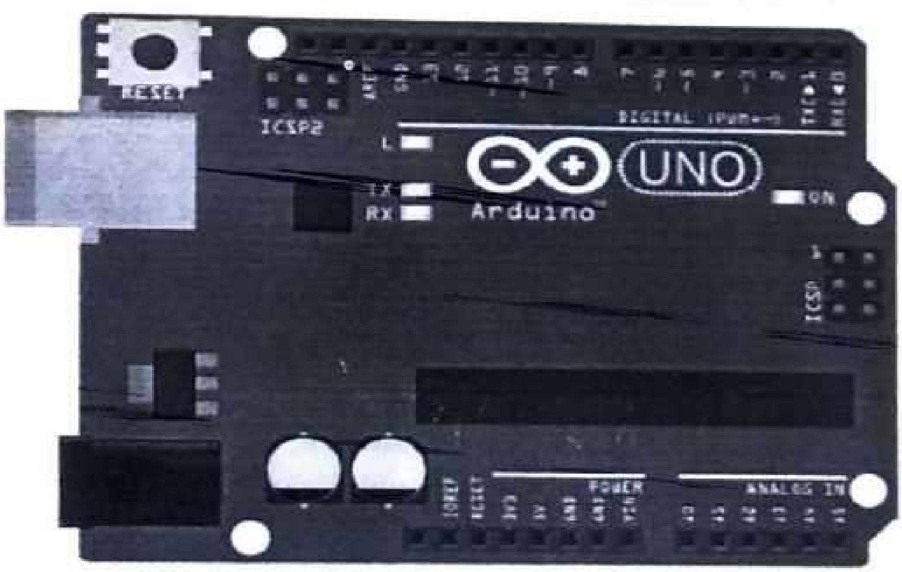
III SESSIONAL TEST SCHEME & SOLUTION

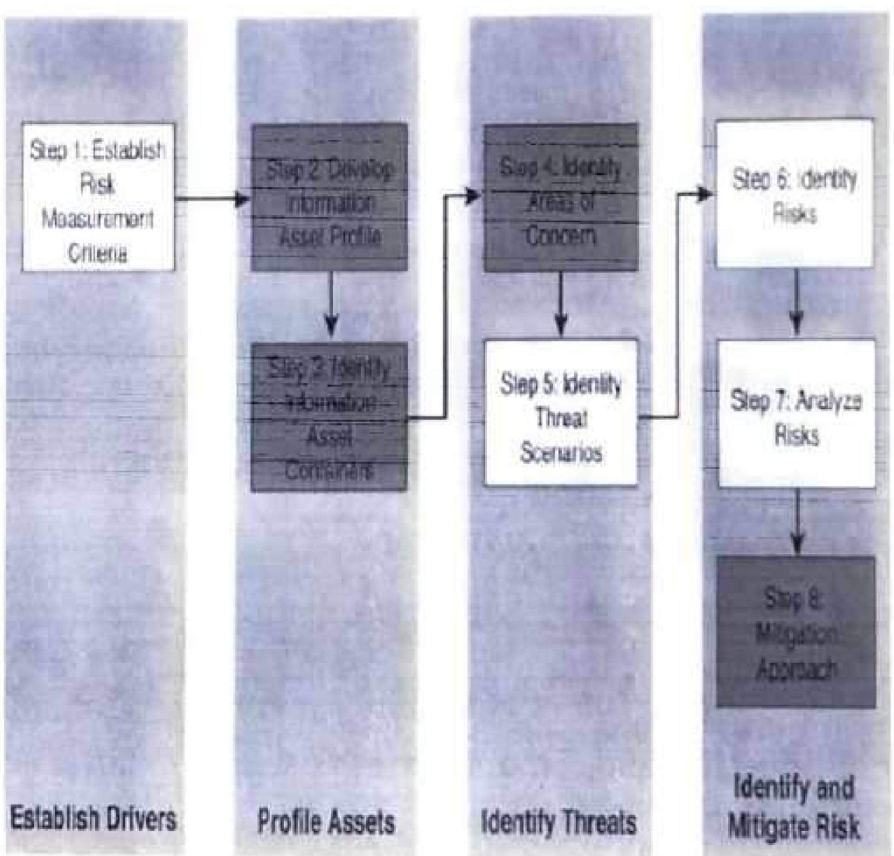
SET-A

Degree	:	**B.E**	Semester	:	VIII A&B
Branch	:	**Computer Science & Engineering**	Date	:	29-06-2022
Course Title	:	**Internet of Things**	Course Code	:	18CS81/17CS81/15CS81
Duration	:	**90 Minutes**	Max Marks	:	30

Note: Answer ONE full question from each part

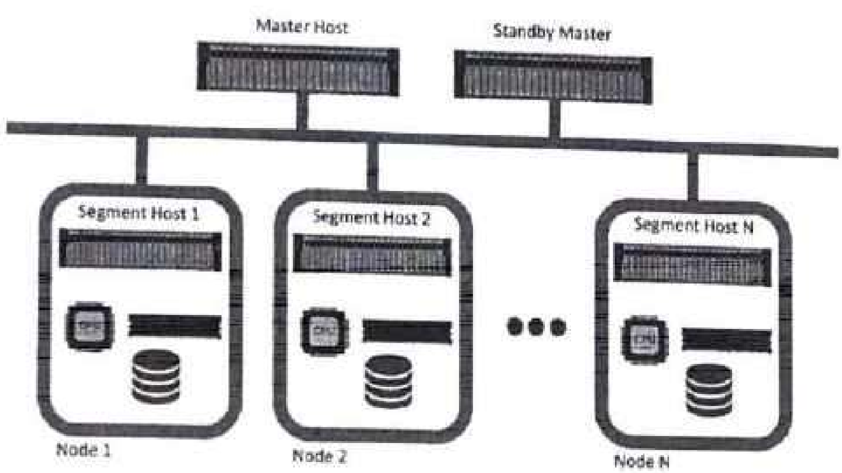
Q. No.	Scheme & Solution	Marks
	PART-A	
1(a)	Raw input data: This is the raw data coming from the sensors into the analytics processing unit. Analytics processing unit (APU): The APU filters and combines data streams (or separates the streams, as necessary), organizes them by time windows, and performs various analytical functions. It is at this point that the results may be acted on by micro services running in the APU. Output streams: The data that is output is organized into insightful streams and is used to influence the behavior of smart objects, and passed on for storage and further processing in the cloud. Communication with the cloud often happens through a standard publisher/subscriber messaging protocol, such as MQTT.  	2M-Diagram 3M-Explanation
(b)	OCTAVE (perationally Critical Threat, Asset and Vulnerability Evaluation) has undergone multiple iterations. The version this section focuses on is OCTAVE Allegro, which is intended to be a lightweight and less burdensome process to implement. FAIR (Factor Analysis of Information Risk) is a technical standard for risk definition from The Open Group. While information security is the focus, much as it is for OCTAVE, FAIR has clear applications within operational technology.	2M-Diagram 3M-Explanation

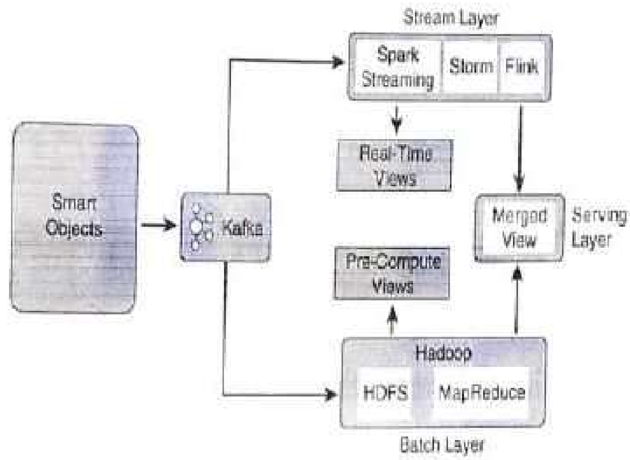
		
(c)	 **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off. **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source).	Diagram- 3M Explanation- 2M

	You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board. **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. **GND**: Ground pins. **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V. **Reset**: Typically used to add a reset button.	
	OR	
2(a)	Erosion of Network Architecture Insecure Operational Protocols Pervasive Legacy Systems Device Insecurity	Challenges-5M
(b)		Diagram- 2M Explanation-3M

	FAIR is a technical standard for risk definition from The Open Group. While information security is the focus, much as it is for OCTAVE, FAIR has clear applications within operational technology. Like OCTAVE, it also allows for non-malicious actors as a potential cause for harm, but it goes to greater lengths to emphasize the point. For many operational groups, it is a welcome acknowledgement of existing contingency planning. Unlike with OCTAVE, there is a significant emphasis on naming, with risk taxonomy definition as a very specific target. FAIR places emphasis on both unambiguous definitions and the idea that risk and associated attributes are measurable. Measurable, quantifiable metrics are a key area of emphasis, which should lend itself well to an operational world with a richness of operational data. At its base, FAIR has a definition of risk as the probable frequency and probable magnitude of loss. With this definition, a clear hierarchy of sub-elements emerges, with one side of the taxonomy focused on frequency and the other on magnitude.	
(c)	Structure Void Setup() Void Loop() Functions Variables Datatypes Operators constants	**Fundamentals- 5M**

PART-B

3(a)	 • Massively parallel processing (MPP) databases were built on the concept of the relational data warehouses but are designed to be much faster, to be efficient, and to support reduced query times.	**Diagram-3M** **Explanation-2M**

	• To accomplish this, MPP databases take advantage of multiple nodes (computers) designed in a scale-out architecture such that both data and processing are distributed across multiple systems. • MPPs are sometimes referred to as analytic databases because they are designed to allow for fast query processing and often have built-in analytic functions.	
(b)	 Lambda is a data management system that consists of two layers for ingesting data (Batch and Stream) and one layer for providing the combined data (Serving). These layers allow for the packages discussed previously, like Spark and MapReduce, to operate on the data independently, focusing on the key attributes for which they are designed and optimized. Data is taken from a message broker, commonly Kafka, and processed by each layer in parallel, and the resulting data is delivered to a data store where additional processing or queries can be run.	Diagram- 2M Explanation- 3M

(c)	Void Setup
	{
	Serial Begin (9600);
	}
	Void loop()
	{
	Serial.println("Hello world");
	Delay(1000);
	}
		void setup
		Program -3M
		void loop -2M

	OR	
4(a)	FNF Flow Monitor (NetFlow cache): The FNF Flow Monitor describes the NetFlow cache or information stored in the cache. The Flow Monitor contains the flow record definitions with key fields and non-key fields within the cache.	

FNF flow record: A flow record is a set of key and non-key NetFlow field values used to characterize flows in the NetFlow cache. Flow records may be predefined for ease of use or customized and user defined. A typical predefined record aggregates flow data and allows users to target common applications for NetFlow. User-defined records allow selections of specific key or non-key fields in the flow record.

Diagram- 2M

FNF Exporter: There are two primary methods for accessing NetFlow data: Using the show commands at the command-line interface (CLI), and using an application reporting tool.

Explanation- 3M

Flow export timers: Timers indicate how often flows should be exported to the collection and reporting server.

NetFlow export format: This simply indicates the type of flow reporting format.

NetFlow server for collection and reporting: This is the destination of the flow export. It is often done with an analytics tool that looks for anomalies in the traffic patterns.

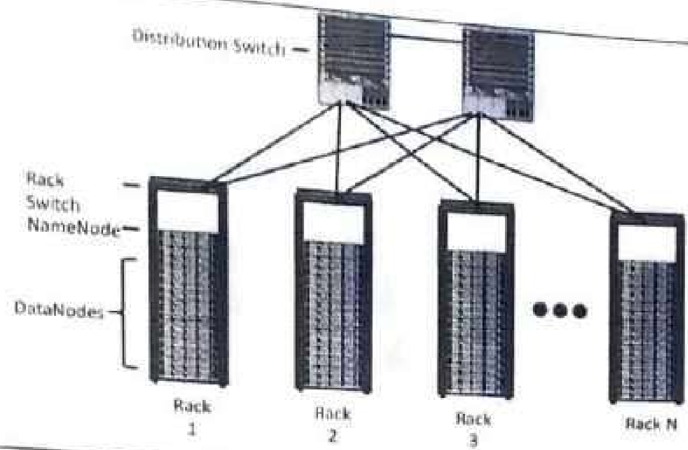
(b)

NameNodes: These are a critical piece in data adds, moves, deletes, and reads on HDFS. They coordinate where the data is stored, and maintain a map of where each block of data is stored and where it is replicated. All interaction with HDFS is coordinated through the primary (active) NameNode, with a secondary (standby) NameNode notified of the changes in the event of a failure of the primary

DataNodes: These are the servers where the data is stored at the direction of the NameNode. It is common to have many DataNodes in a Hadoop cluster to store the data. Data blocks are distributed across several nodes and often are replicated three, four, or more times across nodes for redundancy. Once data is written to one of the DataNodes, the DataNode selects two (or more). Figure shows the relationship between NameNodes and DataNodes and how data blocks are distributed across the cluster.

Diagram- 2M

Explanation- 3M



(c)

```
# include<wire.h>
#include<LiquidCrystal_I2C.h>
Void Setup()
{
lcd.init();
lcd.backlight();
lcd.print("hi");
}
Void loop()
{
lcd.clear();
lcd.print("hello world");
Delay(1000);
lcd.clear();

lcd.print("IoT lab");
Delay(1000);
lcd.clear();
}
```

void Setup
Program-3M
void loop - 2M

Course Incharge

HOD CSE

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062.

IQAC- Coordinator

Principal

K.S. School of Engineering & Mar
Bangalore-560 062

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU - 560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SESSION: 2021-2022 (EVEN SEMESTER)

III SESSIONAL TEST QUESTION PAPER

SET-B

USN: | | | | | | | | | | |

Degree	:	B.E	Semester	:	VIII A&B
Branch	:	Computer Science and Engineering	Course Code	:	18CS81/17CS81/15CS81
Course Title	:	Internet of Things	Date	:	29/06/2022
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	K-Level	CO mapping
	PART-A			
1(a)	**Explain** distributed hadoop cluster with a neat diagram.	5	Understanding K2	CO4
(b)	**Illustrate** the different types of data analysis.	5	Understanding K2	CO4
(c)	**Explain** the Raspberry Pi Learning board.	5	Understanding K2	CO5
	OR			
2(a)	**Explain** the edge analytics core functions with a neat diagram.	5	Understanding K2	CO4
(b)	**Illustrate** data flow in apache kafka with a neat diagram.	5	Understanding K2	CO4
(c)	**Give main idea** about smart city security architecture.	5	Understanding K2	CO5
	PART-B			
3(a)	**Explain** FNF Components with a neat diagram.	5	Understanding K2	CO4
(b)	**Give main idea** about big data analytics tools and technologies.	5	Understanding K2	CO4
(c)	**Develop** a program to display message in LCD with I2C using Arduino Programming.	5	Applying K3	CO5
	OR			
4(a)	**Explain** Security between levels and zones in the process control hierarchy model.	5	Understanding K2	CO4
(b)	**Explain** the following: (a) Supervised learning (b) Unsupervised learning (c) Neural networks	5	Understanding K2	CO4
(c)	**Develop** a program to control a LED using HC-06 Bluetooth Module and Arduino Programming.	5	Applying K3	CO5

Course Incharge   HOD CSE   IQAC- Coordinator   Principal

HOD
Dept. of Computer Science & Engineering
K.S. School of Engineering & Management
Bangalore-560 062

Principal / Director
K.S. School of Engineering & Manag
Bangalore-560 062

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BENGALURU-560109
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

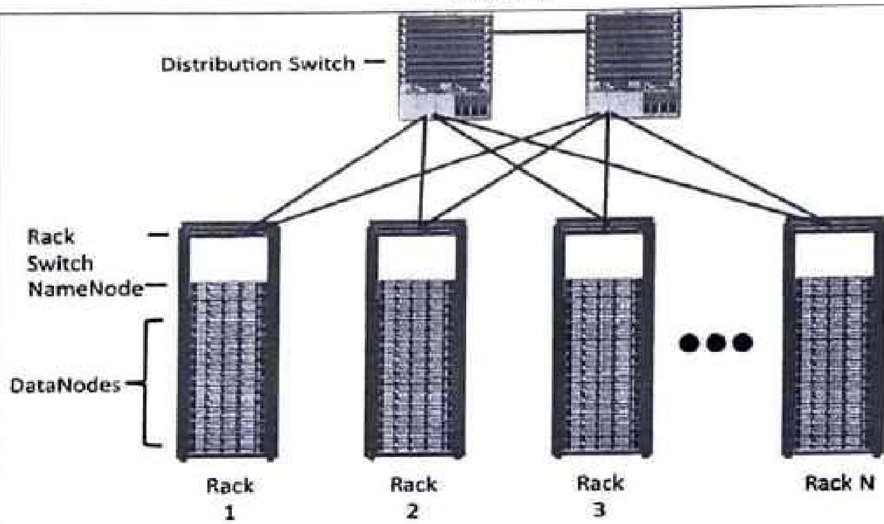
SESSION: 2021-2022 (EVEN SEMESTER)

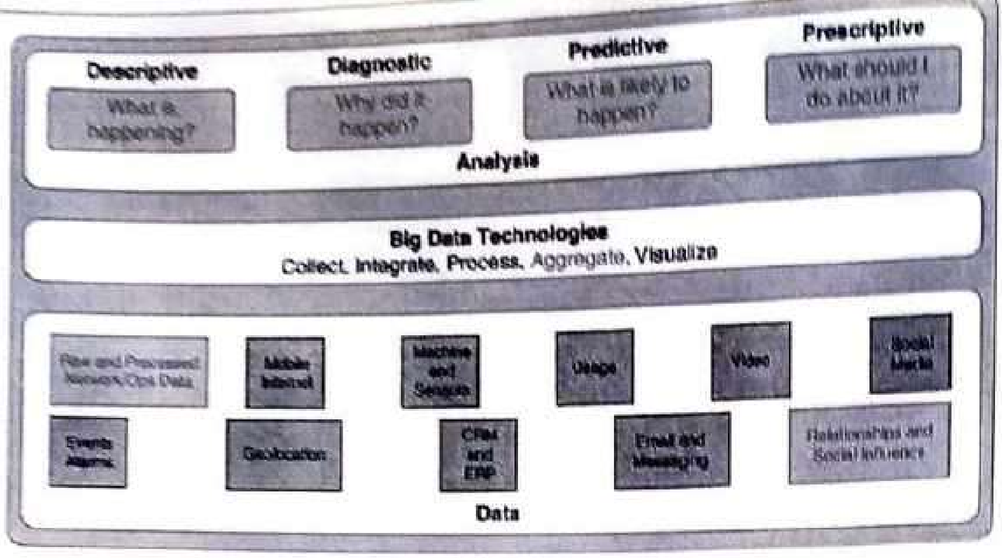
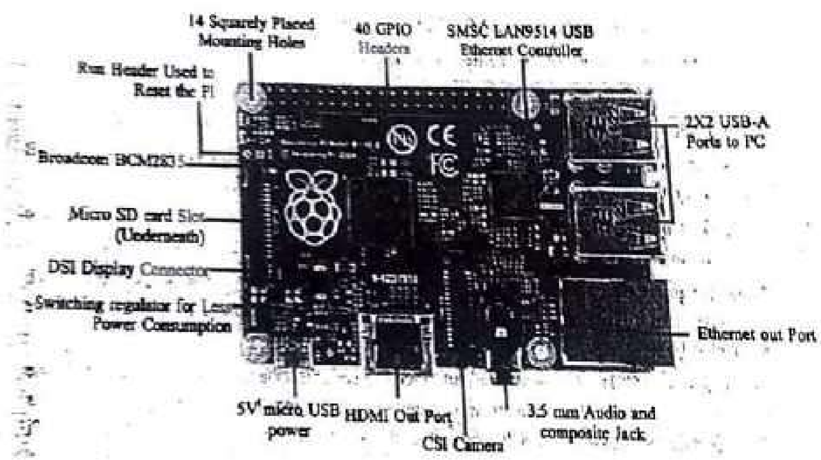
III SESSIONAL TEST SCHEME & SOLUTION

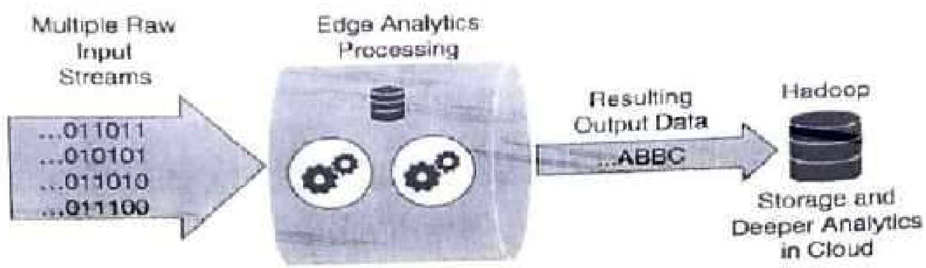
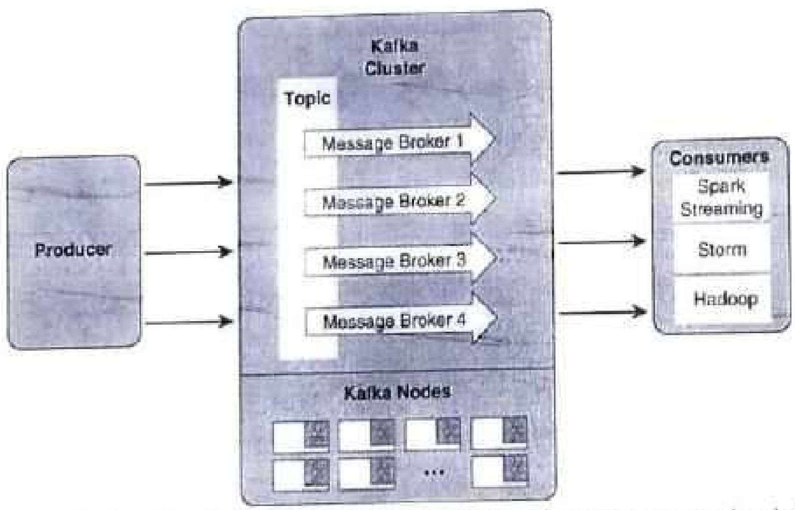
SET-B

Degree	: B.E	Semester	: VIII A&B
Branch	: Computer Science & Engineering	Date	: 29-06-2022
Course Title	: Internet of Things	Course Code	: 18CS81/17CS81/15CS81
Duration	: 90 Minutes	Max Marks	: 30

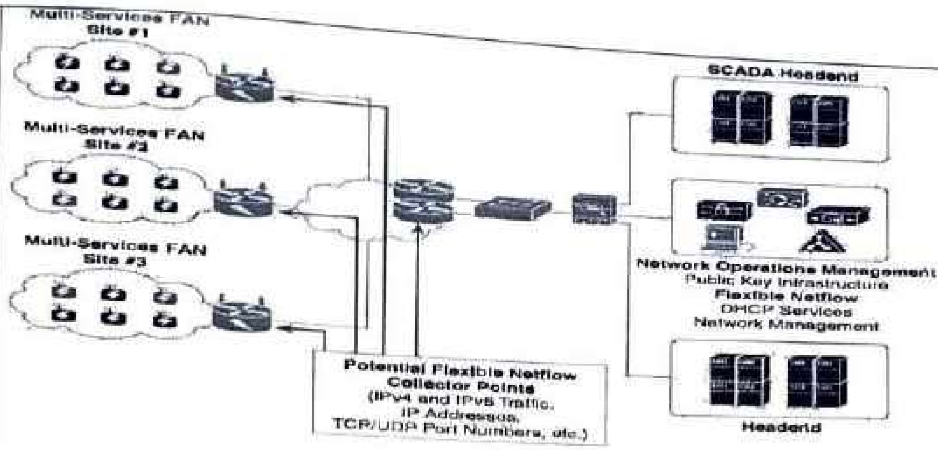
Note: Answer ONE full question from each part

Q. No.	Scheme & Solution	Marks
	PART-A	
1(a)	 Name Nodes: These are a critical piece in data adds, moves, deletes, and reads on HDFS. They coordinate where the data is stored, and maintain a map of where each block of data is stored and where it is replicated. All interaction with HDFS is coordinated through the primary (active) NameNode, with a secondary (standby) NameNode notified of the changes in the event of a failure of the primary DataNodes: These are the servers where the data is stored at the direction of the NameNode. It is common to have many DataNodes in a Hadoop cluster to store the data. Data blocks are distributed across several nodes and often are replicated three, four, or more times across nodes for redundancy. Once data is written to one of the DataNodes, the DataNode selects two (or more). Figure shows the relationship between NameNodes and DataNodes and how data blocks are distributed across the cluster.	**2M-Diagram** **3M-Explanation**

(b)	 Descriptive: Data analysis tells you what is happening, either now or in the past. Diagnostic: When you are interested in the —why,I diagnostic data analysis can provide the answer. Predictive: Analysis aims to foretell problems or issues before they occur. Prescriptive: Prescriptive analysis goes a step beyond predictive and recommends solutions for upcoming problems.	**3M- Diagram** **2M- Explanation**
(c)	 Processor Power Source SD Card GPIO CSI Ethernet port Status LED	**Diagram- 3M** **Pins- 2M**

	OR	
2(a)	Raw input data: This is the raw data coming from the sensors into the analytics processing unit. Analytics processing unit (APU): The APU filters and combines data streams (or separates the streams, as necessary), organizes them by time windows, and performs various analytical functions. It is at this point that the results may be acted on by micro services running in the APU. Output streams: The data that is output is organized into insightful streams and is used to influence the behavior of smart objects, and passed on for storage and further processing in the cloud. Communication with the cloud often happens through a standard publisher/subscriber messaging protocol, such as MQTT.  	3M-Diagram 2M-Explanation
(b)	 Apache Kafka is a distributed publisher-subscriber messaging system that is built to be scalable and fast. It is composed of topics, or message brokers, where producers write data and consumers read data from these topics. Figure shows the data flow from the smart objects (producers), through a topic in Kafka, to the real-time processing engine. Due to the distributed nature of Kafka, it can run in a clustered configuration that can handle many producers and consumers simultaneously and exchanges information between nodes, allowing topics to be distributed over multiple nodes. The goal of Kafka is to provide a simple way to connect to data sources and allow consumers to connect to that data in the way they would like.	Diagram- 2M Explanation-3M

	Smart and connected city. A smart city is quite simply a city that utilizes digitalization and new technology to simplify and improve the life for its residents, its visitors and businesses. A smart city uses digital technology to connect, protect, and enhance the lives of citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions.	
(c)	A smart city collects and analyzes data from IoT sensors and video cameras. In essence, it "senses" the environment so that the city operator can decide how and when to take action. Some actions can be performed automatically. For example, a public waste bin can contact the city for service when it is near capacity instead of waiting for a scheduled pickup. • Smart Lighting • Smart Waste • City Transportation • Smart Parking • Environmental Monitoring	**Explanation-3M** Examples 2M
	PART-B	
3(a)	FNF Flow Monitor (NetFlow cache): The FNF Flow Monitor describes the NetFlow cache or information stored in the cache. The Flow Monitor contains the flow record definitions with key fields and non-key fields within the cache. FNF flow record: A flow record is a set of key and non-key NetFlow field values used to characterize flows in the NetFlow cache. Flow records may be predefined for ease of use or customized and user defined. A typical predefined record aggregates flow data and allows users to target common applications for NetFlow. User-defined records allow selections of specific key or non-key fields in the flow record. FNF Exporter: There are two primary methods for accessing NetFlow data: Using the show commands at the command-line interface (CLI), and using an application reporting tool. Flow export timers: Timers indicate how often flows should be exported to the collection and reporting server. NetFlow export format: This simply indicates the type of flow reporting format. NetFlow server for collection and reporting: This is the destination of the flow export. It is often done with an analytics tool that looks for anomalies in the traffic patterns.	**Diagram-3M** **Explanation-2M**



(b)

Generally, the industry looks to the ―three Vsl to categorize big data:

- Velocity: Velocity refers to how quickly data is being collected and analyzed.
- Variety: Variety refers to different types of data. Often you see data categorized as structured, semi-structured, or unstructured.
- Volume: Volume refers to the scale of the data. Typically, this is measured from gigabytes on the very low end to petabytes or even exabytes of data on the other extreme.

The characteristics of big data can be defined by the sources and types of data.

- First is machine data, which is generated by IoT devices and is typically unstructured data.
- Second is transactional data, which is from sources that produce data from transactions on these systems, and, have high volume and structured.
- Third is social data sources, which are typically high volume and structured.
- Fourth is enterprise data, which is data that is lower in volume and very structured. Hence big data consists of data from all these separate sources.

Explanation-3M

Characteristics-2M

(c)

```
# include<wire.h>
#include<LiquidCrystal_I2C.h>
Void Setup()
{
lcd.init();
lcd.backlight();
```

Void Setup **Program-3M**