Department of Computer Science and Engineering

Course File (Theory)

Name of Subject - **Computer Network**

Semester - **4th**

Section - NA

Discipline - Department of Computer Science and Engineering

Academic Year - **2022-23**

Name of Teacher - **Dr. Balram Timande**

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1. Department Vision and Mission

Vision

Nurturing globally competent computer science & engineering graduates by inculcating values of research qualities and society.

Mission

- To impart high quality professional training with an emphasis on basic principles of computer science and engineering
- To strengthen links with industry through partnerships and collaborative development works.
- To attain self-sustainability and overall development through research, consultancy and development activities.
- To make the students as for as possible industry ready to enhance their employability in the industries.

2. LIST OF PEO, PSO, and PO

Programme Education Objectives (PEO's)-

- **PEO1:** To provide the imperatives knowledge of science and engineering concepts fundamental for a computer professional and equip the proficiency of mathematical foundations and algorithmic principles for competent problem solving ability.

- **PE02:** To inculcate ability in creativity & design of computer support systems and impart knowledge and skills for analyze, design, test and implement various software applications

- **PE03:** To exhibit leadership capability, triggering social and economical commitment and inculcate community services and protect environment

- **PE04:** To provide an educational foundation that prepares computer professional for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.

List of PSO:

PSO-1	The Computer Science and Engineering graduates are able to gain critical understanding of hardware and software tools catering to the contemporary needs of IT industry for the development of different projects in inter-disciplinary field.
PSO-2	The Computer Science and Engineering graduates are able to analyze, design, develop, test and apply computational expertise, mathematical foundations and managerial skills to solve complex Engineering problems considering environmental and ethical and social issues.

Programme Outcomes (PO's)

PO-1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO-2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering.

PO-3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO-4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in the field of Engineering.

PO-5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO-6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO-7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO-8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO-9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

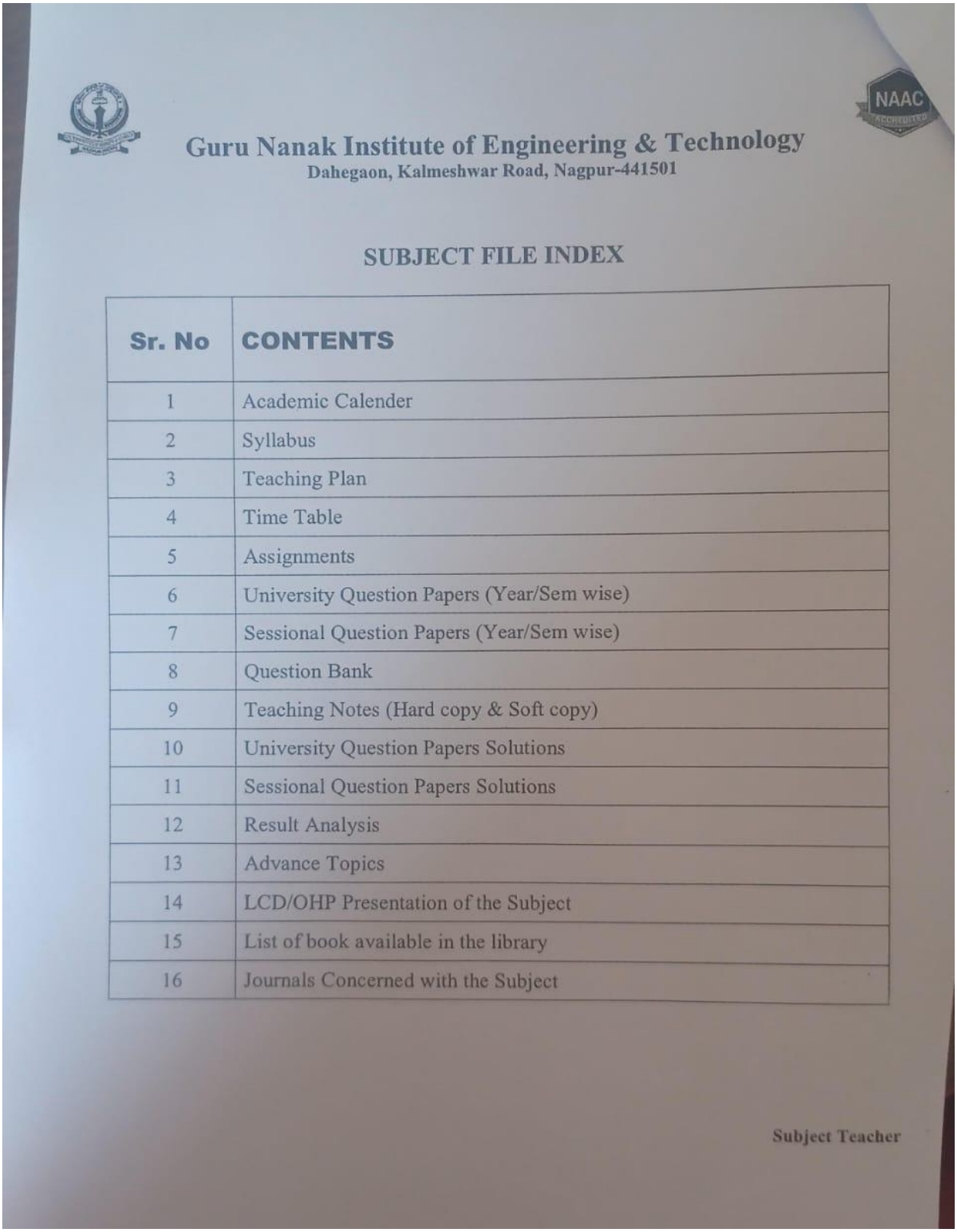
PO-12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. List of Course Outcomes: At the end of course syllabus, students will be able to—

Course Outcomes:

At the end of this course Student are able to:

CO1	Describe the functions of each layer in OSI model along with basic networking concepts.
CO2	Explain physical layer functionality and its working along with transmission media with real time applications.
CO3	Describe the functions of data link layer and explain the protocols used in data link layer.
CO4	Classify the routing protocols and analyze how to map IP addresses. Identify the issues related to transport layer, congestion control
CO5	Describe Quality of Service, DNS, Application layer protocols & Network security issues.



Guru Nanak Institute of Engineering & Technology
Dahegaon, Kalmeshwar Road, Nagpur-441501

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Subject Teacher

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY

Dahegaon, Kalmeshwar road, Nagpur

NAAC Accredited

Session 2022-23 (EVEN)

ACADEMIC CALENDAR

(For B.E./ B. Tech. –IV, VI Sem / VIII Sem)

Sr. No.	Months	Teaching Learning	Date
1	Dec-2022	Faculty Subject Choice	12thDec 2022
2		Load Calculation, Departmental Planning and Faculty Requirement	15thDec 2022
3		Verification of Classrooms and Laboratories	19th Dec 2022
4		Stationary/ Equipment Requirement	30thDec 2022
5	Jan2023	Display of Time- Table (6th and 8thSem)	5th Jan 2023
6		Preparation of Student List and Attendance Register (6th and 8thSem)	9th Jan 2023
7		Preparation of Lesson Plan/ Teaching Plan	11th Jan 2023
8		Commencement of Classes (6th and 8thSem)	16thJan 2023
9		Student Registration to the Department (6th and 8thSem)	16thto 30th Jan 2023
10		Finalization of Elective-I (6th and 8thSem)	18thJan 2023
11		Teacher Guardian Allotment (6th and 8thSem)	20thJan 2023
12		Preparation of Course File, Lab Manual etc.	23rd Jan 2023
13		Republic Day	26th Jan 2023
14		Industrial Visit/ III Cell Activity/ T&P Activity/ TG Meeting	23rd to 27thJan 2023
15		Attendance Review	30th Jan 2023
16		Monthly Audit/ Student Feedback	31st Jan 2023
17	Feb2023	Display of Assignment-I & II, Submission: 06-02-2023	1st Feb 2023
18		Project Presentation-I	6th to 11th 2023
19		Display of Question Bank (6th and 8thSem)	13thFeb 2023
20		Industrial Visit/ III Cell Activity/ T&P Activity/ TG Meeting	13th to 17thFeb 2023
21		Sessional-I Exam (6th and 8thSem)	20th to 24thFeb 2023
22		Paper Publication in Journal/Conference (8thSem)	24th Feb 2023

23		Attendance Review/ Parents Teacher Meeting	27th Feb 2023
24		Monthly Audit/ Student Feedback	28th Feb 2023
25	March-2023	Display of Assignment-III & IV, Submission: 06-03-23	1st March 2023
26		Display of Question Bank (6th and 8thSem)	2nd March 2023
27		Project Presentation-II	6th to 10th March 2023
28		Industrial Visit/ III Cell Activity/ T&P Activity/ TG Meeting/ Forum Installation	13th to 17th March 2023
29		Sessional-II Exam (6th and 8thSem)	20th to 24th March 2023
30		Attendance Review/ Provisional Student Detention List	29th March 2023
31		Monthly Audit/ Student Feedback	31st March 2023
32	April-2023	Display of Assignment-V & VI, Submission: 10-03-23	4th April 2023
33		Display of Question Bank (6th and 8thSem)	7th April 2023
34		Project Presentation-III	10th to 14th April 2023
35		Industrial Visit/ III Cell Activity/ T&P Activity/ TG Meeting	17th to 21st April 2023
36		Attendance Review/ Final Student Detention List	25th April 2023
37		Monthly Audit/ Student Feedback	28th April 2023
38	May-2023	Internal Practical (6th and 8thSem)	1st to 5th May 2023
39		PUT Exam (6th and 8thSem)	8th to 12th May 2023

Note: - Above mentioned date are subject to change due to unavailable circumstances.

Prof. NehaChourasia	**Prof. RajendraBhombe**	**Dr. HemantHajare**
Associate Dean (Academics)	**Vice- Principal**	**Principal**

2. Course Syllabus

Unit I: **(07 Hrs)**

Introduction to Data Communication:

Data Communication Components, Data Representation, data flow (Simplex, Half-Duplex and Full-Duplex mode), Network Criteria, Type of connection, physical topology, Categories of Network (LAN, MAN, WAN,PAN), study of OSI reference model.

Unit II: **(07 Hrs)**

Physical Layer and Media:

Analog and digital Data, Analog and digital signals, TRANSMISSION MODES: Serial and Parallel transmission, Asynchronous and Synchronous Transmission. COMMUNICATION MEDIA: guided media and unguided.

Unit III: **(07 Hrs)**

Data Link Layer:

Types of errors, framing (character and bit stuffing), Protocols: for noiseless channels (Simplex, Stop and wait), for noisy channels (Stop and wait ARQ, Go back-N ARQ, Selective repeat ARQ), Point-to-Point (PPP), Multiple Access Protocol: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA.

Unit IV: **(07 Hrs)**

Network Layer:

IPv4 Addresses, IP addressing Methods with sub-netting and super-netting, **Routing Protocols**: Distance Vector, Link State, Path Vector.

Transport Layer:

Duties of transport layer, Process-to-process delivery, Congestion control: Data Traffic, Congestion control Category (Open loop, closed loop),

Unit V: **(08 Hrs)**

Quality of Service: Introduction to QoS, Techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm. **Application Layer:** Domain Name System, Functions of Network management system, Voice over IP, Firewall

3. Lesson Plan

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Dahegaon, Kalmeshwar Road, Nagpur – 441501. Phone No. 07118-661400

Department of Computer Science Engineering
Session 2022-23

Sr. No	Lecture No.	Topic	Lesson Outcome	Text Book/Reference Book	Page No.	NPTEL/Swayam Link	Youtube Link
1	1	Data Communication Components, Data Representation	Uderstand various components of CN	BOOK-1	3 to 13	https://onlinecourses.nptel.ac.in/noc22_cs19/preview	https://www.youtube.com/watch?v=VwN91x5i25g&list=PLBlnK6fEyqRgMCUAG0XRw78UA8qnv6jEx
2	2	Network Criteria, Type of connection	Able to explain network criteria and connections	BOOK-1	3 to 13		
3	3	Network Physical Topology	Understand different types of N/W topology	BOOK-1	3 to 13		
4	4	Data Flow (Simplex, Half Duplex and Full Duplex)	Able to explain different modes of communication	BOOK-1	3 to 13		
5	5	OSI Reference Model	Able to expalin different layers functioning in OSI model	BOOK-1	29 to 42		
6	6	OSI Reference Model		BOOK-3	42		
7	7	Categories of network (LAN, MAN,WAN and PAN)	Understand different network types	BOOK-1	395-467		

Unit-II Physical Layer and Media

8	8	Analog and Digital Data	Able to apply knowledge of analog and digital data	BOOK-3	141	https://onlinecourses.npt	1. https://www

9	9	Analog and Digital Signals	and signals	BOOK-3	151	el.ac.in/noc22_cs19/preview	.youtube.com/watch?v=lg-f92uY1Lc 2. https://www.youtube.com/watch?v=gO7vm7QnZsA 3. https://www.youtube.com/watch?v=--0W2qIeUt8
10	10	Serial Transmission Mode	Understand functioning of serial , parallel , Synchronous and Asynchronous data transmission	BOOK-1	131		
11	11	Parallel Transmission Mode		BOOK-1	131		
12	12	Asynchronous Transmission Mode		BOOK-1	133 to 135		
13	13	Synchronous Transmission Mode		BOOK-1	133 to 135		
14	14	Guided Communication Media	Able to expalin guided and unguided medium of transmission	BOOK-1	191		
15	15	Un-Guided Communication Media		BOOK-1	191		

Unit-III Data Link Layer

16	16	Types of Errors	Able to explain various types of error and their detection	BOOK-1	267	https://onlinecourses.nptel.ac.in/noc22_cs19/preview	1. https://www.youtube.com/watch?v=JRgmPco0K
17	17	Data Framing	Understand how data framed between header and trailer	BOOK-1	348		WI 2. https://www.youtube.com/watch?v=2oi7aCRgcL0 3. https://www.youtube.com/watch?v=epFQFWy-79Y
18	18	Protocol for Noiseless channel	Able to apply different types of protocol used in Data link layer to perform error free data transmission	BOOK-1	312		
19	19	Protocol for Noiseless channel		BOOK-1	312		
20	20	Protocol for Noisy channel		BOOK-1	318		
21	21	Protocol for Noisy channel		BOOK-1	318		

22	22	PPP Protocol		BOOK-1	346		
23	23	Multiple Accsess protocol: Pure ALOHA		BOOK-1	364 to 367		
24	24	Multiple Accsess protocol: Slotted ALOHA		BOOK-1	364 to 367		
25	25	Multiple Accsess protocol: CSMA		BOOK-1	364 to 367		
26	26	Multiple Accsess protocol: CSMA-CD and CSMA-CA		BOOK-1	364 to 367		

Unit-IV Network Layer and Transportation Layer

28	28	IPv4 Addresses	Understand IPv4 addressing	BOOK-1	549 to 563	https://onlinecourses.npt	1. https://www
29	29	IP Addressing methods: with subnetting	Understand subnetting and supernetting concepts	BOOK-1	554	el.ac.in/noc22_cs19/preview	.youtube.com/watch?v=rW1jPlYgp_0 2. https://www.youtube.com/results?search_query=Network+Layer+and+Transportation+Layer 3. https://www.youtube.com/watch?v=rA0p0ouD3aE 4.
30	30	IP Addressing methods: with supernetting		BOOK-1	554		
31	31	Routing Protocol: Distance vector	Able to explain different kinds of routing protocols	BOOK-1	658 to 674		
32	32	Routing Protocol: Link state		BOOK-1	658 to 674		
33	33	Routing Protocol: Path Vector		BOOK-1	658 to 674		
34	34	Function of transportation layer: Process to Process delivery	Can explain process to process delivery	BOOK-1	703		
35	35	Congestion Control: Data Trafic	Able compare open loop and closed loop category	BOOK-1	761		

36	36	Congestion Control: category (Open Loop and Closed Loop)	of Congession control	BOOK-1	766		https://www.youtube.com/watch?v=Tn08RMwr4Zo
37	37	Congestion Control: category (Open Loop and Closed Loop)		BOOK-1	767		

Unit-V Quality of Services (QoS)

38	38	Introduction to QoS	Understand what is quality of services and the technology to improve it.	BOOK-1	775	https://onlinecourses.nptel.ac.in/noc22_cs19/preview	https://www.youtube.com/watch?v=CQ5dMXl7AoE
39	39	Techniques to Improve QoS: Leaky Bucket		BOOK-1	776		
		Algorithm					
40	40	Techniques to Improve QoS: tocken Bucket Algorithm	Able to apply what is quality of services and the technology to improve it.	BOOK-1	776		
41	41	**Application Layer:** Domain name system		BOOK-1	797		
42	42	Domain name system	Able to explain domain name process	BOOK-1	797		
43	43	Function of Network Management System	Able to explain function of NMS	BOOK-1	873		
44	44	Voice over IP and Firewal	Able to apply voice over IP protocol. Can explain Firewall system which offer security	BOOK-1	1021		

4. Time Table- (Class Schedule)

GURUNANAK INSTITUTE OF ENGINEERING & TECHNOLOGY, NAGPUR

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

List Of Experiment

Session 2022-23(EVEN)

W.E.F:03/03/2023

IV Sem

Class Hour		1	2	3	4	5	6	7	8
Time		9.45 am to 10.45 am	10.45 am to 11.45 am	11.45 am to 12.45 pm	12.45 pm to 01.30 pm	1.30 pm to 2.30 pm	2.30 pm to 3.30 pm	3.30 pm to 4.30 pm	4.30 pm to 5.30 pm
MON	IV	DBMS	CN	TOC	Lunch/ Problem Solving /Internet/ Library/ Sports/ HobbyClub	DMGT	DSPD	SP	FORUM ACTIVITY
TUE	IV	DSPD	DSPD(LAB)B1/DBMS(LAB)B2/ C/W(LAB) B3			DMGT	TOC	Library	SUBJECT PROBLEM SOLVING
WED	IV	DMGT	TOC	SP		CN	DBMS	TECHNICAL UP GRADATION	
THU	IV	DSPD(LAB)B2/DBMS(LAB)B3 / C/W(LAB) B1		TOC		SP	DSPD	SUBJECT PROBLEM SOLVING	Sport

FRI	IV	CN	DSPD(LAB)B3/DBMS(LAB)B1/ C/W(LAB) B2		DBMS	DSPD	Internship

Batch: B1 = Roll No. 01 to 23

Batch: B2 = Roll No. 24 to 46 Batch:

B3 = Roll No. 47 to 70

*** T – Tutorial**

TEACHING FACULTY

Sr. No.	Code	Name of Subject	Theory/Practical	AbbreVation	Name of Faculty
1.	BECSE401T	Discrete Mathematics and Graph Theory	Theory	SB	Prof.Sandeep Bhongade
2.	BECSE402T	Data Structure and Program Design	Theory	SG	Prof.ShubhangiGhadinkar
3.	BECSE403T	Database Management Systems	Theory	MS	Prof.MayuriShrungare
4.	BECSE404T	Computer Network	Theory	BT	Dr. Balram Timande
5.	BECSE405T	Theory of Computation	Theory	KA	Prof.KamakhayaArgulewar
6.	BECSE406T	System programming	Theory	NS	Prof.NayanShambharkar
7.	BECSE402P	Data Structure and Program Design Lab	Practical	SG	Prof.ShubhangiGhadinkar
8.	BECSE403P	Database Management Systems Lab	Practical	MS	Prof.MayuriShrungare
9.	BECSE407P	Computer Workshop-II (Python)	Practical	KA	Prof.KamakhayaArgulewar

10	**BECSE408**	Internship	**Practical**	**SG**	**Prof.ShubhangiGhadinkar**

5. Assignment Assignment-1

1. a. Compare Connection oriented and connectionless service. 6M b. Explain the functions and protocols and services of each layer?
2. What are the major components of an optical communication system?
3. a) Explain about the Guided transmission Medias in computer networks?

   b) Briefly explain about the public switched telephone networks
4. Write about network software & hardware.
5. Discuss about a) Computer applications 6M b) Features of LAN, MAN, WAN.

Assignment-2

1. Explain the operation of the bit-oriented protocol HDLC with the required frames.
2. Explain the various error detection and correction Mechanisms used in computer network.
3. Discuss about a) GO BACK NARQ 6M b) Selective repeat ARQ
4. Explain about the Elementary data link protocols?
5. a. Discuss stop and wait protocol 7M b. Explain about the Carrier Sense Multiple Access Protocols?

Assignment-3

1. a.)State the major difference between distance vector routing and link state routing. 7M b) How these routing techniques work
2. Explain about the Routing algorithms.
3. Discuss about a) concept of leaky bucket algorithm? 7M b) token bucket algorithm with neat diagram.
4. Explain in detail congestion control algorithms.
5. Explain CSMA/CD protocol.

Assignment-4

1. a) Explain the duties of transport layer. 6M b) Write short notes on performance issues of transport layer.
2. Show the different approaches in Packet Switching. Explain them in detail.
3. Enumerate the mechanism of three way handshake protocol for TCP.
4. Explain in detailed about the Transport Layer.
5. Describe about a) TCP connection management. 5M b) Avoidance of congestion in TCP.

Assignment-5

1. Explain how security is provided in interact operations in detail.
2. a) Explain the working of Electronic mail. How SMTP used in Email applications 6M b) List and discuss the types of DNS records.

3. Discuss in detail about world wide web.

4. a) Explain the encryption and decryption methods. 6M b) Discuss Application layer in details.

5. Explain in detail about function and structure of e-mail protocol.

University Question Paper

Computer Networks

P. Pages : 2 **NRT/KS/19/3493**

Time : Three Hours ★0607★ Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.

1.	a)	What are different network criteria ? Explain.	**5**
	b)	Draw and explain OSI reference model.	**8**
		OR	
2.	a)	Differentiate between OSI and TCP/IP model.	**6**
	b)	How can computer networks be classified based on transmission technology and scales.	**7**
3.	a)	List and explain different framing methods with example.	**7**
	b)	Explain stop and wait ARQ protocol.	**6**
		OR	
4.	a)	Differentiate between Go-back N ARQ and selective Repeat ARQ.	**6**
	b)	What are the 3 kinds of frames in HDLC protocol ? Explain each one in detail.	**7**
5.	a)	Discuss about pure ALOHA and slotted ALOHA.	**7**
	b)	Explain Reservation and polling with suitable explain.	**6**
		OR	
6.	a)	Write down the difference between Traditional Ethernet and fast Ethernet.	**6**
	b)	Write short note on LCP and NCP.	**7**

7.	a)	Describe shortest path algorithm.	**7**
	b)	Explain static and dynamic routing with suitable example.	**7**

OR

8.		Write short note on :	**14**
		i) Mobile routing basic algorithm.	
		ii) Distance vector routing.	
		iii) Flooding.	
9.	a)	Explain Leaky bucket algorithm and Token bucket algorithm with proper diagram.	**10**
	b)	Explain ARP and RARP protocol.	**4**

OR

10.	a)	Compare IPV_4 and IPV_6.	**4**
	b)	Explain IP and ICMP protocol.	**4**
	c)	Describe how chock packet algorithm helps in congestion control.	**6**
11.	a)	Draw and explain Bluetooth architecture.	**7**
	b)	Explain in brief DSL technology.	**6**

OR

12.		Write short note on **any three.**	**13**
		i) ATM layers.	**5**
		ii) SONET	**5**
		iii) Wireless LAN 802.11	**5**
		iv) VLAN	**3**

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7. Sessional Question Paper

Sessional-I (Feb-2024)

Subject: Computer Network (CN)
Code:----------
Branch/Semester:-CSE-4th Semester

Time: 12:15 PM to 01:15 PM **Date-** -Feb-2024

Maximum Marks: 30

Note:Attempt any 03 Questions from group CO-1 and CO-2 each. All Questions carry equal marks.

Ques.	Description	Marks	Blooms level	COn
1	List various components used in data communication and explain each in brief	5	Un	CO-1
2	Discuss on different types of data representation used in computer network for communication.	5	Un	
3	Explain each network criteria in brief	5	Un	
4	Explain different types of Data flow in computer network.	5	An	
5	Write short note on (any one) 1. Bus topology & Ring topology 2. Tree topology & Mesh topology	5	Un	CO-2

6	Explain 1) LAN 2) MAN	5	An
7	Explain 1) WAN 2) PAN	5	An
8	Draw and discuss in brief on OSI reference model	5	Un

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
Dahegaon, Kalmeshwar Road, Nagpur-441 501.

Department of Computer Science and Engineering

Sessional - II

Year/Sem: IV SEM
Time: - 01 Hours

Subject: Computer Network
Maximum Marks: - 20

INSTRUCTIONS

1) All Questions carry marks as indicated.
2) Solve FIVE questions.
3) Illustrate your answer wherever necessary with the help of neat sketches.
4) Assume suitable data whenever necessary.
5) Use of non programmable calculator is permitted.

1.	**What do you mean by BIT stuffing in HDLC frame? Explain.**	**4**
2.	Explain the Network Hardware components HUBs, Bridges, Repeaters, Switch, Router and NIC.	**4**
3.	**Explain in brief about Ethernet.**	**4**
4.	**Write short notes on flow control.**	**4**

5.	**Explain why BGP uses the service of TCP instead of UDP.**	**4**
6.	**What are the performance issues of transport control protocol?**	**4**
7.	**Explain 3 phase operation in TCP.**	**4**
8.	**What is IPv6? Explain it's advantages over IPv4. Also explain it's frame format.**	**4**

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
Dahegaon, Kalmeshwar Road, Nagpur-441 501.
Department of Computer Science and Engineering

Pre-University Test

Year/Sem: IV SEM Subject: Computer Comm. N/W
Time: - 03 Hours Maximum Marks: - 80

INSTRUCTIONS TO CANDIDATE.

1. All questions carry marks as indicated.
2. Solve two questions as follows:

Q. No. 1 OR Q. No. 2

Q. No. 3 OR Q. No. 4

Q. No. 5 OR Q. No. 6

Q. No. 7 OR Q. No. 8

Q. No. 9 OR Q. No. 10

3. Assume suitable data wherever necessary.

4. Illustrate your answer wherever necessary with the help of neat sketches.

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1. a) Explain the concept of layered network architecture with reference to OSI and TCP/IP **7** model.

b) **Draw & explain TCP/IP protocol architecture.** **6**

OR

2. a) Write a short note on ATM along with ATM cell format. **7** b) Compare X.25 with frame relay. **6**

3. a) Compare circuit switching & packet switching. **7** b) Explain the classification of transmission media. **7**

OR

4. a) Explain SONET network. **7** b) Write short notes on selection of IEEE 802.11. a, b, g and n. **7**

5. a) Explain the Network Hardware components HUBs, Bridges, Repeaters, Switch, Router and NIC. **7**

b) **What do you mean by BIT stuffing in HDLC frame? Explain.** **7**

OR

6. a) Explain the different sliding window protocols. **7 i) Go-Back-N**

ii)Selective Repeat

b) **Write short notes on flow control.** **7**

7. a) What is congestion control? What are it's causes and give the congestion control policies? **6** b)

Explain the difference between IPv4 and IPv6-addressing. **7**

OR

8. a) What are the different Routing methods? Explain Distance Vector Routing. **6** b) Explain 3 phase

operation in TCP. **7**

9. a) Write short notes on **13**

i) File transfer protocol ii) Simple mail transfer protocol iii) DNS.

OR

10. a) Explain middleware data related functions for WSN. **6**

b) Explain the concept of Peer to Peer file sharing. **7**

11. a) Explain secret key Algorithm Draw its block diagram and give the advantages and **6**

disadvantages of it.

b) Explain concept of Digital Signature and public key cryptography. **7**

OR

12. a) Write short notes on following.

a)Network Tester

b)Network simulation.

c)Internet access through Dialup/DSL/Leased Line/Mobile Handset

d)Protocol Analyzer

8. Question Bank

Subject: COMPUTER NETWORKS UNIT-1

1. a. Compare Connection oriented and connectionless service. 6M b. Explain the functions and protocols and services of each layer? 6M

2. What are the major components of an optical communication system? 12M

3. a) Explain about the Guided transmission Medias in computer networks? 6M b) Briefly explain about the public switched telephone networks 6M

4. Write about network software & hardware 12M

5. Discuss about a) Computer applications 6M b) Features of LAN, MAN, WAN 6M

6. With a neat diagram describe in detail about the Network architecture. 12M

7. Explain in detail about a) Data Link Layer and Network Layer 6M b) Physical Layer 6M

8. Distinguish between point to point links and multi point links. Give relevant diagrams 12M

9. Discuss various types of networks topologies in computer network. 12M

10. Explain the ISO-OSI model of computer network with a neat diagram 12M

QUESTION BANK 2019 2

UNIT-2

1. Explain the operation of the bit-oriented protocol HDLC with the required frames 12M

2. Explain the various error detection and correction Mechanisms used in computer network 12M

3. Discuss about a) GO BACK NARQ 6M b) Selective repeat ARQ 6M

4. Explain about the Elementary data link protocols?. 12M

5. a. Discuss stop and wait protocol 7M b. Explain about the Carrier Sense Multiple Access Protocols? 5M

6. Briefly discuss about data link layer design issues? 12M

7. Explain about the data Link Layer switching 12M

8. Explain MAC sub layer protocol and frame structure of IEEE 802.11. 12M
9. Describe sliding window protocol using Go back n. 12
10. Compare and distinguish in detail the concept of Virtual-Circuit and Data gram Networks. 12M

UNIT-3

1. a.)State the major difference between distance vector routing and link state routing. 7M b) How these routing techniques work 5M
2. Explain about the Routing algorithms. 12M
3. Discuss about a) concept of leaky bucket algorithm? 7M b) token bucket algorithm with neat diagram 5M
4. Explain in detail congestion control algorithms 12M
5. Explain CSMA/CD protocol 12M
6. Classify the functions of Bridges & Switches in brief. 12M
7. Explain the function of ARP & RARP 12M
8. a. Explain distance vector routing in detail. 7M b. Discuss about Inter-network Routing? 5M
9. Write a detail note on Internet protocols 12M QUESTION BANK 2019 3
10. a) Explain about the Shortest Path Algorithm? 7M b) Explain packet switching in detail. 5M

UNIT-4

1. a) Explain the duties of transport layer. 6M b) Write short notes on performance issues of transport layer 6M
2. Show the different approaches in Packet Switching. Explain them in detail.
3. Enumerate the mechanism of three way handshake protocol for TCP 12M
4. Explain in detailed about the Transport Layer. 12M

5. Describe about a) TCP connection management. b) Avoidance of congestion in TCP 7M
6. Explain the function of TCP/IP protocol. 7. a) Explain about elements of transport protocols b) Briefly explain the internet transport protocols 5M 8. a) Discuss TCP and its various operations b) Write short notes on User Datagram Protocol (UDP).
9. Explain the operation of TCP with neat sketch.
10. Discuss the various timers used by TCP to perform its various operations.

UNIT-5

1. Explain how security is provided in interact operations in detail 12M
2. a) Explain the working of Electronic mail. How SMTP used in Email applications 6M b) List and discuss the types of DNS records. 6M
3. Discuss in detail about world wide web 12M
4. a) Explain the encryption and decryption methods. 6M b) Discuss Application layer in details 6M
5. Explain in detail about function and structure of e-mail protocol. 12M
6. a) Discuss the File transfer Protocol (FTP)with a neat diagram. 6M b) Explain briefly simple network management protocol 6M QUESTION BANK 2019 4
7. Write short notes on IMAP and MIME with an example 12M
8. a)Discuss the features of HTTP and also discuss how HTTP works. 6M b) Explain about Application layer and its services in detail? 6M
9. Describe the role of a DNS on a computer network with reference to its components. 12M
10. a) Write briefly about World wide web 6M b) Describe about High speed LANs 6M

9. Teaching Notes.

"Computer networking is nothing but connecting computers and other devices together to enable communication for data exchange between them"

Network: A network is a collection of computers and devices that are connected together to enable communication and data exchange.

Nodes: Nodes are devices that are connected to a network. These can include computers, servers, printers, routers, switches, and other devices.

Protocol: A protocol is a set of rules and standards that govern how data is transmitted over a network. A protocol is a set of rules or algorithms which define the way how two entities can communicate across the network and there exists different protocol defined at each layer of the OSI model. Few of such protocols are TCP, IP, UDP, ARP, DHCP, FTP, and so on.

Examples of protocols include TCP (Transmission Control Protocol- is a standard that defines how to establish and maintain a network conversation by which applications can exchange data.)/IP (Internet Protocol), HTTP (Hypertext Transfer Protocol) is the set of rules for transferring files -- such as text, images, sound, video and other multimedia files -- over the web. As soon as a user opens their web browser, they are indirectly using HTTP, and FTP (File Transfer Protocol) is a network protocol for transmitting files between computers over Transmission Control Protocol/Internet Protocol (TCP/IP) connections.

Topology: Network topology refers to the physical and logical arrangement of nodes on a network. The common network topologies include bus, star, ring, mesh, and tree.

LAN: A Local Area Network (LAN) is a network that covers a small area, such as an office or a home. LANs are typically used to connect computers and other devices within a building or a campus.

WAN: A Wide Area Network (WAN) is a network that covers a large geographic area, such as a city, country, or even the entire world. WANs are used to connect LANs together and are typically used for long-distance communication.

IP Address: An IP address is a unique numerical identifier that is assigned to every device on a network. IP addresses are used to identify devices and enable communication between them.

DNS: The Domain Name System (DNS) is a protocol that is used to translate human-readable domain names (such as www.google.com) into IP addresses that computers can understand. Google maintains the IP addresses 8.8.8.8 and 8.8.4.4 as the primary and secondary DNS addresses for Google Public DNS

Firewall: A firewall is a security device that is used to monitor and control incoming and outgoing network traffic. Firewalls are used to protect networks from unauthorized access and other security threats.

1	Data Communication Components, Data Representation	**Unit-1**
2	Network Criteria, Type of connection	
3	Network Physical Topology	
4	Data Flow (Simplex, Half Duplex and Full Duplex)	
5	OSI Reference Model	
6	OSI Reference Model	
7	Categories of network (LAN, MAN,WAN and PAN)	

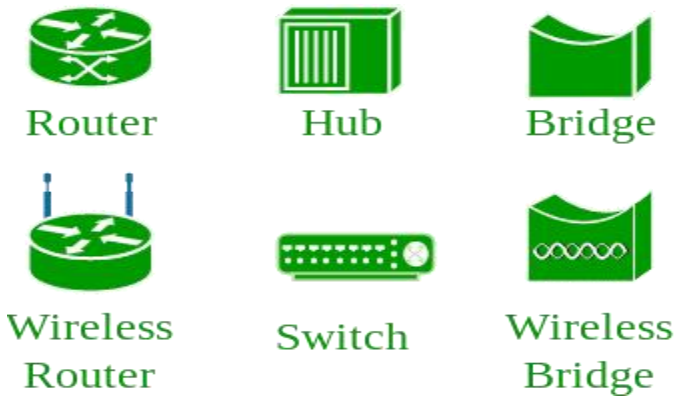
Computer Network uses distributed processing in which task is divided among several computers. Instead, a single computer handles an entire task; each separate computer handles a subset.

Following are the advantages of Distributed processing:

- **Security:** It provides limited interaction that a user can have with the entire system. For example, a bank allows the users to access their own accounts through an ATM without allowing them to access the bank's entire database.
- **Faster problem solving:** Multiple computers can solve the problem faster than a single machine working alone.

- **Security through redundancy:** Multiple computers running the same program at the same time can provide the security through redundancy. For example, if four computers run the same program and any computer has a hardware error, then other computers can override it.

Computer Network: An interconnection of multiple devices using multiple paths for the purpose of sending/receiving data or media. Computer networks can also include multiple devices/mediums which help in the communication between two different devices; these are known as **Network devices** and include things such as routers, switches, hubs, and bridges.



Computer Network Components

Computer networks include multiple devices/mediums which help in the communication between two different devices; these are known as **Network devices.** Computer network components or devices are the major parts which are needed to *share information within the network.* Some important network components are **NIC**, **switch**, **cable**, **hub**, **router**, and **modem etc.** Depending on the type of network that we need to install, some network components can be removed. For example, the wireless network does not require a cable.

Following are the major components required to install a network:

NIC

- NIC stands for **network interface card**. ○ NIC is a hardware component used to connect a computer with another computer onto a network
- It can support a transfer rate of 10,100 to 1000 Mb/s.

- The MAC address or physical address is encoded on the network card chip which is assigned by the IEEE to identify a network card uniquely. The MAC address is stored in the PROM (Programmable read-only memory).

There are two types of NIC:

1. Wired NIC
2. Wireless NIC

Wired NIC: The Wired NIC is present inside the motherboard. Cables and connectors are used with wired NIC to transfer data.

Wireless NIC: The wireless NIC contains the antenna to obtain the connection over the wireless network. For example, laptops, Mobile phones contain the wireless NIC.

Hub

A Hub is a hardware device that divides the network connection among multiple devices. When computer requests for some information from a network, it first sends the request to the Hub through cable. Hub will broadcast this request to the entire network. All the devices will check whether the request belongs to them or not. If not, the request will be dropped.

Nowadays, the use of hub is obsolete since it consumes more bandwidth for communication, and it is replaced by more advanced computer network components such as Switches, Routers.

Switch

A switch is a hardware device that connects multiple devices on a computer network. A Switch contains more advanced features than Hub. **The Switch contains the updated table that decides whether the data is transmitted or not. Switch delivers the message to the correct destination based on the physical address present in the incoming message.** A Switch does not broadcast the message to the entire network like the Hub. It determines the device to whom the message is to be transmitted. Therefore, we can say that switch provides a direct connection between the source and destination. It increases the speed of the network.

Router - A router is a hardware device which is used to connect a LAN with an internet connection. It is used to receive, analyze and forward the incoming packets to another network.

- A router works in a **Layer 3 (Network layer)** of the **OSI (Open System Interconnection)** Reference model.
- A router forwards the packet based on the information available in the routing table. ○ It determines the best path from the available paths for the transmission of the packet.

Advantages of Router: ○ **Security:** The information which is transmitted to the network will traverse the entire cable, but the only specified device which has been addressed can read the data.

- **Reliability:** If the server has stopped functioning, the network goes down, but no other networks are affected that are served by the router.
- **Performance:** Router enhances the overall performance of the network. Suppose there are 24 workstations in a network generates a same amount of traffic. This increases the traffic load on the network. Router splits the single network into two networks of 12 workstations each, reduces the traffic load by half. ○ **Network range:.** better network range compared to other devices

Modem

- It stands for Modulator/Demodulator. It converts the digital data into an analog signal over the telephone lines.
- A modem is a hardware device that allows the computer to connect to the internet over the existing telephone line.
- A modem is not integrated with the motherboard rather than it is installed on the PCI slot found on the motherboard.

Cables and Connectors

Cable is a transmission media used for transmitting a signal.

There are three types of cables used in transmission:

- Twisted pair cable ○ Coaxial cable ○ Fibre-optic cable

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Data Representation

A network is a collection of different devices connected and capable of communicating. For example, a company's local network connects employees' computers and devices like printers and scanners. Employees will be able to share information using the network and also use the common printer/ scanner via the network. Data to be transferred or communicated from one device to another comes in various formats like audio, video, etc. This tutorial explains how different data types are represented in a computer and transferred in a network.

Different Data types in a computer network:

1. Texts
2. Numbers
3. Images
4. Videos
5. Audios

Textual data:

Data in text format is represented using bit patterns (combinations of binary bits - 0 and 1). Textual data is nothing but a string, and a string is a collection of characters. **Each character is given a specific number according to an international standard called Unicode, for example ASCII codes.** Now, these codes are converted into binary bits to represent the textual data in a pattern of bits, and these bits are transferred as a stream via the network to other devices.

[Unicode: *It is the universal standard of character encoding. It gives a unique code to almost all the characters in every language spoken in the world. It defines more than 140000 characters. It even defined codes for emojis.* ***The first 128 characters of Unicode point to ASCII characters****. ASCII is yet another character encoding format, but it has only 128 codes to 128 characters. Hence, ASCII is a subset of Unicode.*]

File

extensions: .doc; .do

cx; .pdf; .txt;

For example:

Character: H; Unicode representation: U+0048 (ASCII CODE: 48H)

Character: h; Unicode representation: U+0068 (ASCII CODE: 68H)

2. Numerical data

Numbers are directly converted into binary patterns by dividing by 2 without any encoding. The numbers we want to transfer generally will be of the decimal number system- $( )_{10}$. We need to convert the numbers from $( )_{10}$ to a binary number system - $( )_2$ to get a bit stream.

Number formats:

1. Integers
2. Date
3. Boolean
4. Decimal
5. Fixed point
6. Floating point

Example:

Number: 780
Binary representation: 1100001100

3. Image

Image data is also transferred as a stream of bits like textual data. An image, also called a picture, is a collection of little elements called "**Pixels**". A single pixel is the smallest addressable element of a picture, and it is like a dot with a size of 1/96 inch or 0.26 mm. The dimensions of an image are given by the **number of pixels along the height of the image X Number of pixels along the width of the image.**

Representation in a computer:

Grayscale images:

A black-and-white/ Grayscale image consists of white, black, and all the shades in between. It can be considered as just **the varying intensity of the White color**. The pixel value in a Grayscale image can be in the range **of 0 to 255**, where 0 represents Black and 255 represents White, and all the numbers in the interval represent different shades. A matrix is created for the image with pixel values of all the pixels in the image. This matrix is called a "**Channel**".

Colored images:

Each pixel comprises three transistors representing three standard colors: **Red, Green, and Blue (RGB), Yellow, Cyan, and Magenta (YCM)**. Any color known can be generated by using these three colors. Based on the intensity of a color in the pixel, three matrices/ channels for each color are generated. Suppose there is a colored image, and three matrices are created for Red, Green, and Blue colors in each pixel in the image:

141	142	143
151	152	153
161	162	163

35	36	37
45	46	47
55	56	57

31	32	33
41	42	43
51	52	53

The first pixel's intensities of Red, Green and Blue colors are [141, 35, 31]. In this way, every pixel is analyzed and converted into binary bits, and this bit stream is transferred to any other device in the network to communicate the image. N-bit streams are used to represent 2N possible colors. From 0 to 255, we can represent 256 shades of color with different 8-bit patterns.

File extensions:

.jpg, jpeg, .png, etc.

4. Audios

Transferring an audio signal is different from other formats. Audio is broadcasting recorded sound or music. An audio signal is **generated as an analog wave, converted into digital format** to be stored in a computer by representing the wave amplitude at moments in bits. Another parameter is the sample rate. It represents the number of samples or, in other words, samples saved.

The audio quality depends **on the sampling rate** and the **bit rate**. If more bits are used to represent the amplitudes in moments and more moments are captured accurately, we can save the audio with every detail accurately. **File extensions:**

.mp3, .m4a, .WAV, .AAC, etc.

5. Videos

A video is a **collection of frames; each frame is a picture** with the same dimensions. These frames/ images are represented as matrices, as we discussed above. All the frames/ images are displayed continuously, one after the other, to show a video in movement. To represent a video, The computer will analyze data about the video like:

1. **FPS** (Frames per second)
2. Duration of the video
3. Image resolution (Number of pixels Horizontally X Vertically)
4. Bit depth (Number of bits required to represent a pixel -> number of colors)

A video is mostly combined with an audio component, like a film or a video game.

File extensions:

.mp4, .MOV, .AVI, etc.

Network Criteria

There are three basic yet important criteria to be fulfilled for a network:

1. Performance
2. Reliability
3. Security

Performance

It measures how well a network can support communication between two nodes in the Network or with nodes of other networks in the global scope. **The two major tasks in a network are the Transmission and reception of information.** We need to focus on **how fast a message is transmitted** and **how fast a node can receive a request and find the needed information**. Hence, to measure the performance of a network, here are the major factors to be considered:

1. **Transit time**: The total time a node takes to transmit a message from the beginning until the last character of the message. Transit stands for Transmission.

2. **Response time**: The total time a node takes to process an inquiry or a request from another node/ device and respond. It is the time between the inquiry's end and the response's beginning.
3. **Throughput**: Throughput measures how much data is transferred successfully from the sender node to the receiver node in a particular time frame. It is measured in bits per second or data per second.
4. **Bandwidth**: The maximum possible throughput capacity of the Network. We can measure it in bits, megabits, or gigabits per second. It defines the highest limit.
5. **Delay/ Latency**: As we discussed, Throughput is the number of data packets successfully delivered in a given time. Delay is the measure of time taken to do the delivery.

Reliability

It is the degree to which a network is **trustworthy, consistent**, and **dependable**. The Reliability of a network is measured by the frequency of failures it is undergoing and the time it takes to recover from the failures. Overall, the **Robustness of the Network** at times of catastrophic events is measured to check how reliable the Network is.

Security

It measures how the Network **secures the data** amid failures and attacks and the policies and procedures it implements to protect itself from damages and unauthorized access. In Reliability, the frequency of failures is checked. In Security, network attacks and data breaches are checked.

Overall goals of a typical network:

1. Scarce resources sharing
2. Feasibility
3. Better performance
4. High Reliability
5. High Security
6. Inter-process communications
7. Flexible access to authorized clients

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Types of Connections:

- Point-to-Point Connection
- Multipoint Connection

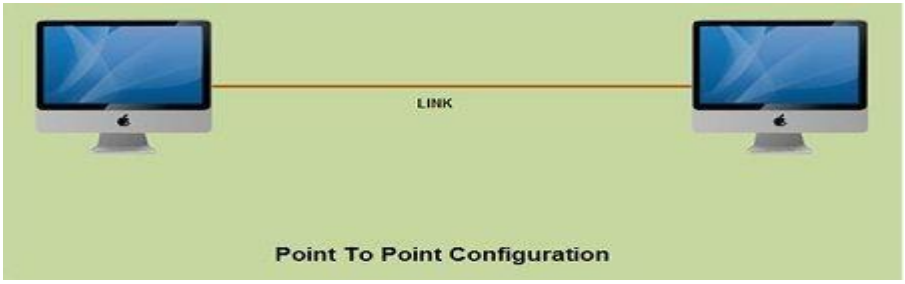
Point-to-Point Connection

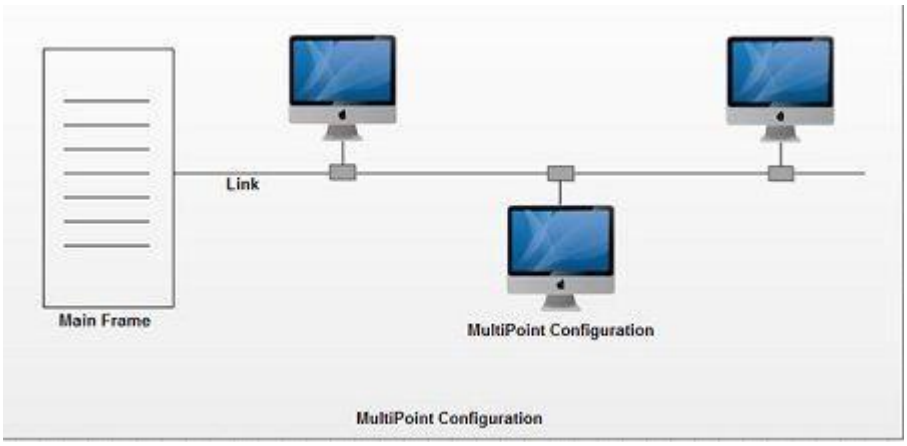
A **point-to-point connection** is a direct link between two devices such as a computer and a printer. It uses dedicated link between the devices. The entire capacity of the link is used for the transmission between those two devices. Most of today's point-to-point connections are associated with modems and PSTN (Public Switched Telephone Network) communications. In point to point networks, there exist many connections between individual pairs of machines.

In networking, the Point-to-Point Protocol (PPP) is a data link protocol commonly used in establishing a direct connection between two networking nodes. It can provide connection authentication, transmission encryption, and compression. PPP is used over many types of physical networks including serial cable, phone line, trunk line, cellular telephone, specialized radio links, and fiber optic links such as SONET. PPP is also used over Internet access connections (now marketed as ―broadband‖).

MultipointConnection

A multipoint connection is a link between three or more devices. It is also known as Multi-drop configuration. The networks having multipoint configuration are called **Broadcast Networks**. In broadcast network, a message or a packet sent by any machine is received by all other machines in a network. The packet contains address field that specifies the receiver. Upon receiving a packet, every machine checks the address field of the packet. If the transmitted packet is for that particular machine, it processes it; otherwise it just ignores the packet.





Broadcast network provides the provision for broadcasting & multicasting. Broadcasting is the process in which a single packet is received and processed by all the machines in the network. It is made possible by using a special code in the address field of the packet. When a packet is sent to a subset of the machines i.e. only to few machines in the network it is known as multicasting.

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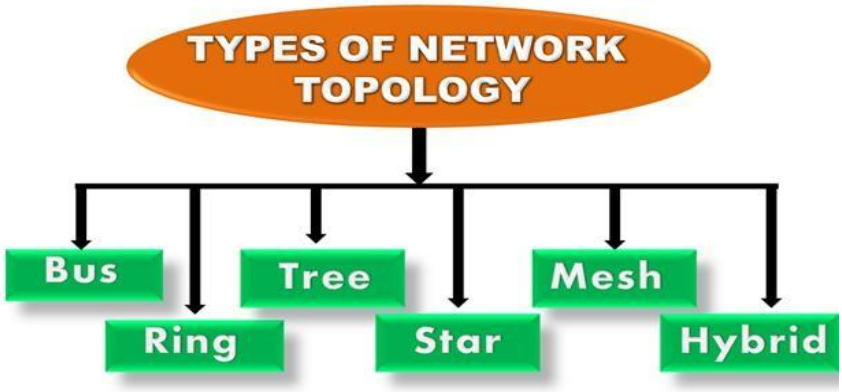
Physical Topologies:

What is Network Topology?

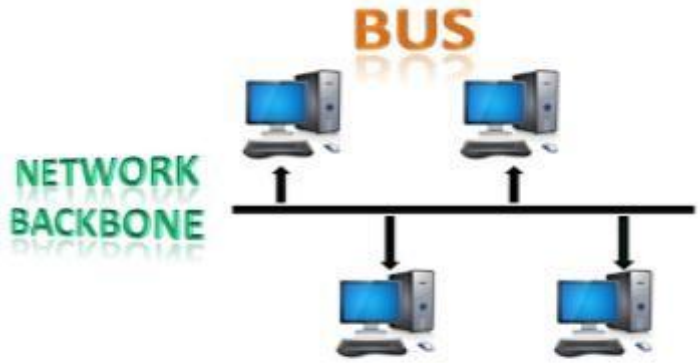
Topology defines the structure of the network of how all the components are interconnected to each other. There are two types of topology: physical and logical topology.

Types of Network Topology

Physical topology is the geometric representation of all the nodes in a network. There are six types of network topology which are Bus Topology, Ring Topology, Tree Topology, Star Topology, Mesh Topology, and Hybrid Topology.



1) Bus Topology



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The bus topology is designed in such a way that all the stations are connected through a single cable known as a backbone cable. ○ Each node is either connected to the backbone cable by drop cable or directly connected to the backbone cable. ○ When a node wants to send a message over the network, it puts a message over the network. All the stations available in the network will receive the message whether it has been addressed or not.

- The bus topology is mainly used in 802.3 (ethernet) and 802.4 standard networks. ○ The configuration of a bus topology is quite simpler as compared to other topologies.
- The backbone cable is considered as a **"single lane"** through which the message is broadcast to all the stations.
- The most common access method of the bus topologies is **CSMA** (Carrier Sense Multiple Access).

CSMA: It is a media access control used to control the data flow so that data integrity is maintained, i.e., the packets do not get lost. There are two alternative ways of handling the problems that occur when two nodes send the messages simultaneously.

- **CSMA CD:** CSMA CD (**Collision detection**) is an access method used to detect the collision. Once the collision is detected, the sender will stop transmitting the data. Therefore, it works on "**recovery after the collision**".
- **CSMA CA: CSMA CA (Collision Avoidance)** is an access method used to avoid the collision by checking whether the transmission media is busy or not. If busy, then the sender waits until the media becomes idle. This technique effectively reduces the possibility of the collision. It does not work on "recovery after the collision".

Advantages of Bus topology:

- **Low-cost cable:** In bus topology, nodes are directly connected to the cable without passing through a hub. Therefore, the initial cost of installation is low.
- **Moderate data speeds:** Coaxial or twisted pair cables are mainly used in bus-based networks that support upto 10 Mbps.
- **Familiar technology:** Bus topology is a familiar technology as the installation and troubleshooting techniques are well known, and hardware components are easily available.
- **Limited failure:** A failure in one node will not have any effect on other nodes.

Disadvantages of Bus topology:

- **Extensive cabling:** A bus topology is quite simpler, but still it requires a lot of cabling.

- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:** If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Attenuation:** Attenuation is a loss of signal leads to communication issues. Repeaters are used to regenerate the signal.

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2) Ring Topology

- Ring topology is like a bus topology, but with connected ends. ○ The node that receives the message from the previous computer will retransmit to the next node.
- The data flows in one direction, i.e., it is unidirectional.
- The data flows in a single loop continuously known as an endless loop. ○ It has no terminated ends, i.e., each node is connected to other node and having no termination point.
- The data in a ring topology flow in a clockwise direction.

  The most common access method of the ring topology is **token passing**. **Token passing:** It is a network access method in which token is passed from one node to another node. **Token:** It is a frame that circulates around the network.

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Working of Token passing - A token move around the network and it is passed from computer to computer until it reaches the destination.

- The sender modifies the token by putting the address along with the data.
- The data is passed from one device to another device until the destination address matches. Once the token received by the destination device, then it sends the acknowledgment to the sender.
- In a ring topology, a token is used as a carrier.

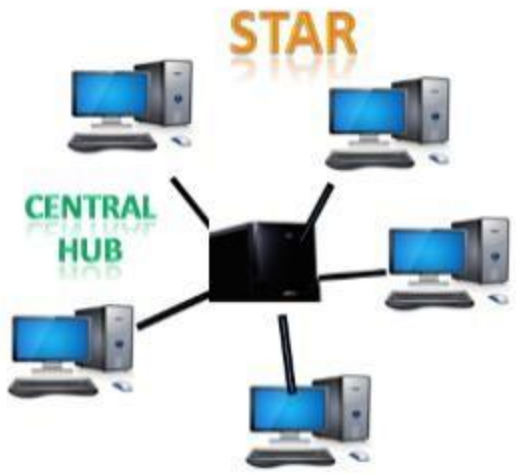
Advantages of Ring topology: - **Product availability:** Many hardware and software tools for network operation and monitoring are available.

- **Cost:** Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Reliable:** It is a more reliable network because the communication system is not dependent on the single host computer.

Disadvantages of Ring topology:

- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Failure:** The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Delay:** Communication delay is directly proportional to the number of nodes. Adding new devices increases the communication delay.

3) Star Topology



- Star topology is an arrangement of the network in which every node is connected to the central hub, switch or a central computer.
- The central computer is known as a **server**, and the peripheral devices attached to the server are known as **clients**.
- Coaxial cable or RJ-45 cables are used to connect the computers. ○ Hubs or Switches are mainly used as connection devices in a **physical star topology**. ○ Star topology is the most popular topology in network implementation.

Advantages of Star topology ○ **Efficient troubleshooting:** Troubleshooting is quite efficient in a star topology as compared to bus topology. In a star topology, all the stations are connected to the centralized network. Therefore, the network administrator has to approach the single station to troubleshoot the problem.

- **Network control:** Complex network control features can be easily implemented in the star topology. Any changes made in the star topology are automatically accommodated.
- **Limited failure:** As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.
- **Familiar technology:** Star topology is a familiar technology as its software/Hardware tools are known and easily available.
- **Easily expandable:** It is easily expandable as new stations can be added to the open ports on the hub.
- **Cost effective:** Star topology networks are cost-effective as it uses inexpensive coaxial cable.

-

  High data speeds: It supports a bandwidth of approx 100 Mbps. **Ethernet 100BASE-T** is one of the most popular Star topology networks.

Disadvantages of Star topology - **A Central point of failure:** If the central hub or switch goes down, then all the connected nodes will not be able to communicate with each other.
- **Cable:** Sometimes cable routing becomes difficult when a significant amount of routing is required.

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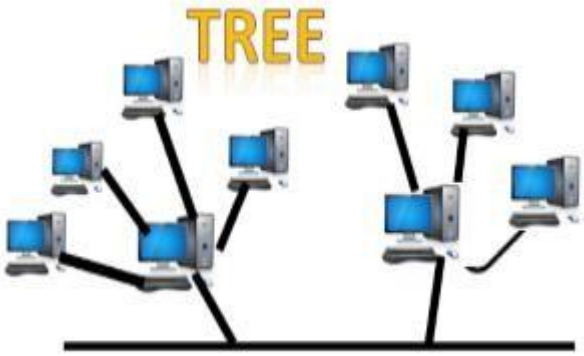
4) Tree topology



- Tree topology combines the characteristics of bus topology and star topology.
- A tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion.
- The top-most node in tree topology is known as a root node, and all other nodes are the descendants of the root node.
- There is only one path exists between two nodes for the data transmission. Thus, it forms a parent-child hierarchy.

Advantages of Tree topology - **Support for broadband transmission:** Tree topology is mainly used to provide broadband transmission, i.e., signals are sent over long distances without being attenuated.
- **Easily expandable:** We can add the new device to the existing network. Therefore, we can say that tree topology is easily expandable.

- **Easily manageable:** In tree topology, the whole network is divided into segments known as star networks which can be easily managed and maintained.
- **Error detection:** Error detection and error correction are very easy in a tree topology.
- **Limited failure:** The breakdown in one station does not affect the entire network.
- **Point-to-point wiring:** It has point-to-point wiring for individual segments.

Disadvantages of Tree topology
- **Difficult troubleshooting:** If any fault occurs in the node, then it becomes difficult to troubleshoot the problem.
- **High cost:** Devices required for broadband transmission are very costly.
- **Failure:** A tree topology mainly relies on main bus cable and failure in main bus cable will damage the overall network.
- **Reconfiguration difficult:** If new devices are added, then it becomes difficult to reconfigure.

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5) Mesh topology

- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- The Internet is an example of the mesh topology.

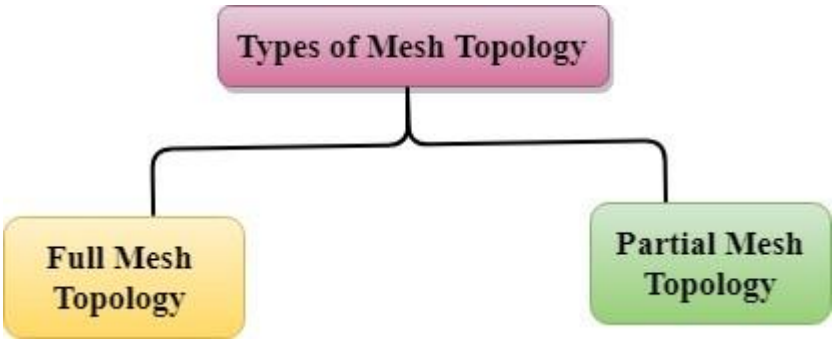
Mesh topology is mainly used for WAN implementations where communication failures are a critical concern.

- Mesh topology is mainly used for wireless networks.
- Mesh topology can be formed by using the formula:
  Number of cables = (n*(n-1))/2;

Where n is the number of nodes that represents the network.

Mesh topology is divided into two categories:

- Fully connected mesh topology
- Partially connected mesh topology



- **Full Mesh Topology:** In a full mesh topology, each computer is connected to all the computers available in the network.
- **Partial Mesh Topology:** In a partial mesh topology, not all but certain computers are connected to those computers with which they communicate frequently.

Advantages of Mesh topology:

Reliable: The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.

Fast Communication: Communication is very fast between the nodes.

Easier Reconfiguration: Adding new devices would not disrupt the communication between other devices.

Disadvantages of Mesh topology

- **Cost:** A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.

  Management: Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.

- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

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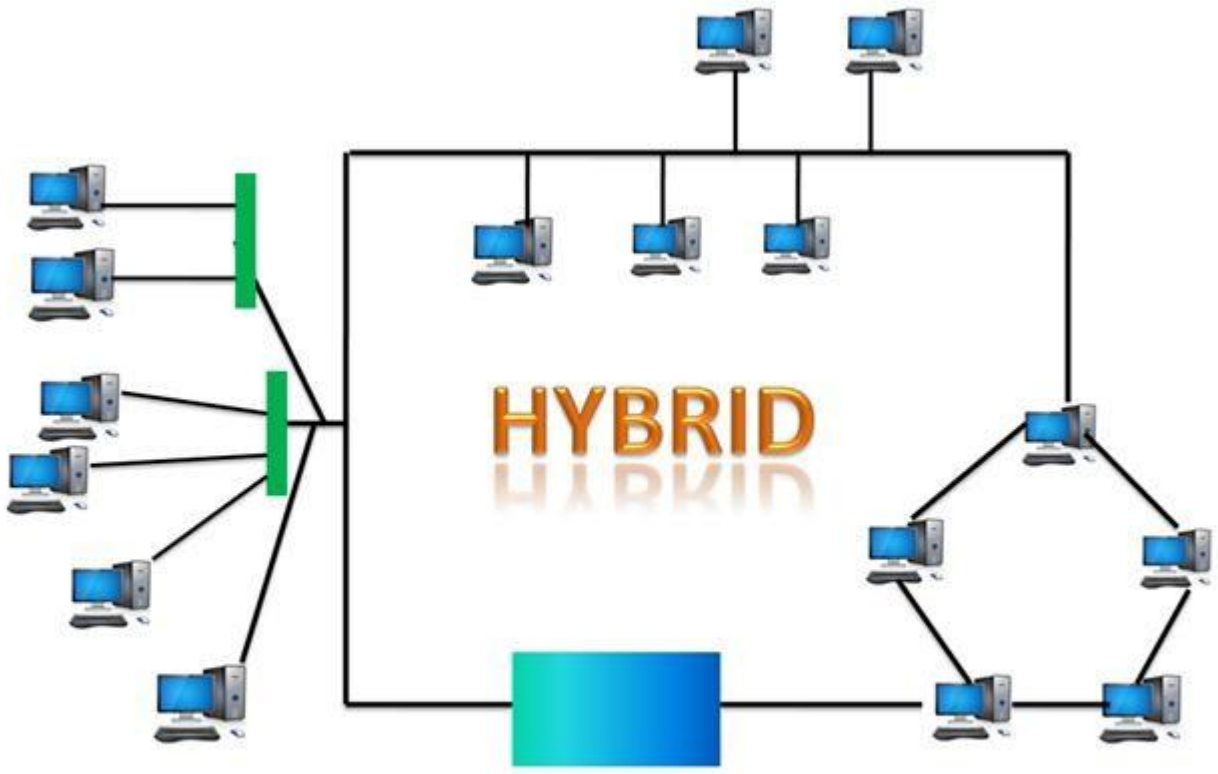
6) Hybrid Topology



- The combination of various different topologies is known as **Hybrid topology**.
- A Hybrid topology is a connection between different links and nodes to transfer the data.
  - When two or more different topologies are combined together is termed as Hybrid topology and if similar topologies are connected with each other will not result in Hybrid topology. For example, if there exist a ring topology in one branch of ICICI bank and bus

topology in another branch of ICICI bank, connecting these two topologies will result in Hybrid topology.

Advantages of Hybrid Topology ○ **Reliable:** If a fault occurs in any part of the network will not affect the functioning of the rest of the network.

- **Scalable:** Size of the network can be easily expanded by adding new devices without affecting the functionality of the existing network.
- **Flexible:** This topology is very flexible as it can be designed according to the requirements of the organization.
- **Effective:** Hybrid topology is very effective as it can be designed in such a way that the strength of the network is maximized and weakness of the network is minimized.

Disadvantages of Hybrid topology ○ **Complex design:** The major drawback of the Hybrid topology is the design of the Hybrid network. It is very difficult to design the architecture of the Hybrid network.

- **Costly Hub:** The Hubs used in the Hybrid topology are very expensive as these hubs are different from usual Hubs used in other topologies.
- **Costly infrastructure:** The infrastructure cost is very high as a hybrid network requires a lot of cabling, network devices, etc.

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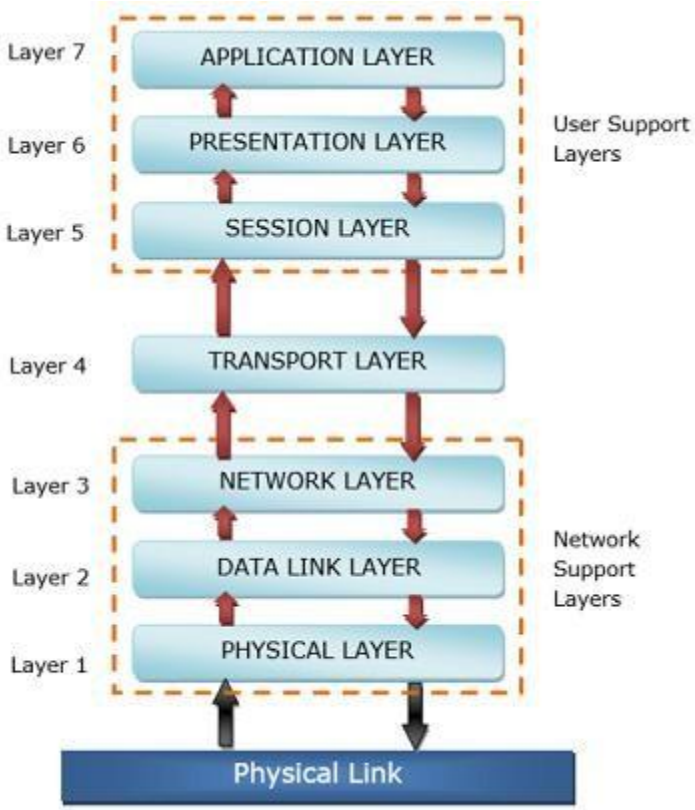
The OSI Reference Model:

OSI or Open System Interconnection model was developed by International Standards Organization (ISO). It gives a layered networking framework that conceptualizes how

communications should be done between heterogeneous systems. It has seven interconnected layers. The seven layers of the OSI Model are a physical layer, data link layer, network layer, transport layer, session layer, presentation layer, and application layer, as shown in the following diagram −



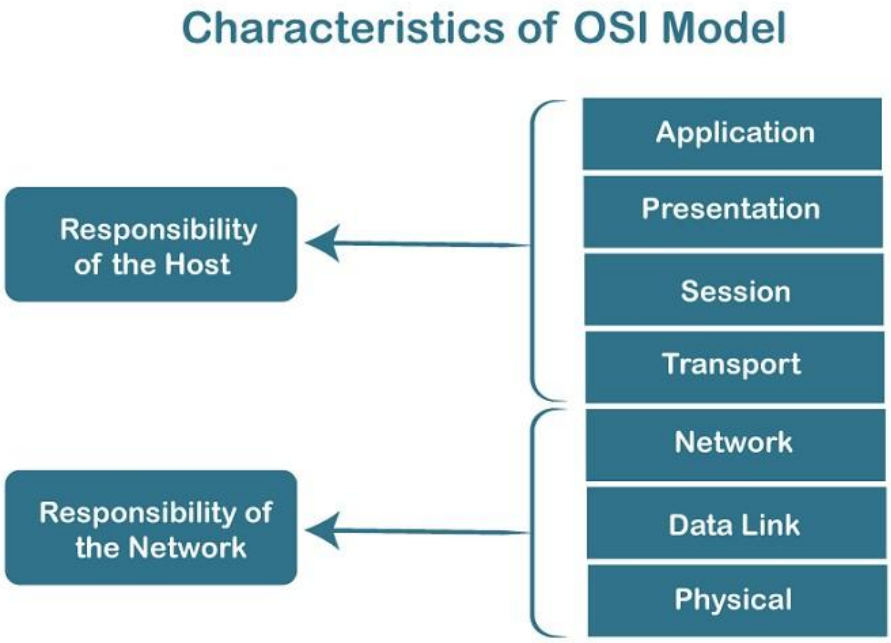
The physical layer, data link layer and the network layer are the network support layers. The layers manage a physical transfer of data from one device to another. Session layer, presentation layer, and application layer are the user support layers. These layers allow communication among unrelated software in dissimilar environments. Transport layer links the two groups.

The main functions of each of the layers are as follows −

- **Physical Layer** − Its function is to transmit individual bits from one node to another over a physical medium.
- **Data Link Layer** − It is responsible for the reliable transfer of data frames from one node to another connected by the physical layer.
- **Network Layer** − It manages the delivery of individual data packets from source to destination through appropriate addressing and routing.

- **Transport Layer** −It is responsible for delivery of the entire message from the source host to destination host.
- **Session Layer** − It establishes sessions between users and offers services like dialog control and synchronization.
- **Presentation Layer** − It monitors syntax and semantics of transmitted information through translation, compression, and encryption.
- **Application Layer** − It provides high-level APIs (application program interface) to the users.

Characteristics of OSI Model:

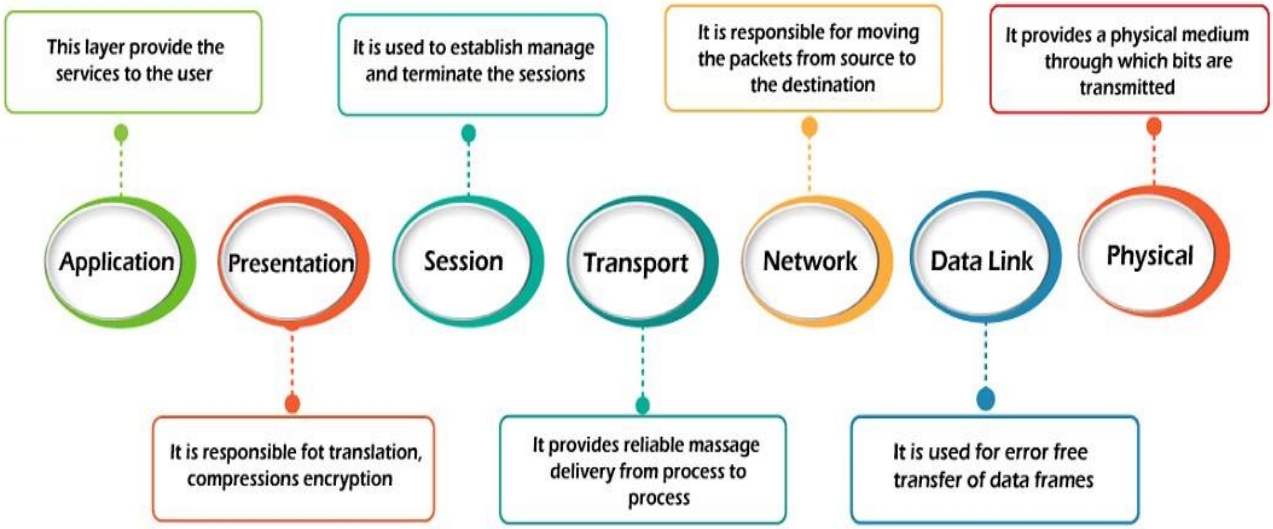


- The OSI model is divided into two layers: upper layers and lower layers. ○ The upper layer of the OSI model mainly deals with the application related issues, and they are implemented only in the software. The application layer is closest to the end user. Both the end user and the application layer interact with the software applications. An upper layer refers to the layer just above another layer.
- The lower layer of the OSI model deals with the data transport issues. The data link layer and the physical layer are implemented in hardware and software. The physical layer is the lowest layer of the OSI model and is closest to the physical medium. The physical layer is mainly responsible for placing the information on the physical medium.

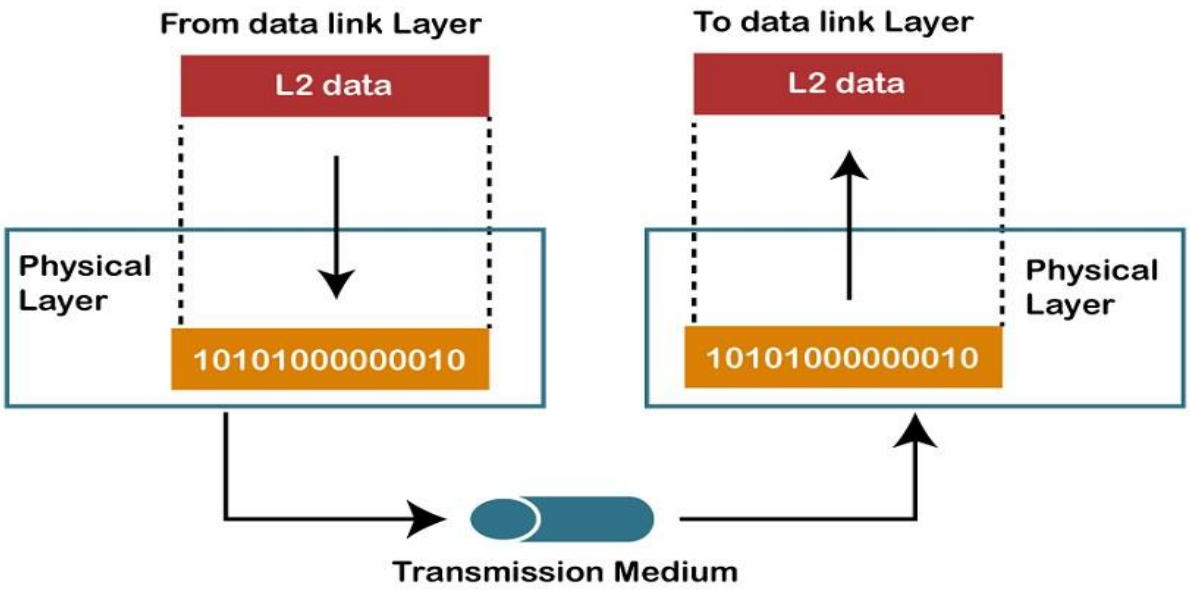
7 Layers of OSI Model

There are the seven OSI layers. Each layer has different functions. A list of seven layers are given below:

1. Physical Layer
2. Data-Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentation Layer
7. Application Layer



1) Physical layer

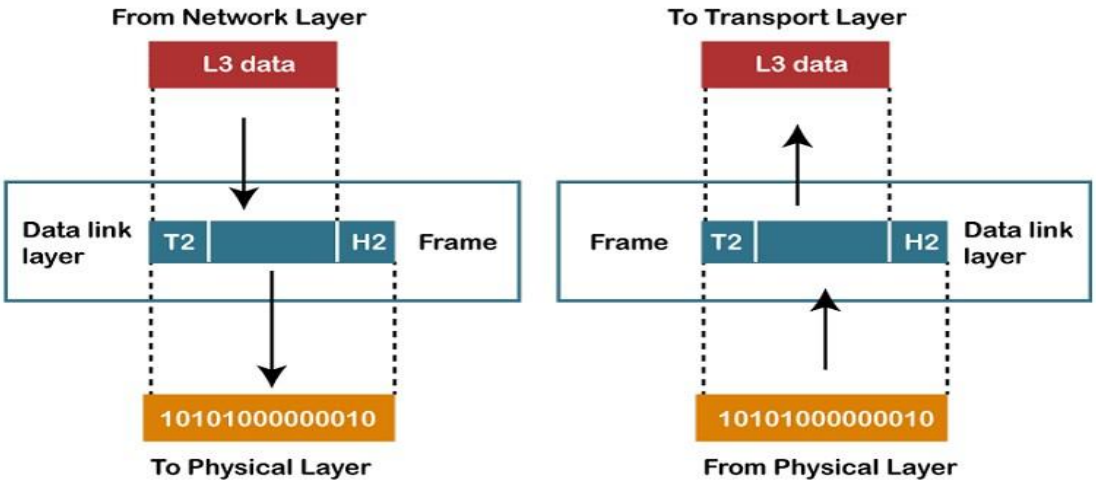


- The main functionality of the physical layer is to transmit the individual bits from one node to another node.
- It is the lowest layer of the OSI model. ○ It establishes, maintains and deactivates the physical connection. ○ It specifies the mechanical, electrical and procedural network interface specifications.

Functions of a Physical layer:

- **Line Configuration:** It defines the way how two or more devices can be connected physically.
- **Data Transmission:** It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network. ○ **Topology:** It defines the way how network devices are arranged. ○ **Signals:** It determines the type of the signal used for transmitting the information.

2) Data-Link Layer



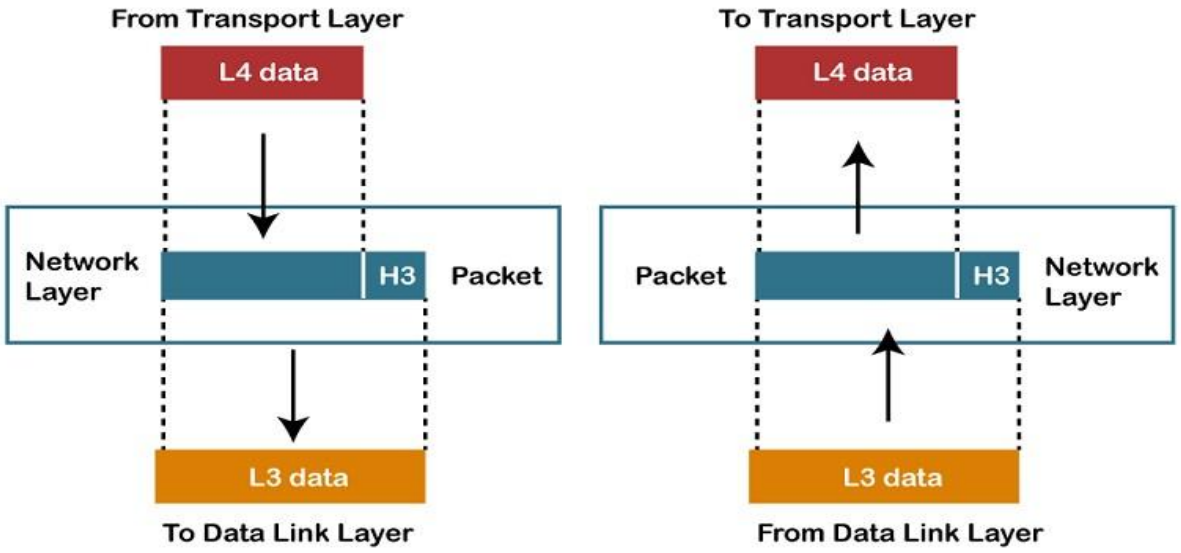
- This layer is responsible for the error-free transfer of data frames. ○ It defines the format of the data on the network.
- It provides a reliable and efficient communication between two or more devices. ○ It is mainly responsible for the unique identification of each device that resides on a local network.
- It contains two sub-layers:
- **Logical Link Control Layer** ○ It is responsible for transferring the packets to the Network layer of the receiver that is receiving. ○ It identifies the address of the network layer protocol from the header.
- It also provides flow control.
- **Media Access Control Layer** ○ A Media access control layer is a link between the Logical Link Control layer and the network's physical layer.
- It is used for transferring the packets over the network.

Functions of the Data-link layer

- **Framing:** The data link layer translates the physical's raw bit stream into packets known as Frames. The Data link layer adds the header and trailer to the frame. The header which is added to the frame contains the hardware destination and source address.

- **Physical Addressing:** The Data link layer adds a header to the frame that contains a destination address. The frame is transmitted to the destination address mentioned in the header.
- **Flow Control:** Flow control is the main functionality of the Data-link layer. It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted. It ensures that the transmitting station such as a server with higher processing speed does not exceed the receiving station, with lower processing speed.
- **Error Control:** Error control is achieved by adding a calculated value CRC (Cyclic Redundancy Check) that is placed to the Data link layer's trailer which is added to the message frame before it is sent to the physical layer. If any error seems to occurr, then the receiver sends the acknowledgment for the retransmission of the corrupted frames.
- **Access Control:** When two or more devices are connected to the same communication channel, then the data link layer protocols are used to determine which device has control over the link at a given time.

3) Network Layer



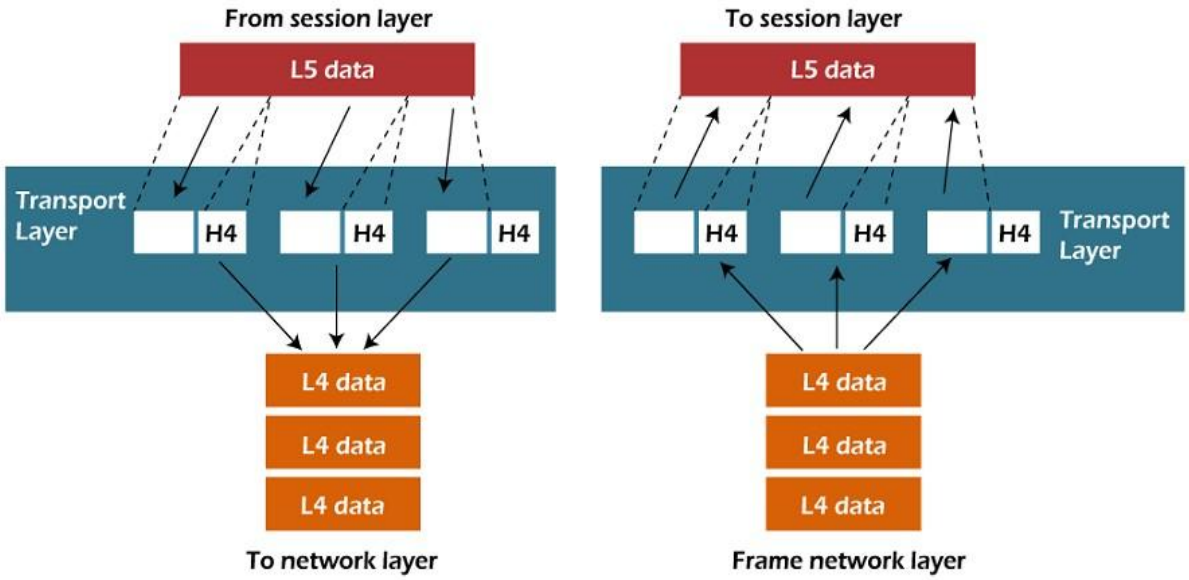
- It is a layer 3 that manages device addressing, tracks the location of devices on the network.
- It determines the best path to move data from source to the destination based on the network conditions, the priority of service, and other factors.
- The Data link layer is responsible for routing and forwarding the packets.
- Routers are the layer 3 devices, they are specified in this layer and used to provide the routing services within an internetwork. ○ The protocols used to route the network traffic are known as Network layer protocols.

Examples of protocols are IP and Ipv6.

Functions of Network Layer:

- **Internetworking:** An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.
- **Addressing:** A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.
- **Routing:** Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination.
- **Packetizing:** A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).

4) Transport Layer



- The Transport layer is a Layer 4 ensures that messages are transmitted in the order in which they are sent and there is no duplication of data.
- The main responsibility of the transport layer is to transfer the data completely. ○ It receives the data from the upper layer and converts them into smaller units known as segments.
- This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably.

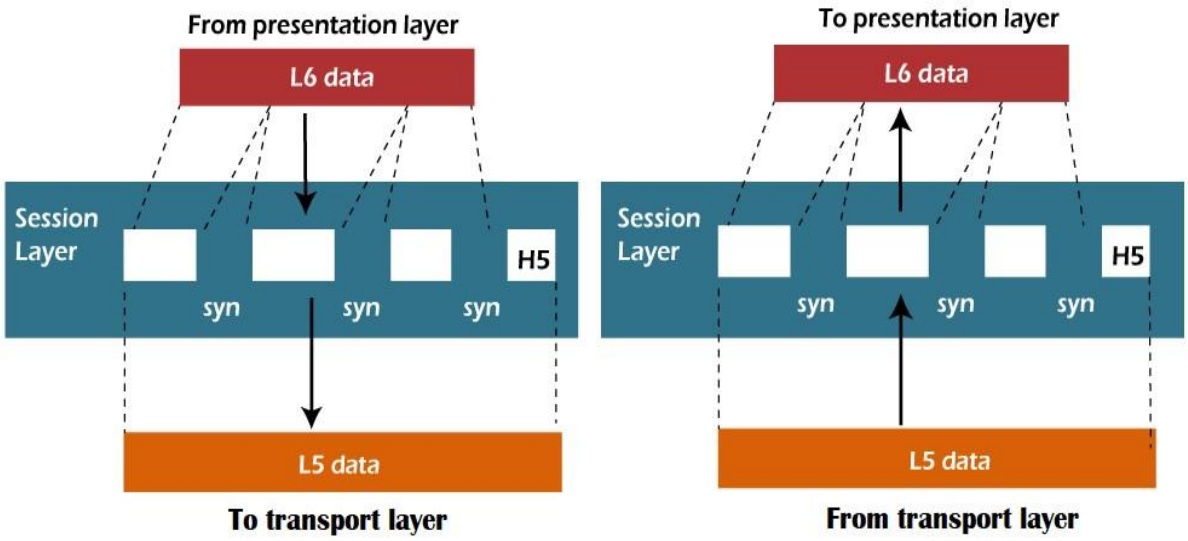
The two protocols used in this layer are:

- **Transmission Control Protocol** ○ It is a standard protocol that allows the systems to communicate over the internet. ○ It establishes and maintains a connection between hosts.
- When data is sent over the TCP connection, then the TCP protocol divides the data into smaller units known as segments. Each segment travels over the internet using multiple routes, and they arrive in different orders at the destination. The transmission control protocol reorders the packets in the correct order at the receiving end. ○ **User Datagram Protocol** ○ User Datagram Protocol is a transport layer protocol. ○ It is an unreliable transport protocol as in this case receiver does not send any acknowledgment when the packet is received, the sender does not wait for any acknowledgment. Therefore, this makes a protocol unreliable.

Functions of Transport Layer:

- **Service-point addressing:** Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one computer to another computer but also from one process to another process. The transport layer adds the header that contains the address known as a service-point address or port address. The responsibility of the network layer is to transmit the data from one computer to another computer and the responsibility of the transport layer is to transmit the message to the correct process.
- **Segmentation and reassembly:** When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment. When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.
- **Connection control:** Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination. A connectionoriented service makes a connection with the transport layer at the destination machine before delivering the packets. In connection-oriented service, all the packets travel in the single route.
- **Flow control:** The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.
- **Error control:** The transport layer is also responsible for Error control. Error control is performed end-to-end rather than across the single link. The sender transport layer ensures that message reach at the destination without any error.

5) Session Layer

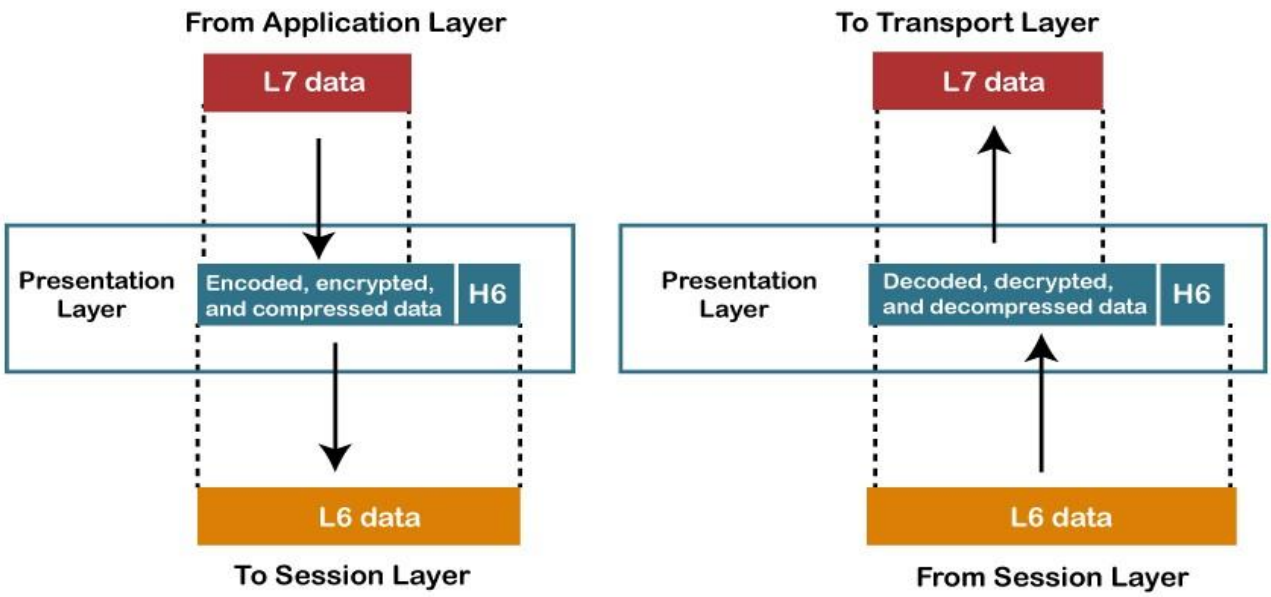


- It is a layer 3 in the OSI model. ○ The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

Functions of Session layer:

- **Dialog control:** Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.
- **Synchronization:** Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

6) Presentation Layer

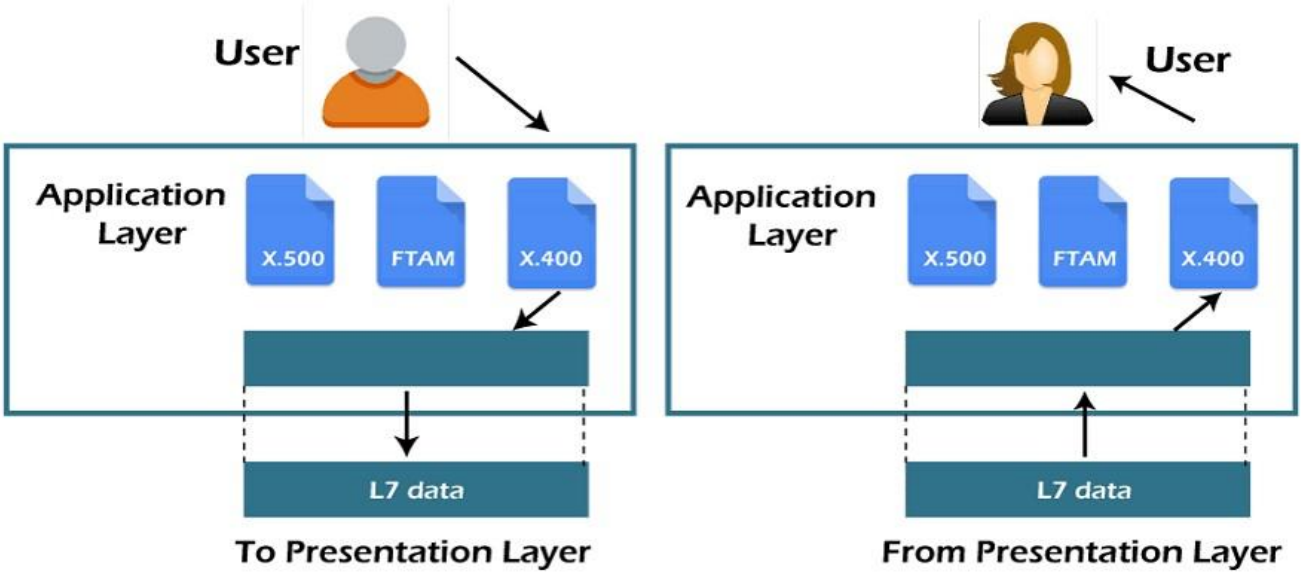


- A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- It acts as a data translator for a network.
- This layer is a part of the operating system that converts the data from one presentation format to another format.
- The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

- **Translation:** The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.
- **Encryption:** Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.
- **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

7) Application Layer



- An application layer serves as a window for users and application processes to access network service.
- It handles issues such as network transparency, resource allocation, etc. ○ An application layer is not an application, but it performs the application layer functions. ○ This layer provides the network services to the end-users.

Functions of Application layer:

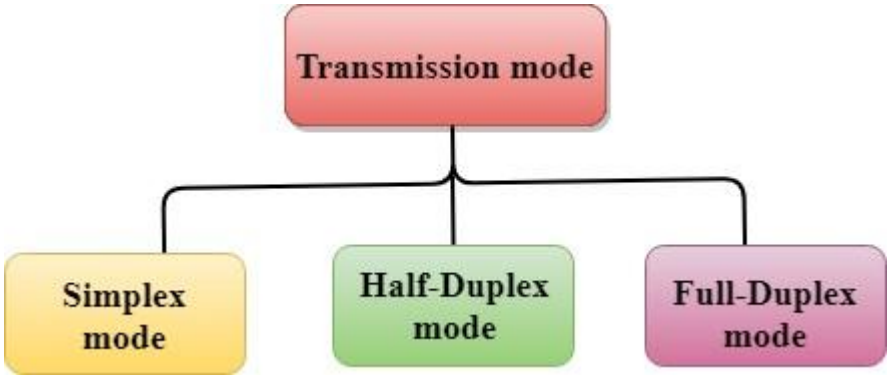
- **File transfer, access, and management (FTAM):** An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.
- **Mail services:** An application layer provides the facility for email forwarding and storage.
- Directory services: An application provides the distributed database sources and is used ○ to provide that global information about various objects.

Transmission modes

- The way in which data is transmitted from one device to another device is known as **transmission mode**.

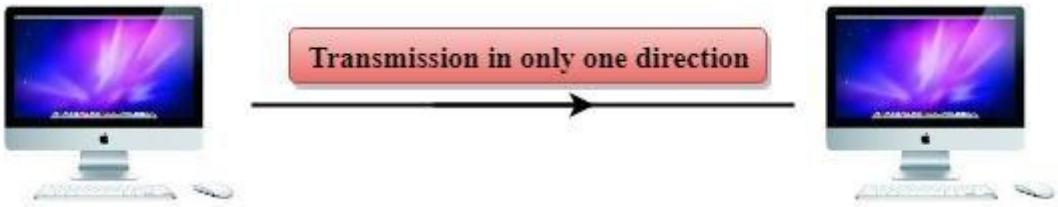
- The transmission mode is also known as the communication mode. ○ Each communication channel has a direction associated with it, and transmission media provide the direction. Therefore, the transmission mode is also known as a directional mode. ○ The transmission mode is defined in the physical layer.

The Transmission mode is divided into three categories:



- Simplex mode ○ Half-duplex mode ○ Full-duplex mode

Simplex mode



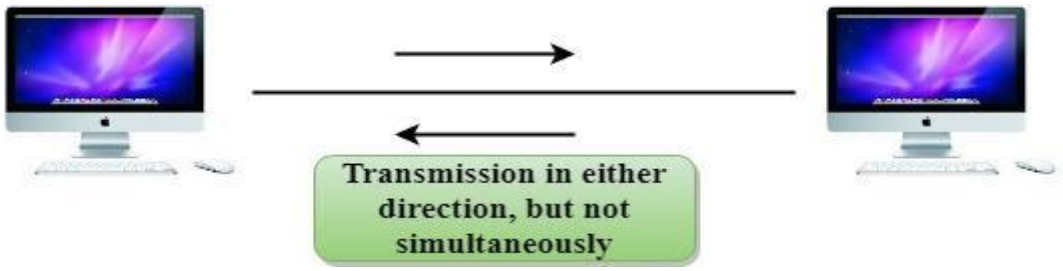
- In Simplex mode, the communication is unidirectional, i.e., the data flow in one direction.
- A device can only send the data but cannot receive it or it can receive the data but cannot send the data.
- This transmission mode is not very popular as mainly communications require the twoway exchange of data. The simplex mode is used in the business field as in sales that do not require any corresponding reply.
- The radio station is a simplex channel as it transmits the signal to the listeners but never allows them to transmit back. ○ Keyboard and Monitor are the examples of the simplex mode as a keyboard can only accept the data from the user and monitor can only be used to display the data on the screen.
- The main advantage of the simplex mode is that the full capacity of the communication channel can be utilized during transmission.

Advantage of Simplex mode: ○ In simplex mode, the station can utilize the entire bandwidth of the communication channel, so that more data can be transmitted at a time.

Disadvantage of Simplex mode:

- Communication is unidirectional, so it has no inter-communication between devices.

Half-Duplex mode



- In a Half-duplex channel, direction can be reversed, i.e., the station can transmit and receive the data as well.
- Messages flow in both the directions, but not at the same time.
- The entire bandwidth of the communication channel is utilized in one direction at a time.
- In half-duplex mode, it is possible to perform the error detection, and if any error occurs, then the receiver requests the sender to retransmit the data.
- A **Walkie-talkie** is an example of the Half-duplex mode. In Walkie-talkie, one party speaks, and another party listens. After a pause, the other speaks and first party listens.
  Speaking simultaneously will create the distorted sound which cannot be understood.

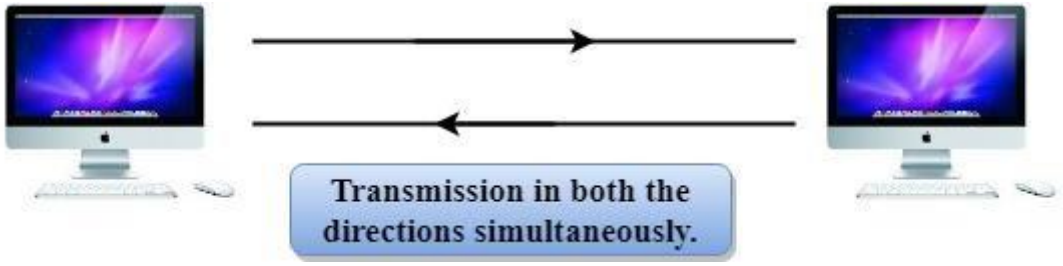
Advantage of Half-duplex mode:

- In half-duplex mode, both the devices can send and receive the data and also can utilize the entire bandwidth of the communication channel during the transmission of data.

Disadvantage of Half-Duplex mode:

- In half-duplex mode, when one device is sending the data, then another has to wait, this causes the delay in sending the data at the right time.

Full-duplex mode



- In Full duplex mode, the communication is bi-directional, i.e., the data flow in both the directions.
- Both the stations can send and receive the message simultaneously.
- Full-duplex mode has two simplex channels. One channel has traffic moving in one direction, and another channel has traffic flowing in the opposite direction. ○ The Full-duplex mode is the fastest mode of communication between devices.
- The most common example of the full-duplex mode is a telephone network. When two people are communicating with each other by a telephone line, both can talk and listen at the same time.

Advantage of Full-duplex mode: ○ Both the stations can send and receive the data at the same time.

Disadvantage of Full-duplex mode: ○ If there is no dedicated path exists between the devices, then the capacity of the communication channel is divided into two parts.

Differences b/w Simplex, Half-duplex and Full-duplex mode

Basis for comparison	Simplex mode	Half-duplex mode	Full-duplex mode

Direction of communication	In simplex mode, the communication is unidirectional.	In half-duplex mode, the communication is bidirectional, but one at a time.	In full-duplex mode, the communication is bidirectional.
Send/Receive	A device can only send the data but cannot receive it or it can only receive the data but cannot send it.	Both the devices can send and receive the data, but one at a time.	Both the devices can send and receive the data simultaneously.
Performance	The performance of halfduplex mode is better than the simplex mode.	The performance of fullduplex mode is better than the half-duplex mode.	The Full-duplex mode has better performance among simplex and half-duplex mode as it doubles the utilization of the capacity of the communication channel.
Example	Examples of Simplex mode are radio, keyboard, and monitor.	Example of half-duplex is Walkie-Talkies.	Example of the Full-duplex mode is a telephone network.

12. Result Analysis

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Dahegaon, Kalmeshwar Road, Nagpur – 441501. Phone No. 07118-661400

Department of Computer Science Engineering Session 2022-23 (Summer-2023)

Result Analysis
Semester – 4TH sem (CBCS)

Sr. No.	Student Name	DMG	DSPD	DMS	C/N	T/C	S/P	Result Pass/Fail	No. of Subjects failed in	Total Marks Obtained out of (800)	%Score
1	ARPITA MUKUNDRAJ KHAWASE	56	54	34	61	49	50	FAIL	1	480	60.00%
2	RIYA SHASHIKANT BANG	74	75	64	67	55	63	PASS	0	575	71.88%
3	HARSHA JITENDRA BHIMTE	53	56	56	54	53	69	PASS	0	522	65.25%
4	BIPASHA NILAMKUMAR RANGARI	55	50	55	49	41	54	FAIL	1	488	61.00%
5	BIPASHA SHAILESH YADAV	75	51	64	66	63	60	PASS	0	558	69.75%

6	LEENA PRAMOD BOBDE	51	57	58	61	53	58	PASS	0	517	64.63%
7	PRIYANKA SURESH CHAVHAN	47	52	68	56	49	61	PASS	0	508	63.50%
8	KHUSHI ARVIND DAMAHE	70	79	71	55	61	72	PASS	0	587	73.38%
9	PRAJKTA NAMDEVRAO DEOSARKAR	77	60	56	53	58	52	PASS	0	540	67.50%
10	JASLEEN KAUR RAKHBIR SINGH DHILLON	80	71	81	75	65	75	PASS	0	626	78.25%
11	DIVYA ANIL BHAGAT	38	50	54	46	48	40	FAIL	2	452	56.50%
12	KHUSHI MAHENDRA FISKE	85	78	61	63	69	75	PASS	0	611	76.38%
13	HITESHI BHAURAO HARODE	82	76	61	52	68	53	PASS	0	572	71.50%
14	SNEHA KACHARU JAGTAP	39	37	33	29	35	40	FAIL	6	387	48.38%
15	JAYASHRI GAJANAN GAJABE	36	37	33	45	35	39	FAIL	5	405	50.63%
16	MADHURI BANDU KAMBLE	46	42	47	35	36	49	FAIL	3	429	53.63%
17	TRUSHNA RAMDAS KAWARE	68	71	68	73	66	60	PASS	0	590	73.75%
18	DIXIKA GAUTAM KOTHARE	62	64	69	53	51	54	PASS	0	532	66.50%
19	MOHINI PANJAB RAJGURU	34	34	69	42	46	66	FAIL	3	471	58.88%
20	KHUSHI SAMEER MUKHARE	68	76	62	63	64	63	PASS	0	476	59.50%
21	POOJA MAHESH SAKHARE	49	41	34	35	48	48	FAIL	3	434	54.25%
22	SAMIKSHA VIJAY PURAMSHETTIWAR	53	42	50	49	36	47	FAIL	2	453	56.63%

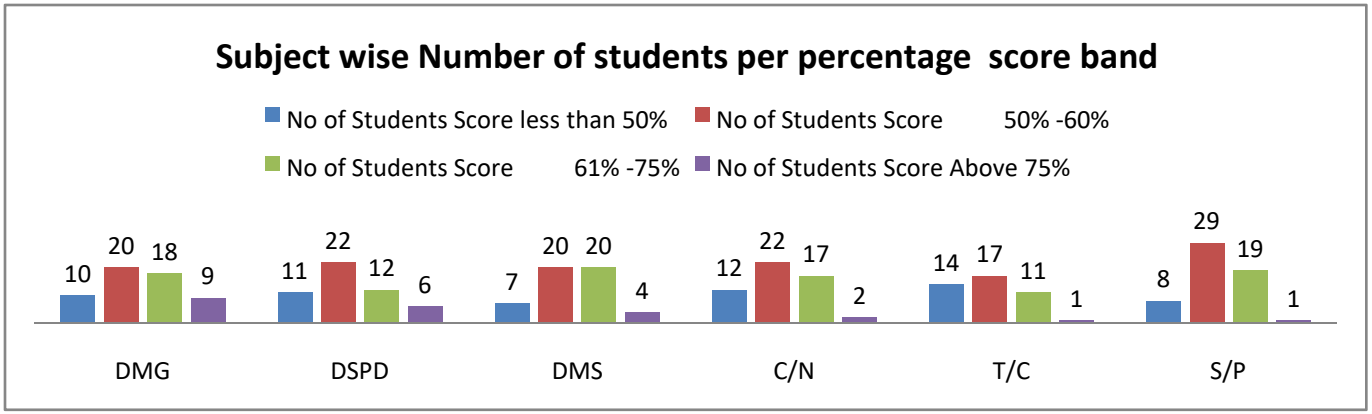
23	RAJANI HAUSILAL PATLE	45	42	53	46	51	58	FAIL	1	470	58.75%
24	SAKSHI JAYWANT NALKANDE	50	41	54	60	58	61	FAIL	1	513	64.13%
25	NAJIYA ABDUL KALAM SHEIKH	65	65	69	53	48	52	PASS	0	532	66.50%
26	SONAL DNYANESHWAR GURVE	67	72	69	62	60	65	PASS	0	571	71.38%
27	RAVISHI RAJENDRA TEMBHARE	55	55	48	41	48	53	FAIL	1	481	60.13%
28	JANHAVI DILIP THAKARE	55	45	48	36	32	37	FAIL	3	431	53.88%
29	PRERNA RAJESH USARE	36	52	46	42	39	47	FAIL	3	438	54.75%
30	VAISHNAVI RAJESH CHUTE	51	47	55	42	47	42	FAIL	2	470	58.75%
31	DIPALI GAJANAN WAGH	78	68	73	72	77	76	PASS	0	629	78.63%
32	RAJJU RAMRATAN WANVE	52	60	57	51	44	59	FAIL	1	503	62.88%
33	ABHISHEK DNYANOBA NAVALE	52	47	31	69	32	53	FAIL	2	460	57.50%
34	ANGADH KESHAVRAO DHOLE	51	50	41	54	35	48	FAIL	2	455	56.88%
35	AYUSH KHEMRAJ RAMTEKE	36	45	53	48	41	49	FAIL	2	446	55.75%
36	AYUSH RAJENDRA MHAISNE	50	49	35	43	31	36	FAIL	4	420	52.50%
37	PRAJWAL ARVIND BAWANKAR	72	66	55	69	70	59	PASS	0	576	72.00%
38	PRATHMESH SHYAM BHINGARE	65	50	48	55	34	35	FAIL	2	467	58.38%
39	AMAN PRAKASH BORKAR	68	48	39	49	47	51	FAIL	1	429	53.63%

40	MAYUR VIJAY CHOPADE	28	45	50	47	39	50	FAIL	2	431	53.88%
41	SHREERAM GAJANAN DAD	54	52	63	43	41	58	FAIL	2	487	60.88%
42	SHRIKANT JUGALKISHOR DAD	47	40	54	65	42	65	FAIL	2	489	61.13%
43	SURAJ DILIP DHOTE	47	41	42	38	36	41	FAIL	5	415	51.88%
44	PRAJWAL CHAITRAM FULZELE	55	53	59	59	45	56	PASS	0	506	63.25%
45	VIVEK BHAURAJ GAUTAM	53	37	62	36	30	53	FAIL	3	447	55.88%
46	SATISH PANCHAM GHARDE	29	36	51	56	46	49	FAIL	2	444	55.50%
47	KANHAIYA MADHUKARRAO GORE	48	40	34	40	41	52	FAIL	4	435	54.38%
48	ROHIT NATTHUJI KHARPURIYE	42	26	29	31	32	26	FAIL	6	356	44.50%
49	TANAY RAVINDRA KSHIRSAGAR	68	51	67	65	56	61	PASS	0	548	68.50%
50	KUSH VIJAY SAHU	84	79	80	67	61	64	PASS	0	619	77.38%
51	YASHWANT ANKUSH LOHANDE	64	49	60	56	48	52	PASS	0	508	63.50%
52	SURAJ VINOD MATE	63	67	51	60	59	62	PASS	0	541	67.63%
53	TEJASKUMAR NITIN POHARE	31	38	31	36	30	36	FAIL	6	372	46.50%
54	ARVIND PRAJWAL RAUT	46	39	38	38	51	52	FAIL	3	443	55.38%
55	PRAJWAL NARESH RAUT	41	48	43	56	40	44	FAIL	4	451	56.38%
56	PRATHAM SUDAM WASNIK	65	48	38	53	38	47	FAIL	2	465	58.13%

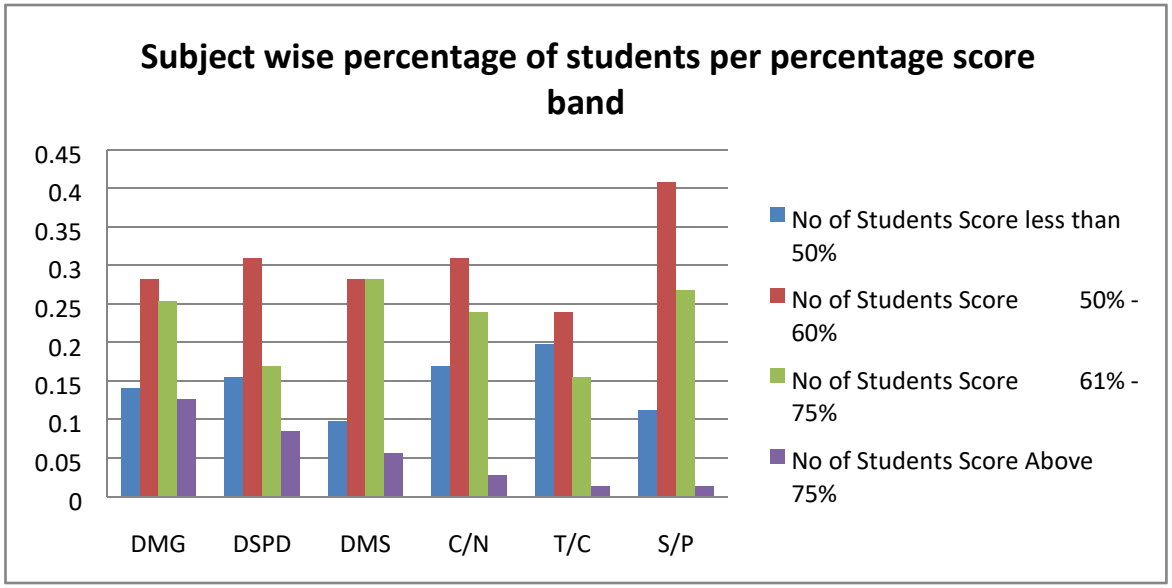
57	SAIFUDDIN ABID QUERESHI	56	43	37	45	35	39	FAIL	4	429	53.63%
58	SHREYASH YASHWANT RAMBHAD	28	27	33	30	34	27	FAIL	6	349	43.63%
59	ABHISHEK ANIL RANGARI	32	29	37	28	34	29	FAIL	6	363	45.38%
60	ASHISH HARICHAND RATHOD	86	76	78	78	63	73	PASS	0	635	79.38%
61	LOKESH KHUSHAL SABLE	50	47	54	48	58	59	PASS	0	490	61.25%
62	BHAVESH SAMPAT SAHU	54	53	45	49	58	61	PASS	0	500	62.50%
63	LOVE VIJAY SAHU	70	54	54	60	55	55	PASS	0	525	65.63%
64	ARYAN ARVIND SAMBHE	55	55	49	59	33	54	FAIL	1	482	60.25%
65	HARSH SANJEEV SHARMA	74	53	40	50	52	57	FAIL	1	511	63.88%
66	OM VIJAY UTTARWAR	45	43	64	50	35	52	FAIL	2	473	59.13%
67	VAIBHAV LAHANU MOHOD	44	56	44	49	45	51	FAIL	2	465	58.13%
68	VRUSHABH VISHWAS VIRKAR	95	67	86	81	54	73	PASS	0	635	79.38%
69	AMIT ABHAY WALEKAR	49	53	61	59	48	54	PASS	0	500	62.50%
70	RITESH SUNILWANKHEDE	70	75	67	64	57	69	PASS	0	583	72.88%
71	ABHISHEK SUNIL WASHIMKAR	87	69	73	71	71	73	PASS	0	633	79.13%
71											
	No. of students due appeared	71	71	71	71	71	71	71			

	No. od students Passed	57	51	51	53	43	57	23		
	No. od students Failed	14	20	20	18	28	14	48		
	Result %	80.3%	71.8%	71.8%	74.6%	60.6%	80.3%	32.39%		
1st	ASHISH HARICHAND RATHOD	86	76	78	78	63	73	PASS	635	79.38%
	VRUSHABH VISHWAS VIRKAR	95	67	86	81	54	73	PASS	635	79.38%
2nd	ABHISHEK SUNIL WASHIMKAR	87	69	73	71	71	73	PASS	633	79.13%
3rd	DIPALI GAJANAN WAGH	78	68	73	72	77	76	PASS	629	78.63%

	DMG	**DSPD**	**DMS**	**C/N**	**T/C**	**S/P**
No of Students Score less than 50%	10	11	7	12	14	8
No of Students Score 50% -60%	20	22	20	22	17	29
No of Students Score 61% -75%	18	12	20	17	11	19
No of Students Score Above 75%	9	6	4	2	1	1



	DMG	DSPD	DMS	C/N	T/C	S/P
No of Students Score less than 50%	14.08%	15.49%	9.86%	16.90%	19.72%	11.27%
No of Students Score 50% -60%	28.17%	30.99%	28.17%	30.99%	23.94%	40.85%
No of Students Score 61% -75%	25.35%	16.90%	28.17%	23.94%	15.49%	26.76%
No of Students Score Above 75%	12.68%	8.45%	5.63%	2.82%	1.41%	1.41%



Criteria	DMG	DSPD	DMS	C/N	T/C	S/P
No of student failed by 1 Mark	1	0	1	0	1	1
No of student failed by 2 Mark	0	2	1	2	0	0
No of student failed by 3 Mark	1	3	1	3	1	1
No of student failed by 4 Mark	1	3	1	1	4	1
No of student failed by 5 Mark	0	2	1	1	1	2

13. Advance Topics

NETWORK VIRTUALIZATION

Unit Structure

5.0 OBJECTIVES:

This is an introductory tutorial, which covers the basics of Virtualization and explains how to deal with its various components and sub-components.

Introduction:

Virtualization is utilization of computer resources which is not in used 100%.

Virtualization is technology that allows you to create multiple simulated environments or dedicated resources from a single, physical hardware system. Software called a hypervisor connects directly to that hardware and allows you to split 1 system into separate, distinct, and secure environments known as virtual machines (VMs).

Virtualization is technology that lets you create useful IT services using resources that are traditionally bound to hardware. It allows you to use a physical machine's full capacity by distributing its capabilities among many users or environments.

5.2 AN OVERVIEW:

Virtualization is a technology that helps users to install different Operating Systems on a hardware. They are completely separated and independent from each other.

5.3 NEED FOR VIRTUALIZATION

Sometimes it's necessary to make a virtual machine of any operating system like (Linux or windows) into an existing and running base operating system on a standalone hardware. Creation of VMs may differ as per need and requirements.

The most important function of virtualization is the capability of running multiple operating systems and applications on a single computer or server. This means increased productivity achieved by fewer servers.

Following figure (i) illustrate the need of the virtualization.

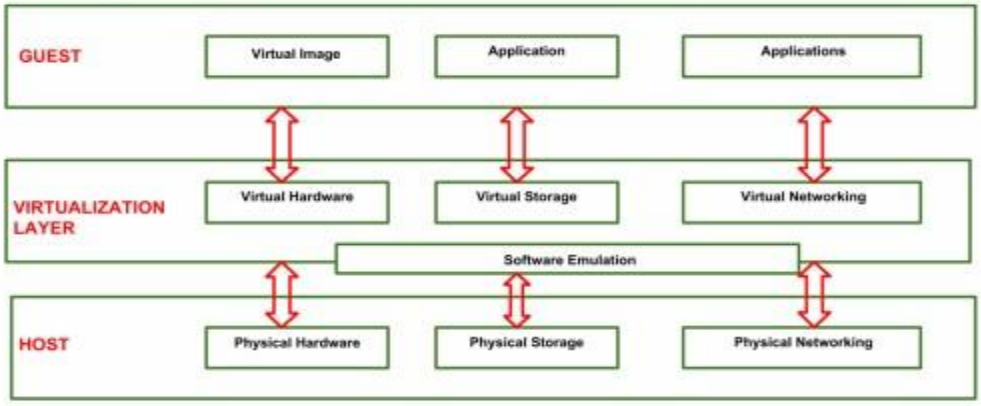


Fig (1-1)

The virtual Enterprise

"A **virtual enterprise is** a temporary alliance of **enterprises** that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose cooperation **is** supported by computer networks. "

Many business functions of your organization can be outsourced. What traditionally were considered core functions are no longer a sacred territory and are available for outsourcing. The difference in cost and efficiency between an "on demand" or pay per usage outsourced service and an on-premises and self-manned typical function could be significant and hard to ignore.

This presents a problem requiring a solution for an Enterprise that outsources most or all its business functions but retains governance for planning, coordinating operations, budgeting, and making all key decisions. In a Wikipedia definition, "a virtual organization is a firm that outsources the majority of its functions." The Virtual Enterprise (VE) can be successful, assuming it employs best of breed outsourced services in a "virtual" Value Chain implementation consisting of company and partner links.

A VE operates over a virtual Value Chain, i.e., a chain whose links are owned by a company and its partners, blurring the borders between the Value Chain of the firm and the Value Network it is a part of.

The Governance is the business function that defines and identifies the Virtual Enterprise, since most or all other functions of the Enterprise (primary and secondary in Porter's definition) could be outsourced.

The VE is defined by a new operating model promoting collaboration and B2B to take advantage of best of breed applications on the market. This VE business model is increasingly achievable by the adoption of business process outsourcing (BPO), application outsourcing – Software as a Service (SaaS) – and, in general, by the fast adoption of infrastructure virtualization technologies, Web Services, SOA, and collaborative technologies of the Web2.0.

The "Virtual" Enterprise could be the darling of the entrepreneurial world, specializing in management and governance skills while outsourcing most of the Functions of the Enterprise today.

Transport Virtualization-VNs

The authors of Network Virtualization define the technical requirements posed by the need to virtualize the network. Based on these requirements, they propose an architectural framework comprised of the functional areas necessary to successfully support concurrent virtual networks (VNs) over a shared enterprise physical network.

When segmenting the network pervasively, all the scalability, resiliency, and security functionality present in a non-segmented network must be preserved and in many cases improved. As the number of groups sharing a network increases, the network devices must handle a much higher number of routes. Any technologies used to achieve virtualization must therefore provide the necessary mechanisms to preserve resiliency, enhance scalability, and improve security.

Central Services Access: Virtual Network Perimeter

The default state of a VN is to be totally isolated from other VNs. In this respect, VNs could be seen as physically separate networks. However, because VNs actually belong to a common physical network, it is desirable for these VNs to share certain services such as Internet access, management stations, DHCP services, *Domain Name System* (DNS) services, or server farms. These services will usually be located outside of the different VNs or in a VN of their own. So, it is necessary for these VNs to have a gateway to connect to the "outside world." The outside world is basically any network outside the VN such as the Internet or other VNs. Because this is the perimeter of the VN, it is also desirable for this perimeter to be protected by security devices such as firewalls and *intrusion detection systems* (IDSs). Typically, the perimeter is deployed at a common physical location for most VNs. Hence, this location is known

as the central services site, and the security devices here deployed can be shared by many VNs.

The creation of VNs could be seen as the creation of security zones, each of which has a unique and controlled entry/exit point at the VN perimeter. Routing within the VNs should be configured so that traffic is steered to the common services site as required. Figure illustrates a typical perimeter deployment for multiple VNs accessing common services. Because the services accessed through the VN perimeter are protected by firewalls, we refer to these as "protected services.

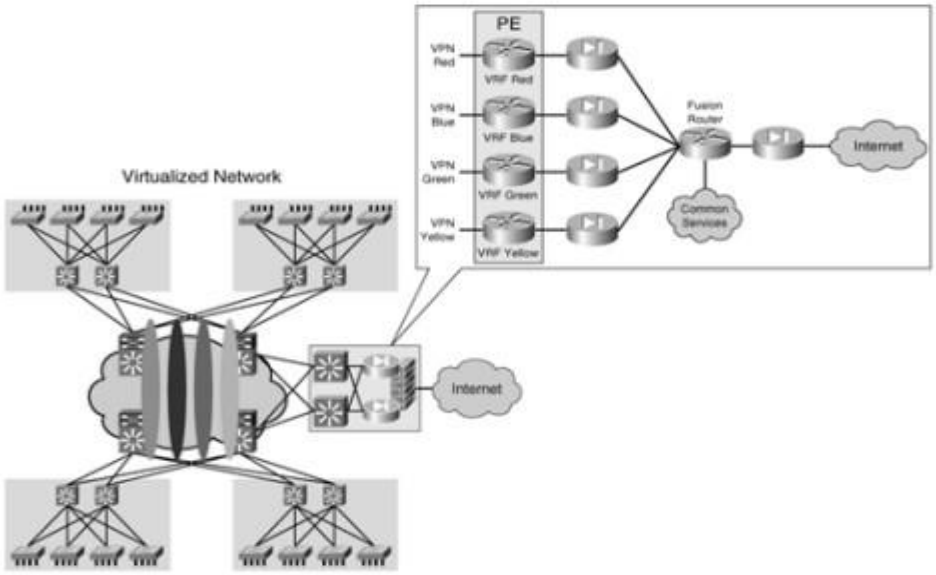


fig-(1-2)

As shown in above Figure, each VN is head ended by a dedicated firewall. This allows the creation of security policies specific to each VN and independent from each other. To access the shared services, all firewalls are connected to a "fusion" router. The fusion router can provide the VNs with connectivity to the common services, the Internet, or even inter-VN connectivity. The presence of this fusion router should raise two main concerns:

- The potential for traffic leaking between VNs
- The risk of routes from one VN being announced to another VN

The presence of dedicated per-VN firewalls prevents the leaking of traffic between VNs through the fusion router by only allowing established connections (connections initiated from "inside" the firewall) to return through the VN perimeter. It is key to configure the routing on the fusion device so that routes from one VN are not advertised to another through the fusion router. The details of the routing configuration at the central site are discussed in Chapter 8, "Traffic Steering and Service Centralization."

Figure shows an additional firewall separating the fusion area from the Internet. This firewall is optional. Whether to use it or not depends on the need to keep common services or transit traffic in the fusion area protected from the Internet.

A Virtualization Technologies primer: theory

- **Devices**—How is traffic separation maintained internally to a device? What are the primitives used for Layer 2, Layer 3, or Layer 4 traffic?
- **Data path**—How is traffic separation enforced across a network path? What tools are available to maintain the separation across a network?
- **Control plane**—Because data-path virtualization essentially builds an overlay topology, what changes are needed for routing protocols to function correctly?

5.4 NETWORK DEVICE VIRTUALIZATION

Network Virtualization (NV) refers to abstracting network resources that were traditionally delivered in hardware to software. NV can combine multiple physical networks to one virtual, software-based network, or it can divide one physical network into separate, independent virtual networks.

Network virtualization software allows network administrators to move virtual machines across different domains without reconfiguring the network. The software creates a network overlay that can run separate virtual network layers on top of the same physical network fabric.

One of the characteristics of a VN is that it provides what are essentially private communication paths between members of a group over a shared infrastructure. This creates two requirements for the network infrastructure:

- **Traffic from one group is never mixed with another**—For sending and receiving traffic over shared links, tunnels (many borrowed from existing *virtual private network* [VPN] solutions) can guarantee data separation. Network devices need to enforce group separation in their internal memory (for example, during routing table lookups, access lists processing or NetFlow statistics gathering).

- **Each VN has a separate address space**—This requirement is derived from the fact that VNs offer the same characteristics as a physical network. Address space and forwarding within it are two of the most basic aspects of any network.

Why Network Virtualization?

Network virtualization is rewriting the rules for the way services are delivered, from the software-defined data center (SDDC), to the cloud, to the edge. This approach moves networks from static, inflexible, and inefficient to dynamic, agile, and optimized. Modern networks must keep up with the demands for cloud-hosted, distributed apps, and the increasing threats of cybercriminals while delivering the speed and agility you need for faster time to market for your applications. With network virtualization, you can forget about spending days or weeks provisioning the infrastructure to support a new application. Apps can be deployed or updated in minutes for rapid time to value.

How does network virtualization work?

Network virtualization decouples network services from the underlying hardware and allows virtual provisioning of an entire network. It makes it possible to programmatically create, provision, and manage networks all in software, while continuing to leverage the underlying physical network as the packet-forwarding backplane. Physical network resources, such as switching, routing, firewalling, load balancing, virtual private networks (VPNs), and more, are pooled, delivered in software, and require only Internet Protocol (IP) packet forwarding from the underlying physical network.

Network and security services in software are distributed to a virtual layer (hypervisors, in the data center) and "attached" to individual workloads, such as your virtual machines (VMs) or containers, in accordance with networking and security policies defined for each connected application. When a workload is moved to another host, network services and security policies move with it. And when new workloads are created to scale an application, necessary policies are dynamically applied to these new workloads, providing greater policy consistency and network agility.

Benefits of network virtualization

Network virtualization helps organizations achieve major advances in speed, agility, and security by automating and simplifying many of the processes that go into running a data center network and managing networking and security in the cloud. Here are some of the key benefits of network virtualization:

- Reduce network provisioning time from weeks to minutes
- Achieve greater operational efficiency by automating manual processes
- Place and move workloads independently of physical topology
- Improve network security within the data center

Example:

One example of network virtualization is virtual LAN (VLAN). A VLAN is a subsection of a local area network (LAN) created with software that combines network devices into one group, regardless of

15. List of Books

	List of Text books/Reference Books			
1	B.A. Forouzan, "Data communication and Networking" 3rd Edition TMH			
2	A.S.Tanenbaun, "Computer Networks" 4th Edition, Pearson			
3	W. Stalling," Data and computer communication" 8th edition PHI/Pearson			

16. Journals concerned with subject.

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journal homepage: www.elsevier.com/locate/comnet

Survey paper

A Survey on Wearable Technology: History, State-of-the-Art and Current Challenges

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Future perspective

ABSTRACT

Technology is continually undergoing a constituent development caused by the appearance of billions new interconnected "things" and their entrenchment in our daily lives. One of the underlying versatile technologies, namely wearables, is able to capture rich contextual information produced by such devices and use it to deliver a legitimately personalized experience. The main aim of this paper is to shed light on the history of wearable devices and provide a state-of-the-art review on the wearable market. Moreover, the paper provides an extensive and diverse classification of wearables, based on various factors, a discussion on wireless communication technologies, architectures, data processing aspects, and market status, as well as a variety of other actual information on wearable technology. Finally, the survey highlights the critical challenges and existing/future solutions.

1. Introduction

Today, the rapid proliferation of the Information and Communications Technology (ICT) niche is being pushed by an increasing number of new services and growing user demands. Generally, the number of interconnected handheld devices has been growing tremendously from year to year, empowered by both consumers and broad penetration of the Internet of Things (IoT) [1]. Small, affordable, and very different in shape, purpose, and application, the IoT devices had a tremendous impact on the development of the telecommunications field, not only bringing new long-range wireless technologies to the market, defining new requirements in terms of reliability and availability but also pushing network operators and vendors to redesign the entire ecosystem, switching from conventional human-generated traffics to more diverse IoT one.

This tremendous impact on the ICT domain and proliferation of the IoT allowed the developers to bring their attention to an entirely new market segment – a separate niche requiring standalone efforts has emerged as devices carried by humans but no necessarily generating the human-type data. Internet of Wearable Things (IoWT) has emerged as part of a broader IoT, bringing new challenges from various technological perspectives to the research community [2].

The terms *wearables*, *wearable devices*, or also *wearable technology* refer to small electronic and mobile devices, or computers with wireless communications capability that are incorporated into gadgets, accessories, or clothes, which can be worn on the human body, or even invasive versions such as micro-chips or smart tattoos [3]. Compared to today's smartphones and tablets, the primary added value is that wearables can provide various monitoring and scanning features, including biofeedback or other sensory physiological functions such as biometry-related ones [4]. Wearables can continuously measure such values —

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Fig. 1. Perspective on the development of personal wearable ecosystems.

Fig. 2. Wearable market growth forecast [9].

restricted by their battery constraints; they are convenient, seamless, portable, and can offer hands-free access to electronics.

The consumer-wearable devices of today are beyond their inception but still very much in their infancy. Most people still use a combination of an activity tracker and a smartphone, see Fig. 1, limiting their experience to the number of steps and heart rate. Indeed, the variety of data collected and processed in a wearable ecosystem context can hand over an unprecedented user experience for humanity [5]. In addition to conventional sports trackers, smartwatches, on-body cameras, heart rate meters, and eye-wear, the upcoming generation of wearables will also involve augmented-, virtual-, mixed-, and enhanced-reality devices, various smart clothes, and industrial wearable equipment.

As foreseen by the ICT industry, almost 70% of early adopters have shown their interest in correlating their lives with the next-generation wearables [6]. Predominately, a significant portion of IoWT available on the market today already provides a smartphone-like experience by employing voice and gesture control together with well-designed input and output interfaces.

Nonetheless, the miniaturization trend, portability, wireless communication, energy-efficient computing, and advanced display technologies have been combined to create state-of-the-art smart devices. The patriarch of these devices, a smartphone, was released back in 1992 [7], and intelligent media are now ready to lead the next great wave of innovation. Comparing traditional smartphones with wearables, both have their pros and cons. A traditional smartphone's main advantage is its higher accuracy in various performance metrics due to less power consumption limitations as a general trade-off to size. On the other hand, wearables are highly battery-constrained devices, yet have the potential to change the world as we know it — just as mobile devices did over the past 20 years. It is expected that they will improve the technological and socio-cultural parts of our lives. Moreover, wearables also have the strength to improve well-established sectors, such as the smartphone industry and other hand-held devices. This trend is confirmed by many recent studies and will be discussed in this survey.

From the monetary perspective, the wearable market is anticipated to keep on growing exponentially in the coming years. The forecast is at more than 20% growth rate annually, and the market is expected to reach over 40 billion EUR per year in the next 5 years with more than 150 billion EUR by 2028 [8–10]. A recent number of wearable shipments, estimated at 113.2 million in 2017 with total market size of $70 billion in 2019, is forecast to reach 222.3 million deliveries yearly by 2021 [11,12]. Moreover, the outbreak of COVID-19 also made a tremendous impact on the wearable devices evolution driven by the implementation of various crowd-sensing and contact-tracing platforms [13–16]. The proliferation of wearables is thus expected to steadily increase over the following decades, with a predominant transition from bracelets and sport trackers to smarter and more feature-rich wearables. Wearable technology has a tremendous impact upon ICT industry, and smart wearables are expected to disrupt most personal and business sectors, such as the industrial, healthcare, and sports domains.

Moreover, the global enterprise wearable market alone accounted for over EUR 18 billion in 2017, and it is predicted to grow at a Compound Annual Growth Rate (CAGR) of 11.8% during the forecast period, 2019 – 2026 [17]. The details on market changes as well as future perspective [9] are given in Fig. 2. Here, wearable devices could be used to improve employees' physical activity, enable relaxation more effectively, and increase workers' safety and work efficiency [18]. Added value is also achieved in other sectors, such as smart city, transportation, gamification, and infotainment. Wearable technology relieves people from continuously having to hold their smartphones in their hands from the usability perspective. This convenience feature allows handling calls, emails, texts, and many other alerts without even getting the bulky devices out [19,20]. Following Llamas' work, "within the enterprise, wearables can help accelerate companies' digital transformation by transmitting information back and forth while allowing workers to complete their tasks faster" [21].

The mobile devices' market growth brings new and usable devices, numerous benefits, and new applications from the users' perspective. One of the primary stimuli brought by wearable technology is the encouragement of proactive solutions to deal with healthcare, fitness, aging, disabilities, education, transportation, enterprise, finance, entrance systems, gaming, music, and many others. Since wearables, as known today, were historically planned as purely medical devices, let us first consider an example from the healthcare field. Unfortunately, people tend to deal with potential health issues reactively, e.g., when they feel sick or in pain, they tend to appoint a visit to their doctor. Carrying a wearable device may potentially forecast the disease by continuous health tracking and even inform the doctor automatically in order to take measures to prevent the incipient threat actively [22]. Even the simple activity trackers are already capable of monitoring sleep patterns, heart rate, level of stress, or body temperature that could be utilized for improving the health habits of any individual [23].

Significantly, the shift toward advanced devices, such as Augmented Reality (AR)/Virtual reality (VR)/Mixed Reality (MR)/eXtended reality (XR) devices, low-end wearables, and other monitoring devices, together with a transition to Beyond Fifth Generation (beyond-5G) mobile networks would also bring several challenges for the device vendors, network operators, and end-users. In particular, those challenges are related to the paradigm shift from conventional Human-to-Human interaction (H2H) to more Machine Type Communications (MTC) interactions [24]. This segment brings completely different requirements,

e.g., utterly different traffic patterns, higher reliability, lower latency, highly mobile scenarios, stringent security and privacy needs, and higher energy-efficiency demands than the H2H ones [25].

All of the conditions mentioned above lead to an indigenous increase in power consumption and the need to recharge the wearable/handheld devices daily, reducing their attractiveness and limiting the wearable applicability. Modern technologies, such as energy harvesting [26] and wireless charging [27], may assist in solving the energy bottleneck, but the corresponding impact on the user's health has not yet been studied in detail [28]. Besides, energy harvesting technologies are still far from mass adoption [29].

Overall, research in wearable technology is growing, which is demonstrated, among others, by the number of publications in the IoWT domain. Nevertheless, only one unified review is available to the research community. In contrast, others have a particular focus on some specific area (eHealth, sensors, adoption, etc.), while this paper attempts to synthesize a standalone executive summary of various technological aspects as well as related challenges. As of February 2021, the authors identified the following papers related to our survey, i.e., at a comparable level of abstraction and topics' coverage.

Several works have already reviewed materials, technologies, and applications involving Wearable devices. One of the broadest and detailed surveys was shown to the IEEE community in 2017 [30]. According to the authors, the paper has a *product survey* style and is mainly focused on the market-available wearable accessories, eTextile and ePatches classification, and computing-, energy specifics, and security aspects with a focus on present technologies. To note, close to half of the paper deals only with the classification of wearable devices available in 2017. A very recent review on wearable technology and consumer interaction [31] introduced five main themes, including decision-making, well-being; consumer behavior; utilities; and Big Data analytics. Above all, they showed the lack of integration within wearable technologies, which is driving to fragmentation, disconnected terminologies, and studies that are not based on appropriate results.

The review performed by Xue et al. [32] introduced issues about technologies, users, and activities with intelligent wearables. Moreover, it identified the main risks (privacy, safety, performance, social and psychological) involving wearables, which were also mentioned as hot topics/themes for wearables in other related reviews [33]. The analysis introduced in [34] focused on the current research highlights based on nanomaterials and evaluated the electronics under the perspective of actuators and sensors. The applications of Wearable Sensors were analyzed for healthcare and human movement monitoring. In contrast, the review introduced in [35] targeted the evaluation/assessment of physical activity apps and wearables. They identified that 75 out of 111 analyzed works used in-device sensors to measure physical activity.

Numerous works specifically target the eHealth segment, e.g., the work [36] dated 2015 provides an extensive overview of wearable health-monitoring systems and related communication aspects sensors and related implementation challenges. Another relevant work [37] also covers the communication and architectural aspect of the eHealth domain, extending [36]. Both are, however, strictly limited to this particular segment. A cross-section of technologies for Sports and e-Health was also assessed in [38]. The primary purpose was to evaluate their reliability and suitability. They detected that most of the analyzed technologies were not formally validated by an independent actor, and only 5% provided a formal validation. The highlights provided in [39] included the rising of wearables and the future for monitoring human activity as well as biological signals.

Different from the other works, this paper provides a synergy of various aspects of wearable devices from perspectives of communications, computing, localization, modern and future communication capabilities and identifies challenges for each of the directions. As such, it provides a standalone dataset of devices up until 2020, discussing the aforementioned aspects without losing itself in (unnecessary) technical details or device classification, as in [30].

In line with the discussions so far, the main goals of this paper are:

- G1. To provide a detailed historical overview of wearable technology evolution;
- G2. To highlight the state-of-the-art in the field of wearable technology, including mass-consumer perspective, main architectures, market-available devices, and related technical classifications;
- G3. To identify open challenges and provide a vision of future developments related to wearable markets and wearable computing.

The rest of the paper is structured as follows. Section 2 provides a detailed insight into the history and development of wearables from the early 13th century till nowadays. Section 3 addresses the state-of-the-art of wearable-technology evolution and outlines the main classification, architectures, communication possibilities, and data processing aspects of modern wearable devices followed by the main trends in active wearable-technology development from both industrial and academic perspectives. Section 4 contributes by providing the list of main open challenges and future perspectives. Section 5 concludes the paper with a discussion summarizing the main findings of this work. The appendix provides the results of the comprehensive market analysis reflecting various types and models of wearable devices being currently available on the market and under research.

2. Historical perspective on wearables

The wearables we know today are mostly treated as smart-by-definition devices. People tend to forget that "smartness" has not always been defined by processing the data on a chip, but rather by delivering a better experience for actual users. The next subsections give an overview of wearables' evolution from the 13th century to 2015. The evolution is also graphically depicted in Fig. 3 for the ease of perception.

2.1. Before the 20th century

The journey of wearables started with the invention of spectacles around the 13th century by English friar Roger Bacon, who was based in Paris and outlined the scientific principles behind the use of corrective lenses in his Opus Majus (c.1266) [40]. Before R. Bacon, there had been mentions of presbyopic monks using segments of glass spheres that could be laid against reading material to magnify the letters (i.e., a magnifying glass called "reading stone"), but those are more questionable in terms of actual *wearability*. Glasses by Bacon were the first wearables designed to be seamlessly carried and improving the vision, thus, becoming the pioneering smart glasses [41].

The first pocket mechanical watch, possible to be carried around, dates back to the beginning of the 16th century, and it is believed to be the Pomander (Bisamapfeluhr in German) watch [42]. Peter Henlein made it in 1505 as a portable but a not-very-precise clock. This design started a hype in wearable watch development, followed by more than ten different models in the next one hundred years [43]. Later on, pocket watches have also been developed significantly with the evolution of miniaturization [44], which led to the idea of strapping the device to the wrist in the 19th century. Military needs primarily drove the developments at that time [45].

From the smart ring's perspective, the first known one is Abacus Ring from the early 17th century during the Qing Dynasty era [46]. Back then, a standard abacus was combined of 10 parallel wires located between two boards on a frame with nine beads on each of them. It was specially designed to be a compact smart accessory used to help traders. It led the way towards modern wearable computers and, at the same time, towards modern smart rings [47].

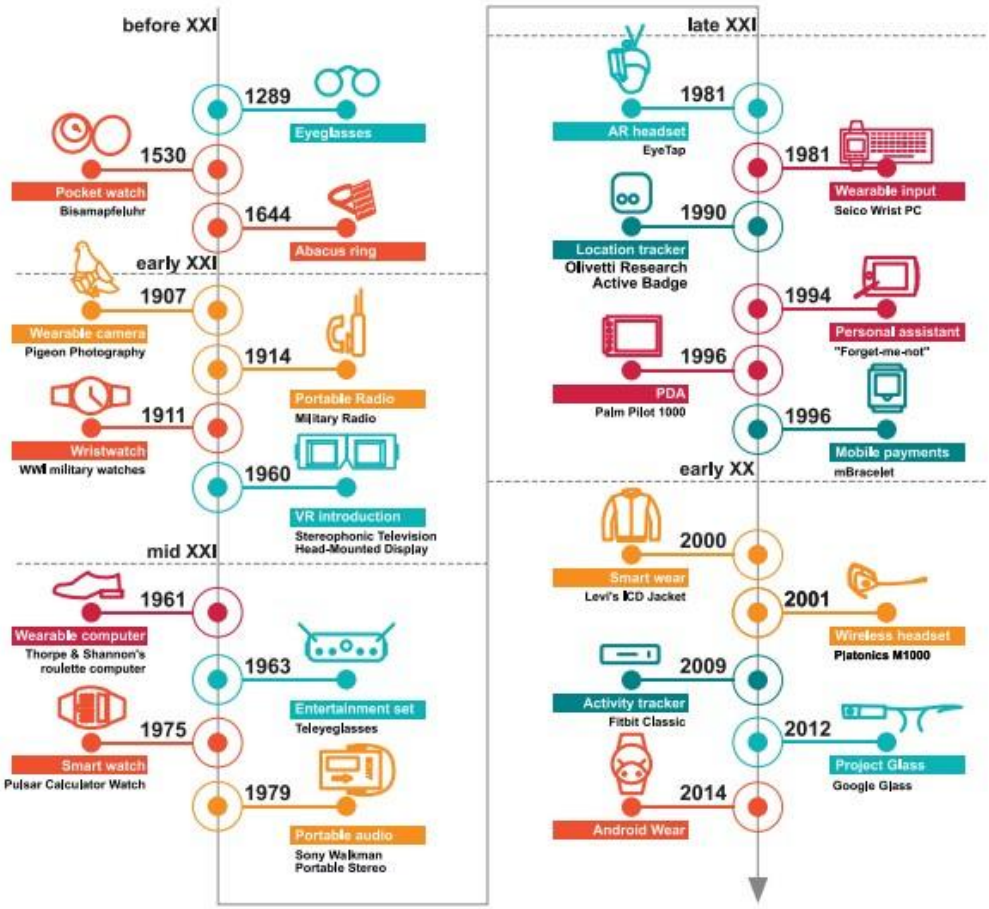

Fig. 3. Milestones of the wearable devices evolution.

2.2. Early 20th century

The first step from the portable cameras' perspective is the Pidgeon camera, developed by the German inventor Julius Neubronner in 1907 [48]. Unlike many other technological breakthroughs of those times, the camera was designed to record Neubronner's pigeon flights, while this invention is sometimes mistakenly referred to as based on military demands. It is probably because pigeon photography was widely used during the first world war for aerial surveillance together with airplanes [49].

Indeed, wearable development driven by the military during the World War I-II period was enormous. In the first place, the first carried-on wireless systems were redesigned for field communications [50]. Those were very bulky and, at first, used to be carried by cavalry horses. A breakthrough in portable radio has been a "packset" system, which later became known as a "walkie-talkie", developed in 1937 by Donald Hings [51].

Wristwatches were necessary for the planning and coordination of various operations, thus, enabling the mass adoption of wearables in the prestigious military area [52] and, thus, allowing the marketing teams to adopt wristwatches globally. Simultaneously, the first wired hands-free devices integrated with flight helmets were being developed for navy and pilots [53].

After World War II recovery, the next big step in the development of wearable technology has been towards the VR by Morton Heilig, who patented "Stereophonic Television Head-Mounted Display" in 1960 [54]. It was soon followed by another patent of the "Sensorama Simulator" being an upgraded version of the initial device [55]. The device was indeed the first VR simulator with a binocular display, vibrating seat, stereophonic speakers, cold air blower, and an odors generator [56].

2.3. Mid 20th century

In 1961, MIT researchers Edward O. Thorpe and Claude Shannon concealed a timing device in a shoe that could accurately predict the ball's landing place on a roulette table. That became the first wearable computer hidden in the shoe [57]. The real story behind the invention was published later, in 1998 [58].

Just a few years later, Hugo Gernsback invented the TV glasses [59]. Those glasses weighed around 140 grams and were built around two battery-powered cathode-ray tubes allowing for the stereoscopic experience [60], which was a breakthrough for 1963.

Next, in 1968, Ivan Sutherland created the "Sword of Damocles" – known to be the first VR Head-Mounted Display (HMD) system, enabling users to immerse themselves in a 3-dimensional environment [61]. The development has taken almost ten years while the prototype was partially see-through and allowing head tracking.

Inspired by Edward O. Thorpe, Alan Lewis invented the digital camera-case computer to predict roulette wheels in 1972 [62]. Following Thorpe's approach, he used a radio connection between the

recipient of the information and the person. The recipient used a computer to predict the roulette wheel and whispered the prediction via a radio link to the hearing aid radio receiver.

A significant breakthrough in the development of smartwatches was the appearance of the Pulsar Calculator Watch in 1975 [63]. The first-ever market-produced calculator watch was retailed at a price as high as $3,950.

In 1977, Hewlett Packard released its first algebraic calculator watch [64]. The HP-01 was a genius of miniature and smart design with 28 keys on the clock display. Four keys are raised for ease of use (amount, alarm, memory, and time), and two were embedded, but one could still use them using the fingers [65]. The rest of the keys were important to press with a pen that instantly snaps the bracelet into the clasp. The cheaper versions, mainly produced by CASIO, still ensure the clock design of the calculator.

During the same year, the first camera-to-tactile vest was designed by the company "Smith-Kettlewell" for the blind in 1977. It took a decade of research. The device used a head-mounted camera to create a tactile representation on 10 inches and 1024 points grid located on the person's vest [66].

The mid-20th century period could be concluded by one more breakthrough in wearable devices – Portable Stereo Sony Walkman was released in 1979 as the first commercially available portable personal stereo cassette player with earphones [67]. Although it had two jack outputs allowing for privacy, it was the first luxury wearable with a leather case and stylish design.

2.4. Late 20th century

The wearable development in the 80s passed relatively fast, mainly driven by improving existing technology from previous years and a new AR wave. In 1981, Steve Mann had formalized the EyeTap project and developed the first backpack-like computer designed to process the data from a next-to-eye-mounted camera and showed it on the screen in front of an eye [68]. That was the first step toward modern AR glasses and the ancestor of Google Glasses [69].

The next massive acceleration of wearable computing development was Seiko's UC 200 WRIST PC introduction in 1981 [70]. It had 2 kB of storage and offered the possibility to spell the time and calculation. Despite that, a separate dock station and keyboard were available for purchase.

Nelsonic Space Attacker Watch pioneered a new niche of portable gaming in 1981 [71]. The watch was equipped with two buttons allowing playing popular arcade games anywhere and anytime. After one year, Nelsonic released portable Pac-Man and, later on, Super Mario Brothers.

The second big father of Google Glass is the Private Eye head-mounted display developed and sold by Reflection Technology in 1989 [72]. It had a monochrome monitor with a futuristic 720 × 280 resolution for that time.

The beginning of the 90s was lightened by creating The Active Badge, the first portable indoor location tracker in 1990 [73,74]. It was made by Olivetti Research and was suitable to transmit unique Identifiable Infrared (IR) signals to communicate a person's location, which could be treated as the birth of the Smart Room concept.

Since the technological development pace was only increasing, Hip-PC debuted by Doug Platt as a shoebox-sized computer just one year later [75]. It was based on Ampro "Little Board" Extended Technology module and, together with Private Eye and keyboard, formed an Agenda palmtop. It already had a floppy drive and many additional extenders.

Two years later, the development of widely known Knowledge-based Augmented Reality for Maintenance Assistance (KARMA) has started at Columbia University [76]. The system was also utilizing the Private Eye for an overlay effect. This project's main goal was to wire-frame schematics and maintenance instructions on top of whatever was being maintained.

The first steps for personal and portable electronic assistants were made already in 1994. Mik Lamming and Mike Flynn developed "Forget-Me-Not", a continuous personal recording system [77]. It was a technology that recorded the interaction with people and stored this information in a database for future use.

In March 1996, Palm launched the first-ever made mass-produced personal digital assistant (PDA) – PalmPilot 1000 [78]. Being essentially a one-chip computer, it has 128 kB of Random-access memory (RAM) and up to 12 MB of storage. These devices received a 160 × 160 pixel screen plus a stylus-based text input.

The year 1998 could be called the beginning of the wearable payment epoch, currently present on Apple Watch and Android Wear. The enabling device was the mBracelet [79]. It was a wrist-wearable computer designed for financial transactions with Automated Teller Machine (ATM). It had three slots that could accept interchangeable iButton buttons. The connection between the mBracelet and the host was through a three-color Light-emitting diode (LED) grid. The mBracelet plug-in interface allowed users to exchange messages by cross-shaking hands.

2.5. Early 21st century

Levi's Industrial Clothing Division (ICD) Jacket led the beginning of the 21st century, designed by Massimo Osti in collaboration with Philips [80]. The jacket was made of technological material with an internal network designed to interconnect electronic gadgets. The development became revolutionary for its time and influenced the further development of brands such as Acronym and Ma.Strum.

The year 2001 is the most known for introducing the first Plantronics M1000 Wireless Headset, followed by the launch of the lightweight M1500 version [81]. It was a combination of an M1000 Bluetooth headset and an innovative Bluetooth mobile phone adapter that plugs directly into the headset jack, giving all mobile users Bluetooth headset freedom.

Fossil Wrist PDA met the market in 2003. Its development began in 1999 by Donald Brewer, who struggled to make the watch small enough for the first year of development. He started the discussions with Microsoft engineers looking for an over-the-wrist platform and concentrated on developing "Smart Personal Objects Technology" (SPOT watches) [82]. After the size has been reduced enough, the screen was attached. The first device had 2MB of memory, which was expanded to 8MB for the commercial release. The price at debut was $249 US.

In 2004, the first-ever GoPro camera met the world [83]. Nick Woodman founded the company after surfing in Australia at 2002. The first model was small, light, and waterproof while being AAA battery-powered.

Later in 2006, "Nike + iPod Sport Kit" was released [84]. It was a device that measures and records distance traveled, pace, and more. Nike+ consists of a small accelerometer installed or already built into shoes, which connects to a Nike+ Sportband receiver connected to Apple products.

Fitbit was founded in early 2007 by James Park and Eric Friedman [85,86]. In 2008, Fitbit Classic was the first wireless activity tracker that could synchronize data with the Internet and have the same data available on a mobile phone. He was also innovative in the sleek form factor.

In 2009, Samsung S9110 Smart Watch was released. The company continued Dick Tracy's idea with a two-band wrist radio [87]. It was a dual-band General Packet Radio Services (GPRS) phone with Exchange email support. Samsung S9110 Smart Watch was the first smartwatches that included a full-color touchscreen, Bluetooth connectivity, music player, and voice recognition feature [88].

In early 2012, Eric Migikovsky thought about a device that could display messages from selected smartphones (Android and Apple devices) after creating the company Inpulse (Allerta) [89]. The initial version of the watch was attractive by the bold and original design. Moreover, it

was easy to read in daylight on the "smartwatch" [90]. The design was highly accepted by the Kickstarter community [91]. After a few generations of watches and its acquisition by Fitbit, Pebble was removed from the market, leaving the niche of e-paper display-based watches abandoned.

In April 2012, information about Project Glass appeared on the Google Plus social network. The first post of the account was about the project's goals: to build a portable computer that will help "explore and share the world". A video called Project Glass was attached to the post with the project [92]. Soon after Google showed the concept, people saw the glasses in real life. Google co-founders Sergey Brin and Larry Page put on glasses in late spring 2012. At the Google I/O event on June 27, 2012, Google showed technology in action to a public audience under the price of $1500 [93]. This milestone is the beginning of VR and AR mass adoption.

The year 2014 could be described as the period of personal activity trackers boom. As a continuation and improvement of Fitbit's story, the most advanced device of that time, Basis, differed from other fitness ranges by collecting data such as heart rate, calorie consumption by activity, several sleep stages, and sweating and skin temperature with Body IQ technology [94]. The market faced numerous projects, and the number of people wearing those went sky-high in just a few years [95].

A standalone invention of 2014 was Tommy Hilfiger's solar power jacket to charge the phone [96]. Solar batteries were sewn into the jacket, connected, in turn, to the battery, which was located in one of the front patch pockets. Two devices could be connected to the battery, for example, a mobile phone or a tablet. Moreover, solar panels could be easily detached.

The next breakthrough for end-users was later in 2014 by introducing Android Wear (currently known as Wear Operating System (OS)) [97]. This marked the time when the first industrial giant officially stepped into wearables. Wear OS was the first operating system specifically designed for wearable devices, particularly for smartwatches, and was the beginning of Google's move towards taking a vital position in the wearable market.

Pushed by the technological race, Apple released its first wearable, Apple Watch, in 2015. While Google was mainly aiming at the market, the Apple Watch story has a more tragic background [98]. Before 2011, Steve Jobs had long and unsuccessfully fought pancreatic cancer, and experienced the healthcare industry's imperfection in the United States firsthand. He saw how inconvenient it was for the nursing staff to communicate with patients, how difficult it was to monitor an outpatient's condition and retrospectively collect the necessary information about the time spent outside the hospital. It was then that Steve Jobs decided that medical care could be improved with technology, and Apple should solve the problem of collecting and structuring data. Existing activity trackers were not suitable for monitoring patient conditions daily. That is why Apple came up with the Watch. The integration with a powerful software and cloud platform was supposed to facilitate doctors' work. Sadly, Steve Jobs passed away four years before the device was released.

The evolution of wearable technology during the period from 2015 till now will be covered in the next section as a state-of-the-art and market overview.

3. State-of-the-art and related work on wearable technologies

This section overviews the current situation in the wearable technology development domain. First, it provides the primary classification types of wearable devices in Section 3.1 followed by the underlying architectures in Section 3.2. Further, we list the data processing and computing techniques in Section 3.3. The discussion on currently available and developing wearable communication technology is provided in Section 3.4. The inseparability aspects from the wearable technology perspective are highlighted in Section 3.6. Section 3.7 shows an actual review of the leading wearable technology research directions from both academia and industry. Finally, this section is concluded with a list of the main directions driven by the mass market.

Fig. 4. Classification of wearable devices based on the on-body location.

3.1. Variety of wearable devices

Generally, the classification of wearable devices could be outlined from various perspectives based on various factors. Interestingly, devices worn and carried can have similar functionality but completely different form-factors, technology levels, different on-body locations, etc. Thus, the broadest classification is based on the application type, even though the other classification groups may significantly overlap.

One of the broadest classifications corresponds, but is not limited, to the following application/functionality types (discussed in more details in Section 3.7), and sorted alphabetically in Table 1.

Another significant factor for classification is related to the device type (without relation to the application area). The types are systematized in Table 2 and sorted alphabetically.

The variety of types could be broadened even further by decreasing the level of generalization. This subsection lists the main concepts present in the market and studied in the literature.

From the broad adoption perspective, the most intuitive consumer classification factor is related to the placement of the wearable on the human body. Here, the main groups (concerning device type) are, see Fig. 4:

- Head-mounted wearables: Those are mainly focused on perception and control aspects. The group related to vision covers: AR/VR/XR/MR glasses, relaxation masks as well as HMD and personal entertainment systems. Audio-related devices include headsets, personal assistants, bass systems. A standalone group is related to neural interfaces.
- Body-worn devices: Those have much broader functionality and could also be divided into the following subgroups:

Table 1
Classification based on the wearable application/functionality types (sorted alphabetically).

Type	Brief description
Communication functionality (C)	Provides the potential not to process the data locally but to exchange it with surrounding nodes and/or remote cloud.
Control/input functionality (CI)	A broad area of input devices ranging from smart buttons to sophisticated gesture recognition devices. This group's main task is to extend conventional Human-Computer Interaction (HCI) input focusing on the usability of the devices keeping a small form-factor as a rule.
Education and professional sports (ES)	Aim at improving the education and training by monitoring assistants.
Entertainment, gaming, and leisure functionality (E)	The improvement of the perception experience include, e.g., audio systems, personal entertainment displays, etc.
Heads-up, Hands-free Information (H)	Extend the conventional ways of the data delivery to the user utilizing personal assistants, AR, XR, Remote Expert Devices, wearable cameras, etc.
Healthcare/medical functionality (HM)	Separated from conventional sensing and monitoring ones due to the need to obtain medical device status that requires significant effort in the device development and testing as well as providing a high level of the obtained data trustability and the need for additional certification, however, covering similar devices, e.g., Electrocardiogram (ECG), Electroencephalogram (EEG) monitors, relaxation devices, neural interfaces, exoskeletons, etc.
Location tracking functionality (LT)	Requires to have either some Global Navigation Satellite System (GNSS) on board or, at least, a wireless communication technology. On the one hand, the concept here corresponds to location awareness from the node's perspective and, on the other hand, to remote localization of the device if needed.
Notification functionality (N)	Ranges from simple vibration notification to complex AR extensions. Similarly to sensing functionality, almost any personal device connected to the cloud directly or via the gateway can carry this functionality.
Output functionality (O)	Various visual, audio, or haptic-enabled devices to provide the user and/or people around with prompt information from the personal ecosystem.
Safety and Security functionality (S)	Personal safety devices, emergency assistants, etc.
Monitoring functionality (M)	Extremely straightforward and cheap to implement this functionality. Generally, any device that has an accelerometer on board can already provide some level of sensing. (Fitness and preventive healthcare — Activity Trackers, ECG, EEG monitors, etc.)
Wearable devices for pets and animals (PF)	Mainly covers smart collars, bark collars, smart clothes, etc.

  - Near-body and Sport: A segment for the devices supplementing existing wearable ecosystem, such as e-patches, smart bands, supplementary activity tracking sensors, etc.
  - On-body: EEG and ECG monitors, posture correcting devices, safety devices, various smart clothes, etc., form this subcategory.
  - In-body: The most significant niche from a medical perspective includes implantables, smart tattoos, etc.

- Lower-body devices: This group is still in the infancy but already includes some wearables such as smart shoes, belts, insoles, etc. Most of them carry specific monitoring functionality for professional sport or medical purposes.
- Wrist-worn and handheld wearables: Those are the most widely adopted and market-filled niche covering smart rings, wrist bands, smartwatches, gesture control devices beyond others.

The wearable-placement classification is one of the most natural ones. Designers, researchers, and early integrators should carefully consider that their device's placement is selected appropriately to fulfill the application requirements listed in the previous subsection.

In addition to the classifications mentioned earlier, wearables can also be classified based on their energy-consumption profile. Usually, devices with displays are comparatively more power-consuming than ones without a graphical output interface [2]. However, it also depends on the nature of the application and the extent of processing they perform. Therefore, wearables can be broadly classified into low, medium, and high-power wearables.

- Low-power wearables are mostly devices involving low-power components with limited capabilities that need to operate for a longer time, mainly for data acquisition/sensing purposes. These may include different healthcare-related wearables requiring low data communication rates. For example, a smart ring for sensing human physiological parameters can be classified as a low-power wearable since it is a compact device with a small battery, radio, and a few sensors onboard [168].
- Medium-power wearables include devices that may have a small display with slightly higher capabilities than low-end wearables. They can also have multiple sensors on board with direct or indirect internet connectivity options demanding medium data rates. These devices include smartwatches, fitness trackers, and other gadgets for activity/gesture recognition applications for individual, commercial, and industrial purposes [169].
- High-power wearables include devices that are more power-hungry since they include heavy processing units demanding high data rates and large displays capable of performing different compute-intensive tasks such as real-time image/video processing, Machine Learning (ML), etc. Examples include various headsets, glasses, head-mounted cameras for video crowdsensing, and others [170–172].

Wearables could also be classified based on the type of battery they use. Currently, there exist three different types of Lithium batteries available to be used in wearables thanks to the lightweight and high-voltage characteristics of Lithium [173]. Lithium Coin, also known as button cell batteries, are one of the earliest batteries developed for wearables such as watches, remote controls, etc. They are lightweight, low cost, and compact in design, mostly similar in size and shape to a coin. However, these were non-rechargeable and disposable batteries that needed to be replaced once depleted, which increases the e-waste problem [174]. Lithium-ion batteries are the most commonly used in wearables such as smartphones, smartwatches, fitness bands, etc. They are rechargeable, lightweight batteries with high-power density. However, the downside is that they are not very safe for wearables since these devices are in close contact with the human body. There have been instances where Lithium-ion batteries of smartphones have exploded due to overcharging/heating. They require special circuitry to ensure safe operating voltage and current. Moreover, their performance degrades over time, even if not used [173]. Lithium Polymer, also known as the Lithium-ion polymer, is rechargeable, lightweight, and comparatively safer than Lithium-ion. However, it is costly with a slightly lower power density than the Lithium-ion [175].

Table 2
Classification based on the wearable device type (sorted alphabetically and application types abbreviations are from Table 1).

Device	Refs.	Apps.	Power Prof.	Brief description
Activity trackers	[99,100]	C, H, LT, N, S, M, PP	L-M	Simple and relatively cheap devices mainly focus on everyday activity monitoring, including the number of steps, basic heart rate, and/or body temperature data collection. The main goal is to increase the overall physical activity participation of an average user.
AR devices	[101–104]	C, CI, ES, E, H, LT, N, OP	H	Augmented reality applications can provide additional "seeing with more eyes" information that cannot be displayed and is usually hidden from the observer in a see-through manner. The most attractive areas of the AR development are related to tourism, exhibitions, and manufacturing.
Audio systems	[105,106]	C, E, H, N, OP	M-H	Conventional wired and wireless headphones, bass systems, as well as hearing aids. Moreover, high-quality wearable audio could be integrated as part of XR or MR system to improve the immersion.
E-Skin (or nano patches)	[107–109]	C, CI, M, PP	L	An artificial skin with mechanical properties of human skin, providing various sensing functions with the main application area of artificial tactile systems. It is commonly located either right on the human skin or the arms of robotic systems to provide close-to-human perception abilities, e.g., to for the operation of humanoids.
E-Textiles (smart fabrics)	[110,111]	C, CI, ES, N, OP, M, PP	L-M	It is very similar to the e-Skin concept but broadens the opportunities to any close-to-the-body textiles that incorporate electronic functionality. Here, the sensors, circuits, or input/output devices are directly integrated with the fabric, allowing for seamless integration of the technology into everyday garments.
EEG and ECG belts	[112–114]	C, ES, M, PP	L-M	Allow monitoring the user's health state from both fitness, medical, and professional sports domains, potentially without the need for specialized medical equipment.
FPV, HMD	[115–117]	C, ES, E, H, N, OP	H	Devices for full immersion of, e.g., the Remote control (RC) of various robotic systems teleoperation, human interaction, e.g., police or firefighters, and/or conventional movie watching.
Haptic suits	[118–122]	C, CI, ES, E, H, N, M	H	Haptic feedback and capture both motion and biometrics features devices. Full or partial body haptic feedback systems are built into the suit and can be engaged in actions, on-demand, or in response to motion capture comparison to provide deeper immersion in various reality applications.
Ingestible and insertibles	[123,124]	C, M, PP	L-M	Objects that go in, through, and underneath the human body or may be a size of a medicine capsule and are packed with sensors, microprocessors, controllers, etc. Ingestibles are considered the next step of wearable technology and used in healthcare for disease diagnostics and monitoring.
Location tackers	[73,125]	C, ES, LT, N, S, M, PP	L-M	Functions of remote position estimation of the user. Those are of specific interest for pet owners and parents besides the historical crime-oriented market.
Neural interfaces	[126–130]	C, CI, H, N, OP, M, PP	M	Allow for a completely new experience in HCI for both complex medical states of the patients with movement disability, treatment of tactile function, behavior monitoring, and gaming.
Personal notification devices	[45,87,97,98]	C, H, LT, N, OP, S	L-M	Those could be considered as one of the earliest areas of mass wearable devices. When the first activity trackers received an embedded vibration motor and Bluetooth communications, it became possible to send a simple sign to the user about the incoming call or received message. Today, we cannot imagine almost any wrist-worn device without this function.
Portable Radio	[50–52]	C, CI, H, LT, N, OP, S	M-H	Those devices were also taking place in the wearable devices evolution back in the first part of the 19th century. Starting with walkie-talkies, we have arrived at the era when surviving a day without your smartphone could be problematic.
Relaxation masks	[131,132]	C, M	L-M	This group is an interesting set of devices that could be affiliated with luxury or medical purposes but keep the same function of improving the sleeping experience. The devices could also be suitable for people who travel a lot to improve the day-time adaptation period after, e.g., jet lag.
Safety buttons	[133,134]	C, CI, LT, N, S, M	L	This group corresponds to a specific set of notification devices but operating vise-versa, i.e., aiming to notify either some special units, e.g., police or hospital or the user's relatives, if something is happening with the owner.
Smart Bands	[135–138]	C, ES, H, LT, N, S, M, PP	L-M	Carry the functionality of modern activity trackers but sometimes also provide gesture recognition, stress/mood detection, or ECG monitoring functionality.
Smart clothes	[96,139–141]	C, CI, ES, E, H, LT, N, OP, S, M	M-H	A broad segment coupling together various common-looking clothes, ranging from pants to scarfs, but with invisibly embedded features, such as heating, charging, displaying, etc.
Smart contact lenses	[142,143]	OP	L	Devices to boost vision and monitor physiological parameters that help track blood glucose level from the body fluid, i.e., also tears intraocular pressure, with the help of the electronic device's resistance and capacitance.
Smart footwear	[144–146]	C, CI, ES, E, LT, M	L-M	Insoles, shoes, and socks are commonly used to monitor a person's posture, gait, a number of steps, beyond others, and are mainly utilized for training professional athletes from monitoring and stimulation perspectives and monitoring of children.
Smart gloves	[139,140,147–149]	C, ES, E, H, M	L-M	Another hand-held type of wearables is commonly utilized for systems requiring either sophisticated gesture recognition, rehabilitation, or providing better haptic feedback and other wearable devices.
Smart necklaces	[150–154]	C, LT, N, S, M	L-M	Luxury jewelry with activity tracking, health monitoring, posture correction, or safety functionality. This group of devices did not find much attention due to the actual need for miniaturization and keeping the appearance high.
Smart patches	[108,155–157]	C, M	L	Nodes consist of a peel-and-stick disposable part that is adhered to the skin and reusable sensor parts. Smart patches are easy to attach, maintain, and remove, acting as an example of Wireless Body Area Network (WBAN) system utilized in sports and healthcare monitoring.
Smart rings	[46,47]	C, CI, ES, E, H, LT, N, OP, S, M	L	Similar functionality as activity trackers but in a smaller form-factor and without displays. Some smart rings also have a notification device functionality but are kept in a fashionable accessorize form.

(continued on next page)

the challenges described above requires a unique, multidisciplinary, and inter-sectoral approach and a concerted effort of the best experts from all over the world to make progress beyond the state-of-the-art.

5. Review summary

The evolution of modern electronics towards miniaturization paves the way for a relatively young segment of IoT devices – wearables, the ones we carry and wear on us daily. Indeed, the main building block for mass adoption and broad integration of modern wearables is technology, including computation, communication, battery, chip size aspects, among many others. The history of wearables, provided in detail in this paper, is enormous and dates hundreds of years ago, leading to the devices currently surrounding people and soon joining our ecosystems.

As for modern devices, evolving from the first healthcare devices and conventional activity trackers, different wearables are presently found on various parts of our body, mainly depending on the application scenario and data collection/output needs. Wearables of today preliminary communicate via short-range wireless technology, with few exceptions based on infrastructure connectivity. This tendency is mainly due to present battery limitations and the overheads brought by higher power consumption while using longer-range communication technology. Nonetheless, most wearables are still utilized for data collection purposes requiring sophisticated techniques to achieve higher efficiency of the entire data processing life cycle. However, the tight coupling of various systems provided by different vendors is still one of the most significant challenges of wearables due to the lack of good-practices on interoperability and the appropriate standardization in the young IoWT niche.

To summarize, wearable technology is an essential building block in the future ICT systems. It is still in its infancy, and several critical challenges from data acquiring and processing, communications, security, privacy aspects, hardware limitations, and user adoption are still to be addressed. This paper highlights those and provides the readers with an excessive summary of potential solutions to overcome the present literature.

CRediT authorship contribution statement

Aleksandr Ometov: Project administration, Data curation, Visualization, Writing – original draft. **Viktoriia Shubina:** Writing – original draft, Writing – review & editing. **Lucie Klus:** Visualization, Writing – review & editing. **Justyna Skibińska:** Writing – review & editing. **Salwa Saafi:** Writing – review & editing. **Pavel Pascacio:** Writing – review & editing. **Laura Flueratoru:** Writing – review & editing. **Darwin Quezada Gaibor:** Writing – review & editing. **Nadezhda Chukhno:** Writing – review & editing. **Olga Chukhno:** Writing – review & editing. **Asad Ali:** Writing – review & editing. **Asma Channa:** Writing – review & editing. **Ekaterina Svertoka:** Writing – review & editing. **Waleed Bin Qaim:** Writing – review & editing. **Raúl Casanova-Marqués:** Writing – review & editing. **Sylvia Holcer:** Writing – review & editing. **Joaquín Torres-Sospedra:** Writing – review & editing. **Sven Casteleyn:** Writing – review & editing. **Giuseppe Ruggeri:** Writing – review & editing. **Giuseppe Araniti:** Writing – review & editing. **Radim Burget:** Writing – review & editing. **Jiri Hosek:** Writing – review & editing. **Elena Simona Lohan:** Project administration, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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List of Acronyms

3G	The Third Generation Cellular Network Technology
3GPP	The 3rd Generation Partnership Project
5G	The Fifth Generation Cellular Network Technology
A-WEAR	A Network for Dynamic Wearable Applications with Privacy Constraints
AAFT	Adjusted Fourier Transform
ACES	Asynchronous Coded Electronic Skin
AHD	Application Hosting Device
AHL	Asymmetric Hearing Loss
AOA	Angle of Arrival
AI	Artificial Intelligence
ALS	Amyotrophic Lateral Sclerosis
API	Application Programming Interface
AR	Augmented Reality
ATM	Automated Teller Machine
BAN	Body Area Network
BLE	Bluetooth Low Energy
BS	Base Station
BLSTM	Bidirectional Long Short-Term Memory
CAGR	Compound Annual Growth Rate
CE	Consumer Electronic
CES	Consumer Electronics Show
CSI	Channel State Information
CHF	congestive heart failure
CoAP	Constraint Application Protocol
CORE	Constrained RESTful Environments
CNN	Convolutional Neural Network
CH	Cluster Head
D2D	Device-to-Device
DLNA	Digital Living Network Alliance
DHKE	Diffie-Hellman Key Exchange
DT	Digital Twin
DTW	Dynamic Time Warping
ECG	Electrocardiogram
EEG	Electroencephalogram
FPV	First-person view
eMTC	enhanced Machine Type Communication
GNSS	Global Navigation Satellite System
GLONASS	Global Navigation Satellite System
GPRS	General Packet Radio Services
GDPR	General Data Protection Regulation
GPS	Global Positioning System
GRU	Gated Recurrent Units
H2H	Human-to-Human interaction
HAR	Human Activity Recognition
HMD	Head-Mounted Display
HRD	Health Recording Devices
HW	Hardware
HC-RAN	Heterogeneous Cloud Radio Access Network
HCI	Human-Computer Interaction
IAAFT	Iterated Adjusted Fourier Transform
ICD	Industrial Clothing Division

ICT	Information and Communications Technology
IDDS	Insertable Drug Deliverables Systems
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IF	Interface
IIoT	Industrial Internet of Things
ILS	Indoor Location Systems
IoT	Internet of Things
IoWT	Internet of Wearable Things
ITB	Inside-the-body
IPS	Indoor Positioning System
IEC	International Electrotechnical Commission
IP	Ingress Protection Code
IR	Identifiable Infrared
ISM	Industrial, Scientific, and Medical
ISO	International Organization for Standardization
KARMA	Knowledge-based Augmented Reality for Maintenance Assistance
LAN	Local Area Network
LBS	Location-Based Service
LSI	Large-Scale Integration
LED	Light-emitting diode
LPWA	Low-Power Wide Area
LPWAN	Low-Power Wide Area Network (protocols)
LSE	Large Scale Environment
LSTM	Long Short-Term Memory
LTE	Long Term Evolution
LoRa	Long Range LPWAN protocol
LOS	Line-of-Sight
MAC	Medium Access Control
M2M	Machine-to-Machine
MCC	Mobile Cloud Computing
MCS	Modulation and Coding Scheme
MEC	Multi-Access Edge Computing (formely Mobile Edge Computing)
mMTC	Massive Machine Type Communications
mmWave	Millimeter Wave
MR	Mixed Reality
MRI	Magnetic Resonance Imaging
MS	Multiple Sclerosis
MTC	Machine Type Communications
MLP	Multilayer Perceptron
ML	Machine Learning
MIMO	Multiple Input Multiple Output
MWC	Mobile WOrld Congress
NB-IoT	Narrowband Internet of Things
NFC	Near Field Communication
NLOS	Non-Line-of-Sight
OGC	Open Geospatial Consortium
OS	Operating System
P2P	Peer-to-Peer
PAN	Personal Area Network
POA	Phase of Arrival
PoW	Proof of Work
PDA	personal digital assistant
QoS	Quality of Service
RAM	Random-access memory
RAN	Radio Access Network
RAT	Radio Access Technology
REST	Representational state transfer
RF	Radio Frequency
RC	Remote control
RFID	Radio Frequency Identification
RNSS	Regional Navigation Satellite Systems
RSS	Received Signal Strength
SAR	Specific Absorption Rate
SDN	Software-Defined Networks
SIM	subscriber identification module
SIoT	Social Internet of Things
SOC	System on Chip
SSD	single-sided deafness
SW	Software
SW	Software
TCP/IP	Transmission Control Protocol/Internet Protocol
THz	Terahertz
TOA	Time-of-Arrival
UPnP	Universal Plug and Play
UWB	Ultra-Wide Band
VLC	Visible Light Communications
VR	Virtual reality
WAN	Wide Area Network
WBAN	Wireless Body Area Network
WPAN	Wireless Personal Area Network
WSN	Wireless Sensor Network
WET	Wireless Energy Transfer
Wi-Fi	Wireless Fidelity
WiGig	Wireless Gigabit Alliance (WiFi at 60 GHz)
WLAN	Wireless Local Area Network
XR	eXtended reality

Appendix. Description of the wearable devices' dataset

During the preparation of this survey, our team has analyzed the market and exiting research projects, which resulted in the dataset allowing for easy analysis of the available wearable devices. The most recent version of the dataset is available via Zenodo repository https://zenodo.org/record/4575153. As of the paper submission date, it provides the data about 224 wearable devices.

In particular, it consists of the following fields (some fields could be empty due to the unavailability of the module):

- **Device** – name of the wearable on the market or project title;
- **Location type** – data on the wearablity, based on the proposed classification;
- **Application type** based on the proposed classification;
- **Device type** based on the proposed classification;
- **Hi/low end** – type of the device according to its' functionality;
- **Prototype** or availability on the market;
- **Energy-related information** – information either on power supply or on the battery type;
- **CPU** – information about the processor;
- **GPU** – information about the graphical card;
- **Camera** – information about the camera(s);
- **Cellular** – information about the cellular module and technology;
- **WiFi** – information about the WiFi module and technology;
- **Bluetooth** – information about Bluetooth module and, optionally, version;
- **RFID** – information about RFID module;
- **Other connectivity** – the list of other connectivity options present on the device;
- **GNSS** – information about conventional positioning systems;
- **RAM** – information about integrated RAM;

- **Storage** – information about available internal storage or slots available for external memory stick;
- **Display** – information about the graphical output interface;
- **Audio output** – information about audio output devices;
- **Mic** – presence of audio input interface;
- **Release** – first release date or year;
- **Price $** – market price as of 2020;
- **Luxury** – information if the device could be considered as a luxury accessories;
- **Activity tracking** – presence of the activity tracking feature with details;
- **Sensors** – list of the sensors and actuators integrated in the device;
- **Description** (optional) – short description of the device;
- **Other comments** – additional notes on the device;
- **Link** – example link with the device information.

An example of one entry could be found in the following listing:

```
[
  {
  "Device": "Focals by North",
  "Location type": "Head_mounted",
  "Application type": "Eyewear",
  "Device type": "AR",
  "Hi or low end": "high",
  "Prototype": "yes",
  "Energy-related information": "700 mAh/18 hours",
  "CPU": "Qualcomm APQ8009w",
  "GPU": "n/a",
  "Camera": "yes",
  "Cellular": "no",
  "WiFi": "no",
  "Bluetooth": "yes",
  "RFID": "no",
  "Other connectivity": "no",
  "GNSS": "no",
  "RAM": "n/a",
  "Storage": "n/a",
  "Display": "yes",
  "Audio output": "yes",
  "Mic": "yes",
  "Release": "n/a",
  "Price $": "n/a",
  "Lyxury": "yes",
  "Acitivity tracking": "yes",
  "Sensors": "9-axis IMU, Ambient Light Sensor,
                          Proximity sensor",
  "Description": "Smart AR glasses. Could be
        used as handsfree and with assistants.",
  "Other comments": "IP55",
  "Link": "https://www.bynorth.com/tech"
  },
<...>
]
```

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16. List of Journals concerned with subject

Computer Networks Q1

Elsevier

Computer Networks is a journal with an H index of 150. It is an journal with a review system, and It has a price of…

Indexation

SJR Impact factor

1,625

Acceptance Rate

22 %

Time to publication

NPD

Inmediate OA:

NPD

Embargoed OA:

NPD

IEEE Network Q1

Institute of Electrical and Electronics Engineers Inc.

IEEE Network is a journal with an H index of 143. It is an journal with a review system, and It has a price of…

Indexation

SJR Impact factor
4,266

Acceptance Rate
22 %

Time to publication
NPD

Inmediate OA:

NPD

Embargoed OA:

NPD

Non OA:

NPD

Mobile Networks and Applications Q2

Springer Netherlands

Mobile Networks and Applications is a journal with an H index of 92. It is an journal with a review system, and It has a price of…

Indexation

SJR Impact factor

0,838

Acceptance Rate

25 %

Time to publication

NPD

Inmediate OA:

2690 €

Embargoed OA:

NPD

Non OA:

0 €

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501

Name of Department

Applied Science & Humanities

Course File (Theory + Lab)

Name of Subject	-	**Advanced Engineering Material**
Subject Code	-	BES2[2T], BES2[2P]
Semester	-	**2nd semester**
Section	-	**C & D**
Discipline	-	
Academic Year	-	**2022-23**

Name of Faculty -

Prof. Divya Lande

Contact No. & Mail Id-

Contact No. .....

Head of Department
Department of ASH

INDEX

Declaration by faculty :

Certification by HoD/ Principal :

1. Department Vision and Mission

Vision
Academic excellence with total commitment to quality education, research & improvement in human values with a holistic concern for better life, environment & society.

Mission
To Groom- Motivated, Environment Friendly, Self-esteemed, Creative and Oriented Engineers. • Promoting value education through motivated trained faculty. • Maintaining conducive Environment for education at affordable cost. • Promoting industry institute interaction, and involving alumni.

2. LIST OF PEO, PSO, and PO

- **Programme Education Objectives (PEO's)-**

PEO 1: Establish successfully as an engineers in all branches.
PEO 2: Become responsive to community needs
PEO 3 Conduct with high ethical standards in profession
PEO 4 Pursue higher studies to foster learning and understanding in an ever widening sphere of technology and management
PEO 5 Expand knowledge and capabilities through lifelong learning experiences

- **List of PSO:**

PSO 1: Develop the ability to understand, demonstrate, identify, analyze and apply the skills and knowledge gained from foundational courses of humanities, sciences and engineering,and relate these fundamentals with core subjects in the relevant field.

PSO 2: Understanding basic skills and principles of engineering by developing and engaging

them in life-long learning with effective skills inculcating quality of reasoning, logic,

analysis and communication.

PSO 3: Cultivate the ability to work in teams and learn by participating in Technical Events and Social Welfare Programs and develop the attitude for working productively as an individual and in cross-disciplinary teams to become better citizens in multicultural world.

PSO 4: Facilitate students to acquire a fair knowledge in discrete mathematics, real analysis

and solve problems efficiently and trained in an effective manner to attend the

competitive exams in order to brighten their future.

PSO 5: Provide a systemic understanding of core physical concepts, principles and theories along with their applications and develop proficiency in the analysis of physical problems and the use of mathematical techniques to solve them.

PSO 6: To understand theoretical chemistry by its practical applications in which traditional and modern apparatus are used with diversity of the subject in the different fields.

PSO 7: Apply reasoning informed by the knowledge to assess societal, health, safety, legal and the consequent responsibilities relevant to the professional engineering and practice

create, select, and apply appropriate techniques, resources for basic civil engineering

PSO 8: Apply the knowledge gained during the course of Basic electrical engineering to identify, formulate and solve real life problems faced in industries and the ability to apply techniques to electrical and renewable energy systems.

PSO 9: Prepare engineering graphics manually with given geometrical dimensions using drawing standards by proper scale and use differing drawing tools/instruments with visualization and draw the shape of simple object form orthographic view to vise versa.

- **List of PO:**

Programme Outcomes (PO's)

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate

consideration for the public health and safety, and the cultural, societal, and environmental

considerations.

PO4. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO5. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO6. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

3. **List of Course Outcomes:** At the end of course syllabus, students will be able to—

CO	Description	Blooms Level
CO-1:	**Understand** Learn the concept of formation of energy bands and to classify solids on its basis	**Un**
CO-2:	**Remember and understand** Identify and explian different types of diodes, Transistors and its applications.	**Re - Un**
CO-3:	**Understand and analyze** learn the concept of magnetism and superconductivity classify and analyze veriouys types of magnetic and superconducting materials.	**Un – An**
CO-4:	**Understand and apply** Learn and explian quantum transitions and apply it toworking of lasers.	**Un-Ap**
CO-5:	**Understand,analyze and cpmpare** Learn the concept of nano materials and compare its properties with those of bulk materials.	**Un,Ap,An**

4.Course Syllabus

B.Tech. Semester II Advanced Engineering Materials (Total Credits 3)

Teaching Scheme	**Examination Scheme**
Lectures: 2 Hours/Week Theory,	**T(U): 70 Marks T(I): 30 Marks**
Tutorial/Activity: 2 Hours/week	**Duration of University Exam: 3 Hours**

Unit - 1: Band theory of solids (6 Hrs) 14 Marks

Basic idea of free electron theory of metals, expression of conductivity of a metal. Formation of energy bands in Solids, Fermi energy and Fermi level.

Classification of solids on the basis of energy band diagram: Conductors, Semiconductors and Insulators, concept of Fermi energy.

Unit-2: Semiconductor Devices (7 Hrs) 14 Marks

Types of Semiconductor diodes, P-N junction Diode: Characteristics of P-N junction Diode, Tunnel Diode, Zener Diode, LED, Photodiode.

Transistors . Hall effect, Hall voltage and Hall coefficient; its applications,

Unit 3: Magnetic and Superconducting Materials (10 Hrs) 14 Marks

Diamagnetic, Paramagnetic, Ferromagnetic, Ferri-magnetic and anti ferromagnetic materials: Explanation on the basis of domain. Hysteresis curve, Characteristics of ferromagnetic, diamagnetic and paramagnetic materials and their applications.

Superconductors: Basics of superconductivity: Zero electrical resistance, Persistent current Effect of Temperature, Effect of Magnetic Field, Critical Current; The Meissner Effect.Type-I and type-II superconductors, London Equation: The penetration depth, Bardeen-Cooper-Schrieffer (BCS) theory.

Unit 4: Lasers (7 Hrs) 14 Marks

Quantum Transitions: Absorption, Spontaneous emission & stimulated Emission, Metastable states, Principle of laser, Laser characteristics, Coherence length and coherence time, Pumping schemes: Three level and Four level.

Optical Resonator, Construction & working of Ruby laser and He-Ne laser, Applications of laser.

Unit 5: Nanoscience and Nanomaterials (6 Hrs) 14 Marks

Introduction to Nanoscience, Classification of nano materials, Types of Synthesis of Nanomaterials, Comparison of properties of nanomaterials with bulk materials,

Some special nanomaterials: 1) Zeolites, 2) Graphine, Application of nanomaterials in engineering.

Reference Books:

1 R.K.Pri, V.K. Babbar "Solid Sate Physics" 2nd Edition
2 M,.N.Avadhanulu, "Laser: Theory and application"
3 S.Pande,A.Golhar,M.Giriya," Advanced engineering material"

5. Advanvced engineering material Lab

List of Experiments to be performed

1 To study V-I characteristics of Semiconductor (p-n junction) diode.

2 To study V-I characteristics of Zener diode.

3 To study characteristics of Transistor in Common Base (CB) mode.

4 To study characteristics of Transistor in Common Emitter (CE) mode.

5 Determination of Band-Gap in a Semiconductor using a reverse- biased p-n junction diode.

6 Determination of Activation Energy & Temperature Co-efficient of a thermistor.

7 To determine wavelength of He-Ne LASER beam using diffraction

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY

APPROVED BY AICTE, DTE & AFFILIATED TO RTM NAGPUR UNIVERSITY, NAGPUR

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6. Time Table- (Class Schedule)

Guru Nanak Institute of Engineering & Technology

Dahegaon, Kalmeshwar Road, Nagpur Pin-441501

Department of Applied Sciences & Humanities (B. Tech. First Year)

Seesion 2022-23

TIME TABLE (EVEN)

w. e. f. 10/04/2023

DAY / TIME	SECTION	09:45 AM – 10:35 AM	10:35 AM – 11:25 AM	11:25 - 11:40 AM	11:40 AM – 12:30 PM	12:30 PM – 01:20 PM	01:20 – 02:00 PM	02:00 PM – 02:50 PM	02:50 PM – 3:40 PM	03:40 PM – 4:30 PM
Monday	A	M - II (FA)	AEM (SG)	SHORT BREAK	AC PR. (A1) (PK)/AEM PR. (A2) (SM/DL)		LUNCH BREAK	AC (PK)	ICC (SS)	CS(MS)
	B	AC PR (B1) (SSS) /AEM PR (B2) (SM/DL)			M - II (FA)	AC (SSS)		AEM (SG)	BEE (MR)	ICC (SS)
	C	WP PR. (C1) (YC) /CS PR.(C2) (MS)			EM (PM)	M - II (FA)		AEM (DL)	CS(MS)	AC (PK)
	D	EM (PM)	ICC (SS)		WP PR (D1) (YC) /CS PR. (D2) (AS)			AC (SSS)	AEM (DL)	M - II (SB)
Tuesday	A	AC (PK)	M - II (FA)		EM (PM)	ICC (SS)		CS(MS)	AEM (SG)	BEE (VD)
	B	M - II (FA)	EM (PM)		WP PR. (B1) (VT)/CS PR. (B2) (AS)			AC (SSS)	M - II (FA)	ICC (SS)
	C	AEM (DL)	ICC (SS)		M - II (FA)	AC (PK)		ICC (SS)	BEE (SG)	CS(MS)
	D	AC (SSS)	M - II (SB)		AC PR (D1) (SSS)/AEM PR (D2) (DL)			AEM (DL)	WP PR. (D2) (YC) /CS PR.(D1)(VK)	
Wednesday	A	EM (PM)	AC (PK)		M - II (FA)	AEM (SG)		AC PR (A2) (PK) /AEM PR (A1) (SM/DL)	BEE (VD)	
	B	AC (SSS)	M - II (FA)		CS(AS)	EM (PM)		AEM (SG)	WP PR. (B2) (VT) /CS PR.(B1)(AS)	
	C	AC (PK)	EM (PM)		AC PR (C1) (PK)/AEM PR(C2) (DL)			M - II (FA)	CS(MS)	AEM (DL)
	D	CS(AS)	M - II (SB)		AC (SSS)	BEE (SG)		CS(AS)	BEE (SG)	ICC (SS)
Thursday	A	AC (PK)	AEM (SG)		WP PR. (A1) (VT) /CS PR. (A2) (MS)			M - II (FA)	BEE (VD)	Class Test (Topicwise)
	B	AC PR (B2) (SSS) /AEM PR (B1) (SM/DL)			AEM (SG)	AC (SSS)		CS(AS)	CS(AS)	
	C	BEE (SG)	M - II (FA)		AC PR (C2) (PK) /AEM PR(C1) (DL)			AEM (DL)	AC (PK)	
	D	AEM (DL)	BEE (SG)		CS(AS)	EM (PM)		AC (SSS)	M - II (SB)	
Friday	A	WP PR. (A2) (VT) /CS PR.(A1) (MS)			M - II (FA)	EM (PM)		CS(MS)	AC (PK)	Libray/ Problem Solving / Sports
	B	AC (SSS)	AEM (SG)		BEE (MR)	M - II (FA)		EM (PM)	BEE (MR)	
	C	EM (PM)	M - II (FA)		WP PR. (C2) (YC) /CS PR.(C1) (MS)			AC (PK)	BEE (SG)	
	D	AEM (DL)	EM (PM)		AC PR (D2) (SSS) /AEM PR (D1) (SM/DL)			AC (SSS)	M - II (SB)	

Principal

Time Table Incharge **HoD** **Vice – Principal**

7. Instructional Schedule (Lesson Plan):

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
Dahegaon, Kalmeshwar Road, Nagpur – 441501. Phone No. 07118-661400
Department of Computer Science Engineering
Session 2022-23

Lesson Plan

Sr. No	Lecture No.	Topic	Lesson Outcome: After learning the lesson students will be able to	Text Book/Reference Book	Page No.	NPTEL/Swayam Link	Youtube Link	CO Attained	Blooms level
1	1	Free electron model of solids, Free electron theory of metals	**Discuss on non conductors, conductorsand insulators**	BOOK-1 Detail given bellow	198-200	https://nptel.ac.in/courses/115102025 2.https://nptel.ac.in/courses/115102025	https://www.youtube.com/watch?v=ORPNkHt2rGBhttps://www.youtube.com/watch?v=3npADYVtQQ	CO-1	Un
2	2	Drift velocity and Electrical conductivity and numaricals	**Explain, demonstrate and evaluate about conductivity**	BOOK-1 Detail given bellow	204-205				Un
3	3	mobility and relaxation time	Explain about mobility of an electron with reference to relaxation time	BOOK-1 Detail given bellow	204-205				Un
4	4	Basic idea of free electron theory of metals	Illustrate basic idea of free electrons via virtual lab	BOOK-3 Detail given bellow	6,7				Un
5	5	Classification of Solids on the basis of Energy Band Structure	compare conductors and non conductor and semiconductoron the basis of energy band diagram	BOOK-3 Detail given bellow	8				Un
6	6	Fermi Dirac distribution Function, Effective Mass	explain about the probability of occurance of electrons at that paticular energy level	BOOK-3 Detail given bellow	207-212				Un
7	7	N and P type Semiconductor, Intrinsic semiconductor , Extrinsic semiconductor	explian the concept of semiconductor	BOOK-1 Detail given bellow	213-220				Un
Unit-II Semiconductor Device									
8	8	P-N junction diode	Define & Explain the P-N junction	BOOK-3 Detail given bellow	24	1.https://archive.nptel.ac.in/courses/115/108/115108127/ 2. https://nptel.ac.in/courses/117103063	1. https://www.youtube.com/watch?v=USiY0JspDEg 2. https://www.youtube.com/watch?v=CjAVfW_6juw 3. https://www.youtube.com/watch?v=6LUL2cBoJ48	CO-2	Un
9	9	V-I Characteristics of P-N junction diode	Explain the p-n junction diode is curve between the voltage and current through the circuit	BOOK-3 Detail given bellow	25-29				Un
10	10	energy band diagram of p-n junction diode	**Demonstrate functioning of serial , parallel , Synchronous and Asynchronous data transmission**	BOOK-3 Detail given bellow	29-31				un
11	11	Reverse saturation current, V-I characteristics Reverse breakdown	Explain the p-n junction diode and characteristics of curve between the voltage and current through the circuit	BOOK-3 Detail given bellow	32				un
12	12	Zener diode	Descibe & explain the zener diode,tunnel diode work	BOOK-3 Detail given bellow	33-34				Re
13	12	Tunnel diode, Transistor action		BOOK-3 Detail given bellow	37-45				Re
14	13	Energy band diagram of a Transistor biased in normal mode	Describe the energy gap of semiconductors	BOOK-3 Detail given bellow	47-49				Re
15	14	Hall effect and numaricals	Explain, demonstrate and evaluate about hall effect,voltage	BOOK-3 Detail given bellow	50-54				Re
Unit-III Magnetic and Superconducting Materials									
16	15	Terms and definition ,relation between magnetiv permiability and suceptibility	Explain basics of magnetisation and magnetic moment	BOOK-1 Detail given bellow	265	1.https://nptel.ac.in/courses/113105081 2.https://nptel.ac.in/courses/115105122 3.https://nptel.ac.in/courses/115105122 4.https://nptel.ac.in/courses/115105122	1. https://www.youtube.com/watch?v=JRgmPco0KWI 2. https://www.youtube.com/watch?v=2oi7aCRgcL0 3. https://www.youtube.com/watch?v=epFQFWy-79Yhttps://www.youtube.com/watch?v=xMsBkykB1Q4https://www.youtube.com/watch?v=rGgKK3-wep. https://www.youtube.com/watch?v=AX962gXo0CI	CO-3	Un
17	16	Origin of Magnertization -Magnetic Moment		BOOK-1 Detail given bellow	348				Un
18	17	Classification of magnetic materials	Descibe types of magnetic materials and its characteristics	BOOK-1 Detail given bellow	229-230				Un
19	18	Dia,Para,Fero,Antifero,ferrimagnetism		BOOK-1 Detail given bellow	230-255				Un
20	19	Ferits and Hysteresis loss	evaluate about ferits and characteristics	BOOK-1 Detail given bellow	79				An
21	20	Soft and Hard magneticmaterial	Distingish between the materials	BOOK-1 Detail given bellow	365				An
22	21	Magnetic materialsand their application	apply the magnetic matyerilas	BOOK-3 Detail given bellow	852				An
23	22	Magnetic devices and Superconductors		BOOK-1 Detail given bellow	364 to 367				An
24	23	Phenomenon of Superconductivity	Discuss the phenomenon and properties of superconductivity	BOOK-1 Detail given bellow	364 to 367				An
25	24	Properties of superconductivity		BOOK-1 Detail given bellow	364 to 367				An
26	25	Type -I and type-II superconductors	Compare the types of superconductors	BOOK-3 Detail given bellow	286-287				An

8. Instructional Schedule (Laboratory Plan):

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY

Dahegaon, Kalmeshwar Road, Nagpur – 441501. Phone No. 07118661400

Department of Applied Science & Humanities

Session 2022-23 (EVEN)

Lab Plan

Subject: Advance Engineering Material Subject Code: BSE2-2P Semester: Even
Faculty Name: Prof. Divya A. Lande Prof. Switi. R. Maske

Experiment. No.	Topic	Lesson Outcome: After learning the lesson students will be able to	Text Book/Reference Book	Page No.	Virtual Lab / Youtube link
1	To study V-I characteristics of Semiconductor (p-n Junction) diode.	**Understand** the working of p-n junction diode	BOOK-1 Detail given below	95-100	1. https://youtu.be/Nds6Qrd6k40 2.https://iitkgp.vlabs.ac.in/exp/characteristics-diode/
2	To study V-I characteristics of Zener diode.	To study the zener diode	BOOK-1 Detail given below	105-110	1. https://youtu.be/ryB36ixUp4w 2. http://ebootathon.com/labs/beta/ec/ElectrcAndCircuitLab/exp1/
3	To study Characteristics Transistor in common Base (CB) Mode.	**Explain** transistor in common base	BOOK-1 Detail given below	132-142	1. https://youtu.be/qOGdUsfcz04 2. http://vlabs.iitkgp.ernet.in/be/exp12/index.l
4	To study Characteristics Transistor in common Emitter (CE) Mode.	**Explain** transistor in common Emitter	BOOK-1 Detail given below	143-152	1. https://youtu.be/TOs8h_AiBJU 2. http://vlabs.iitkgp.ernet.in/be/exp11/index.l
5	Determination of Band -Gap in a Semiconductor Using a reverse biased p-n junction diode.	**Demonstrate** band - gap in semiconductor	BOOK-1 Detail given below	14-19	1. https://youtu.be/7LeH6OSFTJ0 2. https://vlab.amrita.edu/?sub=1&brch=282&

6	Determination of activation energy and temprature coefficient of a thermistor.	**Demonstrate** activation energy and temprature coefficient of a thermistor.	BOOK-1 Detail given below	20-28	1. https://youtu.be/y7U4GDUK0BU 2. https://vlab.amrita.edu/?sub=1&brch=282&

9. Instructional Schedule (Tutorial):

10. Mapping of Course Content Unit wise with course outcome:

UNIT	CO-1	CO-2	CO-3	CO-4	CO-5
1	Y				
2		Y			
3			Y		
4				Y	
5					Y

11.Mapping Experiment List with course outcomes

Expt.No.	CO-1	CO-2	CO-3	CO-4	CO-5
1		Y			
2		Y			
3		Y			
4		Y			
5	Y				
6	Y				

12. Mapping of CO with PEO

(3=Highly mapped; 2=Moderately mapped; 1=weakly mapped)

	CO-1	CO-2	CO-3	CO-4	CO-5
PEO-1	3	2	2	2	2
PEO-2	1	3	1	1	1
PEO-3	1	1	3	3	1
PEO-4	3	3	1	1	1
PEO-5	1	1	3	3	2

13. Mapping of CO with PSO

	CO-1	CO-2	CO-3	CO-4	CO-5
PSO-1	3	2	3	1	2
PSO-2	3	2	1	1	1
PSO-3	2	1	1	1	1
PSO-4	2	1	1	2	3
PSO-5	3	3	1	1	1
PSO-6	1	3	3	1	1
PSO-7	3	3	2	1	1
PSO-8	1	1	2	3	1
PSO-9	1	2	3	2	3

14. Mapping of CO with Blooms Taxonomy

	CO-1	CO-2	CO-3	CO-4	CO-5
Me	1	1	1	1	1
Un	1	3	3	3	3
Ap	3	1	1	3	3
An	1	1	3	1	3
Ev	1	1	1	1	1
Cr	1	1	1	1	1

15. Mapping of CO with PO

		CO-1	CO-2	CO-3	CO-4	CO-5
Engineering knowledge:	PO-1	3	3	3	3	3
Problem analysis	PO-2	1	3	2	3	3
Design/development of solutions	PO-3	1	3	2	3	3
Conduct investigations of complex problems	PO-4	0	3	0	3	3
Modern tool usage	PO-5	0	2	0	2	2
The engineer and society	PO-6	0	0	1	1	1
Environment and sustainability	PO-7	0	0	0	2	2
Ethics	PO-8	0	0	0	0	0
Individual and team work	PO-9	0	2	0	3	3
Communication	PO-10	3	3	3	3	3
Project management and finance	PO-11	0	0	0	0	0
Life long learning	PO-12	2	2	2	2	2

16. Average PO Mapping

	CO-1	CO-2	CO-3	CO-4	CO-5	Avg. PO
PO-1	3	3	3	3	3	3
PO-2	1	3	2	3	3	2.4
PO-3	1	3	2	3	3	2.4
PO-4	0	3	0	3	3	3.0
PO-5	0	2	0	2	2	2.0
PO-6	0	0	1	1	1	1.0
PO-7	0	0	0	2	2	2.0

17. CO Attainment

CO-1 **Understand** Learn the concept of formation of energy bands and to classify solids on its basis

CO-2 **Remember and understand** Identify and explian different types of diodes, Transistors and its applications.

CO-3 **Understand and analyze** learn the concept of magnetism and superconductivity classify and analyze veriouys types of magnetic and superconducting materials.

CO-4 **Understand and apply** Learn and explian quantum transitions and apply it toworking of lasers.

CO-5 **Understand,analyze and cpmpare** Learn the concept of nano materials and compare its properties with those of bulk materials.

18.PO Attainment

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems

and design system components or processes that meet the specified needs with appropriate

consideration for the public health and safety, and the cultural, societal, and environmental

considerations.

PO4. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO5. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO6. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

19. Roll List:

Section C

S.No	Name of the Students	University Roll No.	Enrollment No.
1	AISHWARYA RAVISH KAMBLE	170579	
2	ARYA AJAY BODELE	170586	
3	DIPALI BHAGWAN ATHILKAR	170594	
4	DIYA RAJESH BHOGE		
5	HITEESHA SACHIN BODELE	170601	
6	HUMANSHI NIUSHIL BHAVE	170602	
7	ISHA HEMANT HADKE	170603	
8	KAJAL RUPESH DHAMGAYE	170607	
9	KHUSHABU DINESH CHOUDHARI	170609	
10	KHUSHI DHANRAJ CHOUDHARI	170610	
11	MANASI OMPRAKASH ARJAPURE	170612	
12	MANASVI BALCHAND JAGTAP	170613	
13	MRUNAL DINESH KAPSE	170615	
14	NAINIKSHA ANIL DHOKE	170618	
15	NISHA RAMKRUSHNA SHETE	170626	
16	NISHA DASHRATH DAMBOLE	170625	
17	PRACHI RAMCHANDRA CHOPDE	170629	
18	PRATIKSHA SHRIKRUSHNAJI HINGANE	170633	
19	RIYA MANOJ KALAMKAR	170637	
20	RUCHIKA KUMAR JAGNIT		
21	SHAZIYA MAZHAR SHAIKH	170645	
22	SHREYA DILIP HEKAD	170649	
23	SHRUTI NATRAJ BHURE	170654	
24	SONALI BHAVRAO DHOLE	170659	
25	SRUSHTI SANJAY BANSOD	170660	
26	SWATI RAJU BAGHMARE	170663	
27	TANUSHREE SHIVRAJ RAMTEKE	170667	
28	ABDUL ASRARABDULSHAKUR	170682	
29	ALKESH PRASHANT DAHAKE	170688	
30	ANUJ NANDUJI KARADBHAJANE	170692	
31	ARJUN NILESH DHORAN	170696	
32	DHANANJAY RATNAKAR JICHKAR	170712	
33	DHRUV NITIN DHOTRE	170713	
34	DIVESH VILAS CHITTALWAR	170715	
35	GANESH BHAGWAT BELSARE	170717	
36	GAURAV VASUDEV BARSAGADE	170718	
37	HARSHAL GOPALRAO DESHMUKH	170724	
38	HARSHAL MAHENDRA GOLAIT	170725	

39	LOKESH RAMAWADH CHAUHAN	170730	
40	NIKHIL KISHRRAO DANGE	170737	
41	NILESH YUVRAJ CHITRIV		
42	OM SUDHIRRAO BOBADE	170742	
43	PAVAN ANANDRAO CHIKHLE		
44	PRADEEP KUMAR	170745	
45	PRAJWAL RAMESH KALE		
46	PRATHMESH GANESHJI CHANDEKAR	170748	
47	PRATHMESH PRABHAKAR MUDE	170749	
48	PRATIK DILIP BORIKAR		
49	RISHABH SANJAY GOUR	170750	
50	RUSHIKESH SHRIKRUSHNA KAJE		
51	SANGHARSHA RAJESH KUMBHALKAR	170758	
52	SANSKAR VIJAYRAO BADHE	170760	
53	SHRAVEN DEVENDRA DHARME	170767	
54	UJWAL LAXMAN BHOYAR	170781	
55	VANSH BADAL BHUTE	170783	
56	VEDANT CHANDRAPRAKASH KAMBE	170784	
57	VEDANT CHANDRAPRAKASH KAMBE	170784	
58	VICK YDEVIDAS BHENDARKAR	170785	

Section D:

S.No	Name of the Students	University Roll No.	Enrollment No.
1	Anjali Ramsurat Yadav	170582	
2	Anushree Kashyap Gajbhiye	170583	
3	Apeksha Amit Karosiya	170584	
4	Babi Naresh Kotangale	170589	
5	Divya Shailendra Patil	170595	
6	Gayatri Narendra Nagpure	170596	
7	Gitika Subhash Machhale	170598	
8	Komal Balidas Ukey	170611	
9	Nandini Manohar Kushwaha	170619	
10	Nisha Arjun Marthe	170624	
11	Ranu Rajendra Wade	170635	
12	Riya Arvind Thokal	170636	
13	Rujal Rajendra Somkuwar	170639	
14	Shravani Rajkumar Yerne	170648	
15	Shreya Gajanan Kamble	170652	
16	Shruti Ravindraj Manwatkar	170655	
17	Shubhanshi Srikrishna Soni	170657	
18	Shweta Ramesh Khirale	170658	
19	Shweta Dhanraj Maraskolhe	170664	
20	Usha Jaideo Nagdiwe	170670	
21	Vaishnavi Pralhad Mankar	170671	
22	Vaishnavi Sushil Nagrare	170674	
23	Yashavee Rajiv Dhanvija	170679	
24	Yugeshwari Deoram Nikhare	170680	
25	Aditya Chandrashekar Sontake	170683	
26	Aniket Umendra Paunikar	170690	
27	Arpit Pramod Mendhe	170697	
28	Atharv Nandkishor Moon	170700	
29	Ayush Mukesh Indurkar		
30	Ayush Praveen Tirpude	170702	
31	Ayush Rajesh Wanjari	170703	
32	Chaitanya Ravishankar Bhakre	170708	
33	Chinmay Vijay Ramteke	170709	
34	Ganesh Prakash Yelakar	170717	
35	Ghanshyam Omprakash Nikhare	170719	
36	Hariom Murlidhar Nikam	170721	
37	Harsh Raju Magar	170723	
38	Manish Bhojraj Parate	170734	
39	Nishant Chhatrapal Nikose	170739	
40	Om Dnyaneshwar Mankar	170740	
41	Pawan Narendra Tidke	170744	

42	Pranav Sanjay Tute	170746	
43	Ritesh Chudiram Meshram	170751	
44	Rohan Mahadeorao Gumgaokar	170754	
45	Sahil Bhaskar Raut	170755	
46	Samyak Tarachand Patil	170757	
47	Sanket Sardar	170759	
48	Satvik Rajendra Sharma	170762	
49	Shantanu Gorakhna Throde	170764	
50	Sujal Pramod Meshram	170770	
50	Sumit Prabhat Gajbhiye	170733	
52	Sumit Purushottam Dholne		
53	Sumit Radheshyam Sonwane		
54	Suraj Kunjbihari Yadav	170774	
55	Suraj Ravindra Mozarkar	170775	
57	Tushar Pawar	170779	
56	Yasin Abdulkadar Sheikh	170793	

19. Internals / Sessional (Theory and Practical)

Section : C

S.No	Name of the Students	University Roll No.	Theory Internal Marks(30)	Practical Internal Marks (25)
1	AISHWARYA RAVISH KAMBLE	170579	29	22
2	ARYA AJAY BODELE	170586	29	23
3	DIPALI BHAGWAN ATHILKAR	170594	29	22
4	DIYA RAJESH BHOGE			
5	HITEESHA SACHIN BODELE	170601	29	23
6	HUMANSHI NIUSHIL BHAVE	170602	29	23
7	ISHA HEMANT HADKE	170603	27	22
8	KAJAL RUPESH DHAMGAYE	170607	29	23
9	KHUSHABU DINESH CHOUDHARI	170609	29	23
10	KHUSHI DHANRAJ CHOUDHARI	170610		
11	MANASI OMPRAKASH ARJAPURE	170612	30	22
12	MANASVI BALCHAND JAGTAP	170613		
13	MRUNAL DINESH KAPSE	170615	29	24
14	NAINIKSHA ANIL DHOKE	170618	29	22
15	NISHA RAMKRUSHNA SHETE	170626	29	24
16	NISHA DASHRATH DAMBOLE	170625	29	24
17	PRACHI RAMCHANDRA CHOPDE	170629	29	24
18	PRATIKSHA SHRIKRUSHNAJI HINGANE	170633	29	23

19	RIYA MANOJ KALAMKAR	170637	29	24
20	RUCHIKA KUMAR JAGNIT			
21	SHAZIYA MAZHAR SHAIKH	170645	29	23
22	SHREYA DILIP HEKAD	170649	29	24
23	SHRUTI NATRAJ BHURE	170654	29	24
24	SONALI BHAVRAO DHOLE	170659	29	22
25	SRUSHTI SANJAY BANSOD	170660	29	22
26	SWATI RAJU BAGHMARE	170663	28	22
27	TANUSHREE SHIVRAJ RAMTEKE	170667	28	22
28	ABDUL ASRARABDULSHAKUR	170682	29	23
29	ALKESH PRASHANT DAHAKE	170688	29	22
30	ANUJ NANDUJI KARADBHAJANE	170692	29	23
31	ARJUN NILESH DHORAN	170696	29	22
32	DHANANJAY RATNAKAR JICHKAR	170712	27	22
33	DHRUV NITIN DHOTRE	170713	24	22
34	DIVESH VILAS CHITTALWAR	170715	29	18
35	GANESH BHAGWAT BELSARE	170717	23	22
36	GAURAV VASUDEV BARSAGADE	170718	29	23
37	HARSHAL GOPALRAO DESHMUKH	170724	30	23
38	HARSHAL MAHENDRA GOLAIT	170725	29	23
39	LOKESH RAMAWADH CHAUHAN	170730	29	22
40	NIKHIL KISHRRAO DANGE	170737	27	22
41	NILESH YUVRAJ CHITRIV			
42	OM SUDHIRRAO BOBADE	170742	28	22
43	PAVAN ANANDRAO CHIKHLE			
44	PRADEEP KUMAR	170745	30	23
45	PRAJWAL RAMESH KALE			
46	PRATHMESH GANESHJI CHANDEKAR	170748	28	23
47	PRATHMESH PRABHAKAR MUDE	170749	25	22
48	PRATIK DILIP BORIKAR			
49	RISHABH SANJAY GOUR	170750	29	22
50	RUSHIKESH SHRIKRUSHNA KAJE			
51	SANGHARSHA RAJESH KUMBHALKAR	170758	29	22
52	SANSKAR VIJAYRAO BADHE	170760	30	22
53	SHRAVEN DEVENDRA DHARME	170767	30	23
54	UJWAL LAXMAN BHOYAR	170781	30	22
55	VANSH BADAL BHUTE	170783	29	22
56	VEDANT CHANDRAPRAKASH KAMBE	170784	29	23
57	VEDANT CHANDRAPRAKASH KAMBE	170784	29	22
58	VICK YDEVIDAS BHENDARKAR	170785	29	22

Section D

S.No	Name of the Students	University Roll No.	Theory Internal Marks(30)	Practical Internal Marks (25)
1	Anjali Ramsurat Yadav	170582	28	22
2	Anushree Kashyap Gajbhiye	170583	26	22
3	Apeksha Amit Karosiya	170584	27	22
4	Babi Naresh Kotangale	170589	30	23
5	Divya Shailendra Patil	170595	28	23
6	Gayatri Narendra Nagpure	170596	28	23
7	Gitika Subhash Machhale	170598	28	23
8	Komal Balidas Ukey	170611	28	22
9	Nandini Manohar Kushwaha	170619	29	23
10	Nisha Arjun Marthe	170624	29	23
11	Ranu Rajendra Wade	170635	29	23
12	Riya Arvind Thokal	170636	29	23
13	Rujal Rajendra Somkuwar	170639	29	22
14	Shravani Rajkumar Yerne	170648	29	22
15	Shreya Gajanan Kamble	170652	30	22
16	Shruti Ravindraj Manwatkar	170655	29	22
17	Shubhanshi Srikrishna Soni	170657	28	23
18	Shweta Ramesh Khirale	170658	29	23
19	Shweta Dhanraj Maraskolhe	170664	29	22
20	Usha Jaideo Nagdiwe	170670	27	22
21	Vaishnavi Pralhad Mankar	170671	29	22
22	Vaishnavi Sushil Nagrare	170674	26	22
23	Yashavee Rajiv Dhanvija	170679	27	22
24	Yugeshwari Deoram Nikhare	170680	27	22
25	Aditya Chandrashekar Sontake	170683	27	20
26	Aniket Umendra Paunikar	170690	22	23
27	Arpit Pramod Mendhe	170697	28	23
28	Atharv Nandkishor Moon	170700	29	22
29	Ayush Mukesh Indurkar			
30	Ayush Praveen Tirpude	170702	23	22
31	Ayush Rajesh Wanjari	170703	29	23
32	Chaitanya Ravishankar Bhakre	170708	22	18
33	Chinmay Vijay Ramteke	170709	29	23
34	Ganesh Prakash Yelakar	170717		
35	Ghanshyam Omprakash Nikhare	170719	30	23
36	Hariom Murlidhar Nikam	170721	29	23
37	Harsh Raju Magar	170723	29	23
38	Manish Bhojraj Parate	170734	23	20
39	Nishant Chhatrapal Nikose	170739	28	23
40	Om Dnyaneshwar Mankar	170740	28	23

41	Pawan Narendra Tidke	170744	29	23
42	Pranav Sanjay Tute	170746	29	23
43	Ritesh Chudiram Meshram	170751	28	23
44	Rohan Mahadeorao Gumgaokar	170754	29	23
45	Sahil Bhaskar Raut	170755	29	22
46	Samyak Tarachand Patil	170757	23	20
47	Sanket Sardar	170759	29	22
48	Satvik Rajendra Sharma	170762	23	20
49	Shantanu Gorakhna Throde	170764	29	22
50	Sujal Pramod Meshram	170770	29	23
50	Sumit Prabhat Gajbhiye	170733	28	22
52	Sumit Purushottam Dholne			
53	Sumit Radheshyam Sonwane			
54	Suraj Kunjbihari Yadav	170774	28	23
55	Suraj Ravindra Mozarkar	170775	30	23
57	Tushar Pawar	170779	28	23
56	Yasin Abdulkadar Sheikh	170793	28	22

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Assignment-I (2022-2023)

SECOND SEM

Branch/Semester: All / 2nd Sem **Subject:** Advanced Engineering Material **Code:** BSE2-2T

Section: C & D **Unit :** II DOD: 05/05/2023

Instruction: All Question are Compulsory DOS: 15/05/2023

Sr. No	Assignment 1	Marks	Blooms Level	Course Outcomes
1	Draw the energy band diagram for the p-n junction diode in forward and reversed biased mode.	3	Remembering	CO-2
2	Explain the formation of depletion region in a p-n junction. Also, draw it well diagram under equilibrium condition.	4	Remembering, Applying	
3	Explain the term: a. Drift current b. diffusion current.	4	Applying	
4	What is Zener diode? Explain the operation of a Zener diode in the forward and reverse bias condition.	5	Remembering, Applying	
5	Discuss the avalanche breakdown and Zener breakdown.	4	Understanding	

6	Explain the principle, construction and working of LED.	3	Understanding	
7	What is tunnel diode? Explain the V-I characteristics of a tunnel diode. State the application of tunnel diode.	4	Remembering, Understanding	
8	Derive expression for "Hall voltage" in Hall effect. Also define and find expression for "Hall Coefficient".	6	Applying	

SUBJECT TEACHER
Prof. Divya Lande

Assignment-II (2022-2023)

SECOND SEM

Branch/Semester: All / 2nd Sem **Subject:** Advanced Engineering Material **Code:** BSE2-2T

Section: C & D **Unit :** I DOD: 26/05/2023

Instruction: All Question are Compulsory DOS: 31/05/2023

Sr. No	Assignment 2	Marks	Blooms Level	Course Outcomes
1	Define the term Mobility and Relaxation time of free electron in a metal.	4	Remembering	CO-1
2	Explain the term drift velocity and carrier mobility	6	Understanding	
3	Using the free electron model derive and expression for electrical conductivity in metals	6	Applying	
4	What is Fermi Function? Draw graph showing its variation with energy at different temperature and show that the Fermi function is symmetrical at E=Ef	5	Remembering	
5	Draw energy band diagram for (i) intrinsic semiconductor (ii) n-type semiconductor (iii) p-type semiconductor at 0K and room temperature.	3	Remembering	

SUBJECT TEACHER

Prof. Divya Lande

Assignment-III (2022-2023)

SECOND SEM

Branch/Semester: All / 2nd Sem **Subject:** Advanced Engineering Material **Code:** BSE2-2T

Section: C & D **Unit :** III DOD: 01/06/2023

Instruction: All Question are Compulsory DOS: 05/06/2023

Sr. No	Assignment 3	Marks	Blooms Level	Course Outcomes
1	How do the property of surface area of Nano-materials differ from bulk-materials	4	Evaluating	CO-5
2	What are Zeolites? Give their applications.	4	Remembering, Understanding	
3	What are the causes of the drastic changes in the properties of the nanomaterials? Describe any one method of synthesis of nano-materials.	6	Remembering, Understanding, Applying	
4	Discuss the classification of Nano-materials.	4	Understanding	
5	Explain Ball Mill method of synthesis of nano materials.	4	Applying	
6	State the applications of nanomaterials in engineering. Explain why Nano-materials exhibit different physical and chemical properties.	6	Understanding, Applying	

SUBJECT TEACHER
Prof. Divya Lande

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501

Sessional-II (2022-2023)

SECOND SEM

Subject: Advanced Engineering Material

Code: BSE2-2T

Branch/Semester: All / 2nd Sem

Time: 3:30 to 4:30 **Date- 07/06/2023 Maximum Marks: 20**

Note: Attempt Questions from group CO-1 and CO-2 each.

Instruction to candidate :

1) All questions carry marks as indicate
2) Solve two questions as follows:
   (i)Q.No.1 OR Q.No.2 (ii) Q.No.3 OR Q.No.

Ques.		Description	Marks	Blooms level	CO-n
1	a)	Using free electron model derive an expression for electrical conductivity in metal. Define the term: Mobility and Relaxation time of free electrons in a metal	6	Applying	CO-1
	b)	Difference between an intrinsic and in n-type semiconductor on the basis of (1) Crystal representation, (2) band representation.	4	Understanding	
OR					
2	a)	Explain Fermi Distribution Function F(E). Show graphically and analytically that F(E) as function of E always pass through a point at different temperature.	6	Understanding	
	b)	Numaricals: (1) Evaluate the Fermi Function for energy KT above the Fermi energy. (2) The Fermi level for potassium is 2.1eV. Calculate the velocity of the electrons at the Fermi level.	4	Evaluating	
3	a)	Draw the energy band diagram for the p-n junction diode in forward biased and reverse biased. Define : Drift current Diffusion current.	6	Remembering	CO-2
	b)	With a net labeled diagram, explain transistor transistor action. When it is based to operate in the active region. Draw energy band diagram of N-P-N transistor common base mode.	4	Remembering & Understanding	
OR					
4	a)	What is Hall Effect? Explain and derive Hall Effect.	6	Applying	
	b)	Explain the principle, construction and working of LED. Explain the operation of Zener diode in the forward biased and reverse biased.	4	Analyzing, Evaluating	

Sessional-I (2022-2023)

SECOND SEM

Subject: Advanced Engineering Material

Code: BES-2T

Branch/Semester: All / 2nd Sem

Time: 9:45 to 10:45 **Date- 10/05/2023**

Maximum Marks: 20

Note: Attempt Questions from group CO-1 and CO-5 each.

Instruction to candidate :

1) All questions carry marks as indicate
2) Solve two questions as follows:
   (i)Q.No.1 OR Q.No.2 (ii) Q.No.3 OR Q.No.4

Ques.		Description	Marks	Blooms level	CO-n
1	a)	Using free electron model derive an expression for electrical conductivity in metal.	6	Applying	CO-1
	b)	Define the term: Mobility and Relaxation time of free electrons in a metal	4	Applying	
OR					
2	a)	Write down fermi distribution function F(E). Show Graphically and analytically that F(E) as a function of E always pass through a point at different temperature.	6	Understanding	
	b)	Explain Fermi Distribution Function F(E). Show graphically and analytically that F(E) as function of E always pass through a point at different temperature.	4	Understanding	
3	a)	Difference between an intrinsic and in n-type semiconductor on the basis of (1) Crystal representation, (2) band representation.	6	Understanding	CO-1
	b)	Numaricals: (1) Evaluate the Fermi Function for energy KT above the Fermi energy. (2) The Fermi level for potassium is 2.1eV. Calculate the velocity of the electrons at the Fermi level.	4	Evaluating	
OR					
4	a)	Explain the synthesis of nanomaterial? Describe any two method.	6	Understanding	CO-5
	b)	What are Nano Science? Explain the properties of Nanomaterial.	4	Remembering & Understanding	

PUT (2022-2023)

SECOND SEM

Subject: Advanced Engineering Material

Code: BSE2-2T

Branch/Semester: All / 2nd Sem

Time: 10:30 to 1:30 **Date- 26/06/2023**

Maximum Marks: 70

Note: Attempt Questions from group CO-1 and CO-2 each.

Instruction to candidate :

1) All questions carry marks as indicate
2) (i) Solve Q.No.1 OR Q.No.2
3) (ii) Solve Q.No.3 OR Q.No.4
4) (iii) Solve Q.No.5 OR Q.No.6
5) (iv) Solve Q.No.7 OR Q.No8.
6) (v) Solve Q.No.9 OR Q.No.10
7) Use of non programmable calculator is permitted.

Ques.		Description	Marks	Blooms level	CO-n
1	a)	Define the term Mobility and Relaxation time of free electron in a metal.	2	Remembering	CO-1
	b)	Explain the term drift velocity and carrier mobility	6	Understanding	
	c)	Using the free electron model derive and expression for electrical conductivity in metals	6	Applying	
OR					
2	a)	What is Fermi Function? Draw graph showing its variation with energy at different temperature and show that the Fermi function is symmetrical at E=Ef	5	Remembering	
	b)	Draw energy band diagram for (i) intrinsic semiconductor (ii) n-type semiconductor (iii) p-type semiconductor at 0K and room temperature.	3	Remembering	
	c)	Using the free electron model derive an expression for electrical conductivity in metals.	6	Applying	
3		Shows that for an intrinsic semiconductor the	5	Understanding	CO-2

	a)	Fermi energy level lies at the middle of the band gap.			
	b)	A strip of n-type germanium of width 0.5mm and thickness 1mm has a Hall coefficient 10^2 m^3/C. If the magnetic field used is 0.1T and current through the sample is 1mA, determine the hall voltage produced.	3	Evaluating	
	c)	Explain the principle, construction and working of LED. What is tunnel diode? Explain the V-I characteristics of tunnel diode. State the application of tunnel diode.	6	Remembering, Understanding, Applying	
OR					
4	a)	Derive expression for "Hall voltage" in Hall effect. Also define and find expression for "Hall Coefficient".	6	Applying	
	b)	Draw energy band diagram for biased n-p-n transistor.	4	Remembering	
	c)	For n-p-n transistor connected in CB mode, the emitter current is 3mA and base current is 25μA. Find the values of collector current and current gain.	4	Evaluating	
5	a)	Explain Ferromagnetic hysteresis on the basis of domain.	4	Analysing	CO-3
	b)	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.	6	Understanding	
	c)	What are hard and soft magnetic materials? Give their characteristic properties and application.	4	Remembering, Understanding	
OR					
6	a)	Explain Meissner effect and isotope effect.	7	Applying	
	b)	Explain the BCS theory with Key note of Cooper Pairs. Distinguish between type –I and type –II superconductors.	4	Understanding, Applying	
	c)	The critical field of niobium is 1 X 10^5A/m at 8K and 2 X 10^5 A/m at 0K. Calculate the transition temperature of the element.	3	Evaluating	
7	a)	Explain the terms: i) Absorption ii) Stimulated Emission iii) Population Inversion iv) Pumping v) Metastable state	5	Applying	
	b)	White light has frequency range of 0.4×10^{15} Hz to 0.7×10^{15} Hz. Find the coherence length.	3	Evaluating	

	c)	Explain the working of Ruby laser with the help of energy level diagram.	6	Applying	CO-4
		OR			
8	a)	Explain in brief the following typical characteristics of laser: i) Coherence ii) Intensity	4	Applying	
	b)	In He-Ne laser, what is the function of Helium atoms? Why is it necessary to use a tube of narrow diameter?	4	Analyzing	
	c)	Compute the coherence length of yellow light with 5893 A^{0} in 10 $^{-12}$ sec pulse duration. Also find the band width. If a light of 6000Å wavelength has a wavetrain 20λ long, what is its coherence time and coherence length	6	Evaluating	
9	a)	How do the property of surface area of Nano-materials differ from bulk-materials	4	Evaluating	CO-5
	b)	What are Zeolites? Give their applications.	4	Remembering, Understanding	
	c)	What are the causes of the drastic changes in the properties of the nanomaterials? Describe any one method of synthesis of nano-materials.	6	Remembering, Understanding, Applying	
		OR			
10	a)	Discuss the classification of Nano-materials.	4	Understanding	
	b)	Explain Ball Mill method of synthesis of nano materials.	4	Applying	
	c)	State the applications of nanomaterials in engineering. Explain why Nano-materials exhibit different physical and chemical properties.	6	Understanding, Applying	

Question Bank
2022-23

Branch	**All(CSE,ETC,EE)**
Semester	**2nd**
Subject	**Advanced Engineering Material**
Subject Code	**BES-2T**

Department of Applied Science & Humanities

	UNIT-I	Marks	Blooms Level	COn
1	Define the term i)Drift velocity ii) Carrier Mobility	2	Remembering	CO-1
2	Explain the terms mobility and relaxation time of free electron in a metal.	4	Analysing	
3	Draw energy band diagram for (i) intrinsic semiconductor (ii) n-type semiconductor (iii) p-type semiconductor at 0K and room temperature.	3	Remembering	
4	Using the free electron model derive an expression for electrical conductivity in metals.	3	Applying	
5	What is Fermi Function? Draw graph showing its variation with energy at different temperatureand show that the Fermi function is symmetrical at E=Ef	4	Remembering	
6	Evaluate the fermi function for energy KT above the Fermi energy.	3	Evaluating	
7	The Fermi level for potassium is 2.1eV. Calculate the velocity of the electron at the Fermi level.	3	Evaluating	
8	Illustrate Fermi Function and its variation with Temperature.	4	Analysing	
9	Define the term mobility and relaxation time of free	2	Remembering	

	electron in a metal.			
10	Elaborate the formation of energy bands in solids on the basis of band theory.	4	Understanding	
UNIT-II		Marks	Blooms Level	COn
11	Derive expression for "Hall voltage" in Hall effect. Also define and find expression for "Hall Coefficient".	4	Applying	CO-2
12	Draw energy band diagram for biased NPN transistor.	2	Remembering	
13	Define tunnel diode ? Explain the V-I characteristics of tunnel diode. State the application of tunneldiode.	3	Remembering, Understanding	
14	Shows that for an intrinsic semiconductor the Fermi energy level lies at the middle of the band gap	3	creating	
15	For npn transistor connected in CB mode, the emitter current is 3mA and base current is 25μA. Find the values of collector current and current gain.	3	Evaluating	
16	A strip of n-type germanium of width 0.5mm and thickness 1mm has a Hall coefficient 10^2 m^3/C. If the magnetic field used is 0.1T and current through the sample is 1mA, determine the hall voltage produced.	3	Evaluating	
17	Explain the principle, construction and working of LED.	4	Understanding, Analysing	
18	Discuss the avalanche breakdown and Zener breakdown	2	Remembering	
19	Define Dark current and draw the V-I characteristics of a photodiode.	3	Understanding	
20	Explain in transistor: i)Base is thin and lightly doped ii)Collector region has large are of cross section and iii)CB Junction is reverse biased.	4	Analysing	
UNIT-III		Marks	Blooms Level	COn
21	Explain Meissner effect and isotope effect.	4	Understanding	CO-3
22	Explain the BCS theory with Key note of Cooper Pairs.	4	Analysing	
23	The critical field of niobium is 1 X 10^5A/m at 8K and 2 X 10^5 A/m at 0K. Calculate the transition temperature of the element.	3	Evaluating	
24	Explain Ferromagnetic hysteresis on the basis of domain.	3	Analysing	
25	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.	4	Understanding	
26	What are hard and soft magnetic materials ? Give their characteristic properties and application.	4	Remembering	
27	Distinguish between type –I and type -II superconductors.	4	Understanding	
28	What should be the characteristics of permanent magnetic material ?	3	Analysing	
29	Write Cooper pair and Coherence length.	2	Understanding	
30	Define superconductor. Explain the effect of isotopic on superconductor.	4	Understanding, Analysing	

	UNIT-IV	Marks	Blooms Level	COn
31	Define the terms: i) Absorption ii) Stimulated Emission iii) Population Inversion	3	Remembering	CO-4
32	Explain in brief the following typical characteristics of laser: i) Coherence ii) Intensity	4	Understanding	
33	Explain the working of Ruby laser and construct the energy level diagram.	4	Analyzing	
34	Calculate the population of two states in a laser that produces light of wavelength 7000A ^{0} at 27 ^{0}C.	3	Evaluating	
35	Differentiate between (any Three points): Four level pumping scheme and Three level pumpingscheme.	4	Understanding	
36	Explain He-Ne laser, what is the function of Helium atoms? Why is it necessary to use a tube of narrow diameter?	4	Analyzing	
37	Explain the terms: 1) Pumping 2) Metastable state	4	Understanding	
38	Compute the coherence length of yellow light with 5893 A ^{0} in 10 $^{-12}$ sec pulse duration. Also find the band width.	3	Evaluating	
39	White light has frequency range of 0.4×10^{15} Hz to 0.7×10^{15} Hz. Find the coherence length.	3	Evaluating	
40	If a light of 6000Å wavelength has a wave train 20λ long, Calculate its coherence time and coherencelength ?	3	Evaluating	
	UNIT-V	Marks	Blooms Level	COn
41	Explain Ball Mill method of synthesis of nanomaterials.	4	Understanding	CO-5
42	State the applications of nanomaterials in engineering	2	Applying	
43	What are the causes of the drastic changes in the properties of the nanomaterials?	3	Remembering, Understanding	
44	Explain any one method of synthesis of nano-materials.	4	Understanding	
45	Discuss the classification of Nano-materials.	3	Understanding	
46	How do the property of surface area of Nano-materials differ from bulk-materials	4	Evaluating	
47	What are Zeolites? Give their applications.	3	Remembering & Applying	
48	Explain why Nano-materials exhibit different physical and chemical properties.	4	Understanding	
49	Discuss Ball Mill Method of synthesis. Give its advantages.	4	Understanding	
50	Write short note on Graphene.	3	Remembering	

Subject Teacher
Prof. Divya Lande

Start your Questions with following list of BT Verbs, to map the Blooms Level.

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Define	Approximate	Apply	Analyze	Compare	Assemble
Describe	Characterize	Assign	Characterize	Conclude	Combine
Draw	Clarify	Construct	Compare	Criticize	Compile
Enumerate	Classify	Demonstrate	Confirm	Defend	Compose
Identify	Compare	Derive	Correlate	Determine	Construct
List	Compute	Determine	Detect	Discriminate	Create
Match	Convert	Draw	Diagnose	Estimate	Design
State	Describe	Employ	Diagram	Evaluate	Develop
Study	Differentiate	Examine	Differentiate	Calculate	Formulate
Write	Discuss	Express	Discriminate	Compute	Generate
	Distinguish	Modify	Distinguish	Explain	Incorporate
	Elaborate	Plot	Examine	Grade	Integrate
	Estimate	Predict	Explain	Justify	Interface
	Explain	Prepare	Figure out	Measure	Model
	Express	Produce	Illustrate	Predict	Modify
	Give	Show	Infer	Prescribe	Organize
	Predict	Depict	Investigate	Rate	Prepare
	Review	Portray	Maximize	Summarize	perform
	Rewrite	Simulate	Minimize	Test	Produce
	Subtract	Sketch	Optimize	Validate	Program
	Summarize	Solve	Point out	Verify	Rearrange
	Translate	Use	transform		Reconstruct

21. University Results

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
Dahegaon, Kalmeshwar Road, Nagpur – 441501. Phone No. 07118-661400
Department of Applied Science & Humanities
Session 2022-23 (EVEN)
Lab Plan

Subject: Advance Engineering Material Subject Code: BSE2-2P Semester: Even Prof. Divya A. Lande Prof. Switi. R. Maske

Experiment. No.	Topic	Lesson Outcome: After learning the lesson students will be able to	Text Book/Reference Book	Page No.	Virtual Lab / Youtube link	CO Attained	Blooms level	Performance date			
								C1	C2	D1	D2
1	To study V-I characteristics of Semiconductor (p-n Junction) diode.	**Understand** the working of p-n junction diode	BOOK-1 Detail given below	95-100	1. https://youtu.be/Nds6Qrd6k40 2.https://be-iitkgp.vlabs.ac.in/exp/characteristics-diode/	CO-2	An	18/04/23	13/04/23	21/04/23	18/04/23
2	To study V-I characteristics of Zener diode.	To study the zener diode	BOOK-1 Detail given below	105-110	1. https://youtu.be/ryB36ixUp4w 2. http://ebootathon.com/labs/beta/ec/ElectronicsDevicesAndCircuitLab/exp1/	CO-2	An	25/04/23	18/04/23	28/04/23	25/04/23
3	To study Characteristics Transistor in common Base (CB) Mode.	**Explain** transistor in common base	BOOK-1 Detail given below	132-142	1. https://youtu.be/qOGdUsfcz04 2. http://vlabs.iitkgp.ernet.in/be/exp12/index.html	CO-2	An	9/5/2023	25/04/23	12/5/2023	2/5/2023
4	To study Characteristics Transistor in common Emitter (CE) Mode.	**Explain** transistor in common Emitter	BOOK-1 Detail given below	143-152	1. https://youtu.be/TOs8h_AiBJU 2. http://vlabs.iitkgp.ernet.in/be/exp11/index.html	CO-2	An	16/5/2023	9/5/2023	18/5/2023	9/5/2023
5	Determination of Band -Gap in a Semiconductor Using a reverse biased p-n junction diode.	**Demonstrate** band - gap in semiconductor	BOOK-1 Detail given below	14-19	1. https://youtu.be/7LeH6OSFTJ0 2. https://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1	CO-1	Un	18/05/23	10/5/2023	25/05/2023	25/05/2023
6	Determination of activation energy and temprature coefficient of a thermistor.	**Demonstrate** activation energy and temprature coefficient of a thermistor.	BOOK-1 Detail given below	20-28	1. https://youtu.be/y7U4GDUK0BU 2. https://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1	CO-1	Un	30/5/2023	28/05/2023	1/6/2023	1/6/2023

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List of Text books/Reference Books

1	Experiments in engineering physics : M. N. Avadhanulu, A. A. Dani and P. M. Pokley

Course Outcomes:	After completion of the course, students will be able to	Blooms Level
CO-1	Learn the concept of formation of energy band and to classify solids on its basis.	Un
CO-2	Identify and explain different types of diodes, transistors and its applications.	An
CO-3	Learn the concepts of magnetism and superconductivity, classify and analyze various types of magnetic and superconducting materials.	Un
CO-4	Learn and explain quantum transitions and apply it to working of laser.	Un
CO-5	Learn the concept of nanomaterials and compare its properties with those of bulk materials.	Un

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Question Bank

2022-23

Branch	**All(CSE,ETC,EE)**
Semester	**2nd**
Subject	**Advanced Engineering Material**
Subject Code	**BES-2T**

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Department of Applied Science & Humanities

	UNIT-I	Marks	Blooms Level	COn
1	Define the term i)Drift velocity ii) Carrier Mobility	2	Remembering	CO-1
2	Explain the terms mobility and relaxation time of free electron in a metal.	4	Analysing	
3	Draw energy band diagram for (i) intrinsic semiconductor (ii) n-type semiconductor (iii) p-type semiconductor at 0K and room temperature.	3	Remembering	
4	Using the free electron model derive an expression for electrical conductivity in metals.	3	Applying	
5	What is Fermi Function? Draw graph showing its variation with energy at different temperatureand show that the Fermi function is symmetrical at E=Ef	4	Remembering	
6	Evaluate the fermi function for energy KT above the Fermi energy.	3	Evaluating	
7	The Fermi level for potassium is 2.1eV. Calculate the velocity of the electron at the Fermi level.	3	Evaluating	
8	Illustrate Fermi Function and its variation with Temperature.	4	Analysing	
9	Define the term mobility and relaxation time of free electron in a metal.	2	Remembering	
10	Elaborate the formation of energy bands in solids on the basis of band theory.	4	Understanding	
	UNIT-II	Marks	Blooms Level	COn
11	Derive expression for "Hall voltage" in Hall effect. Also define and find expression for "Hall Coefficient".	4	Applying	CO-2
12	Draw energy band diagram for biased NPN transistor.	2	Remembering	
13	Define tunnel diode ? Explain the V-I characteristics of tunnel diode. State the application of tunneldiode.	3	Remembering, Understanding	
14	Shows that for an intrinsic semiconductor the Fermi energy level lies at the middle of the band gap	3	creating	
15	For npn transistor connected in CB mode, the emitter current is 3mA and base current is 25μA. Find the values of collector current and current gain.	3	Evaluating	
16	A strip of n-type germanium of width 0.5mm and thickness 1mm has a Hall coefficient 10^2 m^3/C. If the magnetic field used is 0.1T and current through the sample is 1mA, determine the hall voltage produced.	3	Evaluating	
17	Explain the principle, construction and working of LED.	4	Understanding, Analysing	

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18	Discuss the avalanche breakdown and Zener breakdown	2	Remembering	
19	Define Dark current and draw the V-I characteristics of a photodiode.	3	Understanding	
20	Explain in transistor: i)Base is thin and lightly doped ii)Collector region has large are of cross section and iii)CB Junction is reverse biased.	4	Analysing	
UNIT-III		Marks	Blooms Level	COn
21	Explain Meissner effect and isotope effect.	4	Understanding	CO-3
22	Explain the BCS theory with Key note of Cooper Pairs.	4	Analysing	
23	The critical field of niobium is 1 X 10^5A/m at 8K and 2 X 10^5 A/m at 0K. Calculate the transition temperature of the element.	3	Evaluating	
24	Explain Ferromagnetic hysteresis on the basis of domain.	3	Analysing	
25	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.	4	Understanding	
26	What are hard and soft magnetic materials ? Give their characteristic properties and application.	4	Remembering	
27	Distinguish between type –I and type -II superconductors.	4	Understanding	
28	What should be the characteristics of permanent magnetic material ?	3	Analysing	
29	Write Cooper pair and Coherence length.	2	Understanding	
30	Define superconductor. Explain the effect of isotopic on superconductor.	4	Understanding, Analysing	
UNIT-IV		Marks	Blooms Level	COn
31	Define the terms: i) Absorption ii) Stimulated Emission iii) Population Inversion	3	Remembering	CO-4
32	Explain in brief the following typical characteristics of laser: i) Coherence ii) Intensity	4	Understanding	
33	Explain the working of Ruby laser and construct the energy level diagram.	4	Analyzing	
34	Calculate the population of two states in a laser that produces light of wavelength 7000A ^{0} at 27 ^{0}C.	3	Evaluating	
35	Differentiate between (any Three points): Four level pumping scheme and Three level pumping scheme.	4	Understanding	
36	Explain He-Ne laser, what is the function of Helium atoms? Why is it necessary to use a tube of narrow diameter?	4	Analyzing	
37	Explain the terms: 1) Pumping 2) Metastable state	4	Understanding	

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38	Compute the coherence length of yellow light with 5893 A ^{0} in 10 $^{-12}$ sec pulse duration. Also find the band width.	3	Evaluating	
39	White light has frequency range of 0.4×10^{15} Hz to 0.7×10^{15} Hz. Find the coherence length.	3	Evaluating	
40	If a light of 6000Å wavelength has a wave train 20λ long, Calculate its coherence time and coherencelength ?	3	Evaluating	
UNIT-V		Marks	Blooms Level	COn
41	Explain Ball Mill method of synthesis of nanomaterials.	4	Understanding	CO-5
42	State the applications of nanomaterials in engineering	2	Applying	
43	What are the causes of the drastic changes in the properties of the nanomaterials?	3	Remembering, Understanding	
44	Explain any one method of synthesis of nano-materials.	4	Understanding	
45	Discuss the classification of Nano-materials.	3	Understanding	
46	How do the property of surface area of Nano-materials differ from bulk-materials	4	Evaluating	
47	What are Zeolites? Give their applications.	3	Remembering & Applying	
48	Explain why Nano-materials exhibit different physical and chemical properties.	4	Understanding	
49	Discuss Ball Mill Method of synthesis. Give its advantages.	4	Understanding	
50	Write short note on Graphene.	3	Remembering	

Subject Teacher
Prof. Divya Lande

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Start your Questions with following list of BT Verbs, to map the Blooms Level.

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Define	Approximate	Apply	Analyze	Compare	Assemble
Describe	Characterize	Assign	Characterize	Conclude	Combine
Draw	Clarify	Construct	Compare	Criticize	Compile
Enumerate	Classify	Demonstrate	Confirm	Defend	Compose
Identify	Compare	Derive	Correlate	Determine	Construct
List	Compute	Determine	Detect	Discriminate	Create
Match	Convert	Draw	Diagnose	Estimate	Design
State	Describe	Employ	Diagram	Evaluate	Develop
Study	Differentiate	Examine	Differentiate	Calculate	Formulate
Write	Discuss	Express	Discriminate	Compute	Generate
	Distinguish	Modify	Distinguish	Explain	Incorporate
	Elaborate	Plot	Examine	Grade	Integrate
	Estimate	Predict	Explain	Justify	Interface
	Explain	Prepare	Figure out	Measure	Model
	Express	Produce	Illustrate	Predict	Modify
	Give	Show	Infer	Prescribe	Organize
	Predict	Depict	Investigate	Rate	Prepare
	Review	Portray	Maximize	Summarize	perform
	Rewrite	Simulate	Minimize	Test	Produce
	Subtract	Sketch	Optimize	Validate	Program
	Summarize	Solve	Point out	Verify	Rearrange
	Translate	Use	transform		Reconstruct

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Sessional-II (2022-2023)

SECOND SEM

Subject: Advanced Engineering Material

Code: BSE2-2T

Branch/Semester: All / 2nd Sem

Time: 3:30 to 4:30 **Date- 07/06/2023**

Maximum Marks: 20

Note: Attempt Questions from group CO-1 and CO-2 each.

Instruction to candidate :
1) All questions carry marks as indicate
2) Solve two questions as follows:
(i)Q.No.1 OR Q.No.2 (ii) Q.No.3 OR Q.No.

Ques.		Description	Marks	Blooms level	CO-n
1	a)	Using free electron model derive an expression for electrical conductivity in metal. Define the term: Mobility and Relaxation time of free electrons in a metal	6	Applying	CO-1
	b)	Difference between an intrinsic and in n-type semiconductor on the basis of (1) Crystal representation, (2) band representation.	4	Understanding	
OR					
2	a)	Explain Fermi Distribution Function F(E). Show graphically and analytically that F(E) as function of E always pass through a point at different temperature.	6	Understanding	
	b)	Numaricals: (1) Evaluate the Fermi Function for energy KT above the Fermi energy. (2) The Fermi level for potassium is 2.1eV. Calculate the velocity of the electrons at the Fermi level.	4	Evaluating	
3	a)	Draw the energy band diagram for the p-n junction diode in forward biased and reverse biased. Define : Drift current Diffusion current.	6	Remembering	CO-2
	b)	With a net labeled diagram, explain transistor transistor action. When it is based to operate in the active region.	4	Remembering	

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		Draw energy band diagram of N-P-N transistor common base mode.		& Understanding	
OR					
4	a)	What is Hall Effect? Explain and derive Hall Effect.	6	Applying	
	b)	Explain the principle, construction and working of LED. Explain the operation of Zener diode in the forward biased and reverse biased.	4	Analyzing, Evaluating	

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Sessional-I (2022-2023)

SECOND SEM

Subject: Advanced Engineering Material

Code: BES-2T

Branch/Semester: All / 2nd Sem

Time: 9:45 to 10:45 **Date- 10/05/2023**

Maximum Marks: 20

Note: Attempt Questions from group CO-1 and CO-5 each.

Instruction to candidate :
1) All questions carry marks as indicate
2) Solve two questions as follows:
(i)Q.No.1 OR Q.No.2 (ii) Q.No.3 OR Q.No.4

Ques.		Description	Marks	Blooms level	CO-n
1	a)	Using free electron model derive an expression for electrical conductivity in metal.	6	Applying	CO-1
	b)	Define the term: Mobility and Relaxation time of free electrons in a metal	4	Applying	
OR					
2	a)	Write down fermi distribution function F(E). Show Graphically and analytically that F(E) as a function of E always pass through a point at different temperature.	6	Understanding	
	b)	Explain Fermi Distribution Function F(E). Show graphically and analytically that F(E) as function of E always pass through a point at different temperature.	4	Understanding	
3	a)	Difference between an intrinsic and in n-type semiconductor on the basis of (1) Crystal representation, (2) band representation.	6	Understanding	CO-1
	b)	Numericals: (1) Evaluate the Fermi Function for energy KT above the Fermi energy. (2) The Fermi level for potassium is 2.1eV. Calculate the velocity of the electrons at the Fermi level.	4	Evaluating	
OR					

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4	a)	Explain the synthesis of nanomaterial? Describe any two method.	6	Understanding	CO-5
	b)	What are Nano Science? Explain the properties of Nanomaterial.	4	Remembering & Understanding	

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501

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INDEX

LAB COURSE FILE

SUBJECT: Advanced Engineering Materials (BSE2-2P)
SEMESTER: Second Semester B.Tech.
ACADEMIC - YEAR: 2021-2022
Batches: A-1, A-2, B-1 & B-2

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10	REFERENCE BOOK	14

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Department of Applied Sciences and Humanities

ADVANCED ENGINEERING MATERAIL LAB COURCE FILE

(Subject Code: BSE2-02Practical)

Academic Year 2021-2022

Second B.Tech **Semester**

Asst. Prof. DIVYA LANDE

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
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PHYSICS DEPARTMENT

Lab Course for the Academic Year 2021-22

(In accordance with **RTMNU** syllabus)

SUBJECT : **Applied Physics Practical**

SUBJECT CODE : **BSE2-02 Practical**

YEAR : **FIRST YEAR/Second Semester B.Tech**

SUBJECT TEACHER : **Prof. Sadaf Gauhar**

Prof. DIVYA LANDE

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Dahegaon, Kalmeshwar Road, Nagpur-441 50

SYLLABUS

Course Outcomes

The course will enable the students to

CO1. Learn the concept of formation of energy bands and to classify solids on its basis.

CO2. Identify and explain different types of diodes, transistors and its applications

CO3. Learn the concepts of magnetism and superconductivity, classify and analyze various types of magnetic and superconducting materials.

CO4. Learn and explain quantum transitions and apply it to working of lasers.

CO5. Learn the concept of nano materials and compare its properties with those of bulk materials.

Unit - 1: Band theory of solids (6 Hrs) 14 Marks

Basic idea of free electron theory of metals, expression of conductivity of a metal. Formation of energy bands in Solids, Fermi energy and Fermi level.

Classification of solids on the basis of energy band diagram: Conductors, Semiconductors and Insulators, concept of Fermi energy.

Unit-2: Semiconductor Devices (7 Hrs) 14 Marks

Types of Semiconductor diodes, P-N junction Diode: Characteristics of P-N junction Diode, Tunnel Diode, Zener Diode, LED, Photodiode.

Transistors . Hall effect, Hall voltage and Hall coefficient; its applications,

Unit 3: Magnetic and Superconducting Materials (10 Hrs) 14 Marks

Diamagnetic, Paramagnetic, Ferromagnetic, Ferri-magnetic and anti ferromagnetic materials: Explanation on the basis of domain. Hysteresis curve, Characteristics of ferromagnetic, diamagnetic and paramagnetic materials and their applications.

_Superconductors: Basics of superconductivity: Zero electrical resistance, Persistent current Effect of Temperature, Effect of Magnetic Field, Critical Current; The Meissner Effect.Type-I and type-II superconductors, London Equation: The penetration depth, Bardeen-Cooper-Schrieffer (BCS) theory.

Unit 4: Lasers (7 Hrs) 14 Marks

Quantum Transitions: Absorption, Spontaneous emission & stimulated

Emission, Metastable states, Principle of laser, Laser characteristics, Coherence length and coherence time, Pumping schemes: Three level and Four level.

Optical Resonator, Construction & working of Ruby laser and He-Ne laser, Applications of laser.

Unit 5: Nanoscience and Nanomaterials (6 Hrs) 14 Marks

Introduction to Nanoscience, Classification of nano materials, Types of Synthesis of Nanomaterials, Comparison of properties of nanomaterials with bulk materials,

Some special nanomaterials: 1) Zeolites, 2) Graphine, Application of nanomaterials in engineering.

Suggested Text Books &Reference Books

1. ***Solid state Physics, S. O. Pillai, New Age publications.***
2. *Charles Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th edition, (1983).*
3. *A.J. Dekker Electrical Engineering Materials, Prentice Hall of India(1971).*
4. *Fundamentals of Physics by D. Halliday, R. Resnick and J. Walker, John Wiley and Sons Inc.*
5. *K. Thyagarajan and A. K. Ghatak, Lasers Theory and Applications, Mcmillan(1981).*
6. *A textbook of Engineering Physics, Dr. M. N. Avdhanulu, Dr. P. G. Kshirsagar, S. Chand Publication*
7. *A text Book of Advanced Engineering Materials, Dr. D. S. Hardas, , Dr.S.Shastri, Dr. (Mrs)S.P. Wankhede, Dr. D. S. Bhoumik, Dr. (Mrs.)S.U.Bhonsule, Dr.Shruti Patle, , Das Ganu Publication ISBN-978-93-84336-70-7 (2021)*
8. *A text Book of Advanced Physics, Dr. D. S. Hardas, Dr.A. R. Panat , Das Ganu Publication ISBN-978-93-81660-49-2 (2013)*
9. *Advanced physical science for Engineers, Dr. S. Patle, Dr. S. U. Bhonsule, Dr. N. Ugemuge, Dr. S. P. Wankhede, DNA publication*
10. *Advanced Engineering Materials, M. N. Avdhanulu, Shilpa A. Pande, Arti R. Golhar, Mohan Giriya, S. CHAND*
11. *W. Saslow, Electricity, Magnetism and light.*
12. *Solid state Physics by R. L. Singhal, Kedarnath Ramnath & Co.Meerut*
13. *Introduction to Lasers Theory and Applications by M. N. Avadhanulu, S. Chand and Company*

14. *Engineering Physics by P. K. Palaniswamy, Scitech(2005)*
15. *Engineering Physics by H. Malik and A. K. Singh,TMH(2010)*
16. *Engineering Physics by D. K. Bhattacharya and A. Bhaskaran, Oxford University Press (2010)*

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Course Code	BSE2-2P				
Course Title	Advanced Engineering Material				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	3	1.5	II

Examination Scheme	
P (U): 25 Marks P (I): 25 Marks	Duration of University Exam. : 03 Hours

Course Outcomes

Students will be able to

CO1. Learn the concept of formation of energy bands and to classify solids on its basis.

CO2. Identify and explain different types of diodes, transistors and its applications

CO3. Learn the concepts of magnetism and superconductivity, classify and analyze various types of magnetic and superconducting materials.

CO4. Learn and explain quantum transitions and apply it to working of lasers.

CO5. Learn the concept of nano materials and compare its properties with those of bulk materials.

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List of Activities

1. Study of band gap of various semiconducting materials.
2. Variation of Fermi energy with respect to various parameters.
3. Identification of N-type & P-type semiconductor on virtual lab.
4. Testing of resistor, transistor, diode, capacitor with the help of multimeter / CRO.
5. Compare Cut-in-voltages of various LEDs.
6. Study of lines of force using bar magnet & iron fillings.
7. Gather information about Maglev train.
8. Write up on History of superconductivity.
9. Study of application of superconductor.
10 Measure the divergence of various sources of light such as torch, laser, tubelight, etc.
11. Understanding the phenomenon of stimulated emission, absorption & stimulated emission.
12. Laser applications in day to day life.
13. Collect information about Holography.
14. Write short note on Discovery of nano materials
15. Applications of nano materials.
16. Industrial Visit

Note : Performance of at least one activities is compulsory in a semester.

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List of Experiments

1. Energy gap of semiconductor /thermistor
2. Parameter extraction from V-I characteristics of PN junction diode.
3. Parameter extraction from V-I characteristics of Zener diode.
4. Parameter extraction from V-I characteristics of PNP/NPN transistor in CB and CE mode.
5. V-I Characteristics of Tunnel diode.
6. V-I Characteristics of Light Emitting Diodes.
7. Study of Diode rectification.
8. Study of Hall Effect and determination of Hall Voltage of given sample.
9. Variation of Hall coefficient (R_H) with temperature.
10. To study B-H curve and to find out the values of coercivity, retentivity and saturation magnetisation of experimental material.
11. Laser source: Determination of wavelength by diffraction grating.

Note: Performance of at least **six** experiments is compulsory in a semester.

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LAB TIME-TABLE (SEM-II/2022)

Day	Time	10.00am - 10.50 am	10.50 am -11.40 am	11.4am - 12.30 pm	12.30 pm - 01.10 pm	01.10 pm - 02.00 pm	02.00 pm - 02.50 pm	02.50 pm - 03.00 pm	03.00 pm - 04.00 pm	04.00 pm - 05.00 pm
MON					SECTION WISE STUDENT					AC -PR. (B2)
TUE						AC- PR. (A2)				
WED										AC- PR. (A1)
THU							AC- P(B1)			
FRI										

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HOD REVIEW:

SL. NO	Date of Review	Remarks	PDC for Completion	Signature
1				
2				
3				
4				
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12				

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13				
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20				

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DISTRIBUTION OF BATCHES

SECTION: A

BATCH: A-1 (1-29)		BATCH: A-2 (30-61)	
GROUP	**ROLL NUMBER**	**GROUP**	**ROLL NUMBER**
G-1	**1-7**	G-1	**30-37**
G-2	**8-14**	G-2	**38-44**
G-3	**15-21**	G-3	**45-51**
G-4	**22-29**	G-4	**52-61**

SECTION: B

BATCH: B-1 (1-30)		BATCH: B-2 (31-61)	
GROUP	**ROLL NUMBER**	**GROUP**	**ROLL NUMBER**
G-1	1-6	**G-1**	31-36
G-2	7-12	**G-2**	37-42
G-3	13-18	**G-3**	43-48
G-4	19-24	**G-4**	49-54
G-5	25-30	**G-5**	55-61

SUBJECT TEACHER
Ass.prof.Sadaf Gauhar
Asst.prof.Divya Lande

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LAB EXPERIMENT SCHEDULE:

SUBJECT: Advanced Engineering Material
SEMESTER: Second Semester B.Tech **Batch: A-1**

Batch: A-1					
DATE	**G-1**	**G-2**	**G-3**	**G-4**	**G-5**
24/05/2022	BASIC CONCEPT OF CHEMISTRY /INTRODUCTION OF LAB				
31/05/2022	1	2	3	4	5
07/06/2022	2	3	4	5	6
21/06/2022	3	4	5	6	1
28/06/2022	REPEAT & MANUAL CHECKING				
05/07/2022	4	5	6	1	2
12/07/2022	5	6	1	2	3
19/07/2022	6	1	2	3	4
26/07/2022	REPEAT PERFORMANCE IF NEED				
02/08/2022	INTERNAL PERFORMANCE & VIVA				

SIGNATURE

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LAB EXPERIMENT SCHEDULE:

SUBJECT: Advanced Engineering Material
SEMESTER: Second Semester B.Tech
Batch: A-2

Batch: A-2					
DATE	**G-1**	**G-2**	**G-3**	**G-4**	**G-5**
24/05/2022	BASIC CONCEPT OF CHEMISTRY/INTRODUCTION OF LAB				
25/05/2022	1	2	3	4	5
01/06/2022	2	3	4	5	6
08/06/2022	3	4	5	6	1
15/06/2022	REPEAT & MANUAL CHECKING				
22/06/2022	4	5	6	1	2
29/06/2022	5	6	1	2	3
06/07/2022	6	1	2	3	4
12/07/2022	REPEAT PERFORMANCE IF NEED				
19/07/2022	INTERNAL PERFORMANCE & VIVA				

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LAB EXPERIMENT SCHEDULE:

SUBJECT: Advanced Engineering Material
SEMESTER: Second Semester B.Tech
Batch: B-1

Batch: B-1					
DATE	**G-1**	**G-2**	**G-3**	**G-4**	**G-5**
23/05/2022	BASIC CONCEPT OF CHEMISTRY /INTRODUCTION OF LAB				
30/05/2022	1	2	3	4	5
06/06/2022	2	3	4	5	6
13/06/2022	3	4	5	6	1
20/06/2022	REPEAT & MANUAL CHECKING				
27/06/2022	4	5	6	1	2
04/07/2022	5	6	1	2	3
11/07/2022	6	1	2	3	4
18/07/2022	REPEAT PERFORMANCE IF NEED				
25/07/2022	INTERNAL PERFORMANCE & VIVA				

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LAB EXPERIMENT SCHEDULE:

SUBJECT: Advanced Engineering Material
SEMESTER: Second Semester B.Tech
Batch: B-2

Batch: B-2					
DATE	**G-1**	**G-2**	**G-3**	**G-4**	**G-5**
26/05/2022	BASIC CONCEPT OF CHEMISTRY /INTRODUCTION OF LAB				
02/06/2022	1	2	3	4	5
09/06/2022	2	3	4	5	6
16/06/2022	3	4	5	6	1
23/06/2022	REPEAT & MANUAL CHECKING				
30/06/2022	4	5	6	1	2
07/07/2022	5	6	1	2	3
14/07/2022	6	1	2	3	4
21/07/2022	REPEAT PERFORMANCE IF NEED				
28/07/2022	INTERNAL PERFORMANCE & VIVA				

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PRACTICAL MARKS VALUATION SHEET:

SECTION: A

Marks allotted for Particular Experiments									
SR NO	ROLL NO	NAME OF THE STUDENT	1	2	3	4	5	6	Total (Out of 25)
1	1	Aastha Ravindrakumar							
2	2	Achal Gangadhar Kalambe							
3	3	Bipasha Nilamkumar Rangari							
4	4	Bipasha Shailesh Yadav							
5	5	Damini Hiralal Gautam							
6	6	Dipali Gajanan Wagh							
7	7	Dixika Gautam Kothare							
8	8	Harsha Jitendra Bhimte							
9	9	Hiteshi Bhaurao Harode							
10	10	Janhavi Dilip Thakare							
11	11	Khushi Dharmaraj Kelwade							
12	12	Khushi Mahendra Fiske							
13	13	Khushi Sameer Mukhare							
14	14	Laxmi Amar Meshram							
15	15	Leena Pramod Bobde							
16	16	Megha Yogiraj Sontakke							
17	17	Mohini Panjab Rajguru							
18	18	Pooja Mahesh Sakhare							
19	19	Prajkta Namdevrao Deosarkar							
20	20	Pratiksha Raju Unpane							
21	21	Prachi Mohan Bahad							
22	22	Prishita Ravi Bagde (NR)							
23	23	Prerna Rajesh Usare							

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24	24	**Priyanka Suresh Chavhan**							
25	25	**Rajju Ramratan Wanve**							
26	26	**Samiksha Vijay**							
27	27	**Sejal Kailash Waghmare**							
28	28	**Sheikh Najiya Abdul Kalam**							
29	29	**Trushna Ramdas Kaware**							
30	30	**Abhishek Anil Rangari**							
31	31	**Abhishek Sunil Washimkar**							
32	32	**Aman Prakash Borkar**							
33	33	**Amit Abhay Walekar**							
34	34	**Anurag Rajesh Lanjewar (NR)**							
35	35	**Anuj Raju Zanzal (NR)**							
36	36	**Aryan Arvind Sambhe**							
37	37	**Ayush Khemraj Ramteke**							
38	38	**Ayush Vinod Verma (NR)**							
39	39	**Ashish Harichand Rathod**							
40	40	**Ayush Sanjay Bhaisare (NR)**							
41	41	**Sahil Dhanraj Raikohad**							
42	42	**Ganesh Tirupati Sirangi (NR)**							
43	43	**Harsh Sharma**							
44	44	**Karan Deepak Parate**							
45	45	**Kamal Rupchand Rane**							
46	46	**Kush Vijay Sahu**							
47	47	**Love Vijay Sahu**							
48	48	**Mandar Rajesh Lanjewar**							
49	49	**Mayur Vijay Chopade**							
50	50	**Pratham Sudam Wasnik**							
51	51	**Prajwal Arvind Bawankar**							
52	52	**Prathmesh Shyam Bhingare**							
53	53	**Ritesh Sunil Wankhade**							
54	54	**Rohan Umendra Sakhare (NR)**							
55	55	**Rohit Natthuji Kharpuriya**							
56	56	**Sagar Dinesh Nagarikar (NR)**							
57	57	**Satish Pancham Gharde**							
58	58	**Shrikant Jugalkishor Dad**							
59	59	**Shrikant Namdeo Landge**							

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60	60	**Tanay Kshirsagar**							
61	61	**Vivek Bhauraj Gautam**							

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MARKS FOR INTERNAL PRACTICAL EXAMINATION 2021-22:

SECTION: A

SR NO	ROLL NO	NAME OF THE STUDENT	Total (Out of 25)
1	1	Aastha Ravindrakumar Raulkar	
2	2	Achal Gangadhar Kalambe	
3	3	Bipasha Nilamkumar Rangari	
4	4	Bipasha Shailesh Yadav	
5	5	Damini Hiralal Gautam (NR)	
6	6	Dipali Gajanan Wagh	
7	7	Dixika Gautam Kothare	
8	8	Harsha Jitendra Bhimte	
9	9	Hiteshi Bhaurao Harode	
10	10	Janhavi Dilip Thakare	
11	11	Khushi Dharmaraj Kelwade	
12	12	Khushi Mahendra Fiske	
13	13	Khushi Sameer Mukhare	
14	14	Laxmi Amar Meshram	
15	15	Leena Pramod Bobde	
16	16	Megha Yogiraj Sontakke	
17	17	Mohini Panjab Rajguru	
18	18	Pooja Mahesh Sakhare	
19	19	Prajkta Namdevrao Deosarkar	
20	20	Pratiksha Raju Unpane	
21	21	Prachi Mohan Bahad	
22	22	Prishita Ravi Bagde (NR)	
23	23	Prerna Rajesh Usare	
24	24	Priyanka Suresh Chavhan	
25	25	Rajju Ramratan Wanve	
26	26	Samiksha Vijay Puramshettiwar	

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27	27	**Sejal Kailash Waghmare**	
28	28	**Sheikh Najiya Abdul Kalam**	
29	29	**Trushna Ramdas Kaware**	
30	30	**Abhishek Anil Rangari**	
31	31	**Abhishek Sunil Washimkar**	
32	32	**Aman Prakash Borkar**	
33	33	**Amit Abhay Walekar**	
34	34	**Anurag Rajesh Lanjewar (NR)**	
35	35	**Anuj Raju Zanzal (NR)**	
36	36	**Aryan Arvind Sambhe**	
37	37	**Ayush Khemraj Ramteke**	
38	38	**Ayush Vinod Verma (NR)**	
39	39	**Ashish Harichand Rathod**	
40	40	**Ayush Sanjay Bhaisare (NR)**	
41	41	**Sahil Dhanraj Raikohad**	
42	42	**Ganesh Tirupati Sirangi (NR)**	
43	43	**Harsh Sharma**	
44	44	**Karan Deepak Parate**	
45	45	**Kamal Rupchand Rane**	
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47	47	**Love Vijay Sahu**	
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49	49	**Mayur Vijay Chopade**	
50	50	**Pratham Sudam Wasnik**	
51	51	**Prajwal Arvind Bawankar**	
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53	53	**Ritesh Sunil Wankhade**	
54	54	**Rohan Umendra Sakhare (NR)**	
55	55	**Rohit Natthuji Kharpuriya (NR)**	
56	56	**Sagar Dinesh Nagarikar (NR)**	
57	57	**Satish Pancham Gharde**	
58	58	**Shrikant Jugalkishor Dad**	
59	59	**Shrikant Namdeo Landge (NR)**	
60	60	**Tanay Kshirsagar**	
61	61	**Vivek Bhauraj Gautam**	

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PRACTICAL MARKS VALUATION SHEET:

SECTION: B

Marks allotted for Particular Experiments									
SR NO	ROLL NO	NAME OF THE STUDENT	1	2	3	4	5	6	Total (Out of 25)
1	1	Dhillon Jasleen Kaur Rakhbir Singh							
2	2	Divya Anil Bhagat (NR)							
3	3	Jyoti Mahagilal Tileshwar (NR)							
4	4	Khushi Arvind Damahe							
5	5	Lila Namdeo Rokade (NR)							
6	6	Madhuri Bandu Kamble (NR)							
7	7	Pragati Arun Mahalle (NR)							
8	8	Pooja Chandrakant Shriwas							
9	9	Ravishi Rajendra Tembhare							
10	10	Riya Shashikant Bang							
11	11	Rohini Pandhree Zilpe (NR)							
12	12	Sayyad Maivish parvin Alim (NR)							
13	13	Shrutika Kishor Wadibhasme							
14	14	Sneha Kacharu Jagtap (NR)							
15	15	Samiksha Umrao Bhagat							
16	16	Sheikh Feeza Zaki (NR)							
17	17	Sheikh Rohma Arshin Mohd Sayeed							
18	18	Shruti Pravin Kolhe							
19	19	VaishnaviRajeshChute							
20	20	Akash Gopal Mohurle (NR)							
21	21	Aniket Umashankar Tiwari (NR)							

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22	22	**Bhavesh Sampat Sahu**							
23	23	**Danish Khan Ahmadullah Khan**							
24	24	**Dhammadip Nilesh Gondane**							
25	25	**Ganesh Sureshrao Paunikar (NR)**							
26	26	**Gaurav Madhukar Palkar (NR)**							
27	27	**Harshal Gulabrao Nagpure**							
28	28	**Harshal Nilkanth Thakre (NR)**							
29	29	**Kranti Dhanraj Choudhary (NR)**							
30	30	**Lokesh Khushal Sable**							
31	31	**Manish Suresh Katre (NR)**							
32	32	**Nikesh Sukhram Khobragade (NR)**							
33	33	**Nikhil Keshorao Bhoskar (NR)**							
34	34	**Nikhil Nareshrao Balanse**							
35	35	**Om Vijay Uttarwar**							
36	36	**Pankaj Ajayrao Kale (NR)**							
37	37	**Prajwal Chaitram Fulzele**							
38	38	**Ritik Vinodkumar Harinkhede (NR)**							
39	39	**Ritik Jitendra Khobragade**							
40	40	**Ritik Krishna Lohande (NR)**							
41	41	**Roshan Dharamlal Turkar (NR)**							
42	42	**Rutwik Sunil Dhamande (NR)**							
43	43	**Sanket Pramod Maske (NR)**							
44	44	**Sayyed Mujahid Sayyed Javed (NR)**							
45	45	**Saifuddin Abid Quereshi**							
46	46	**Suraj Mate**							
47	47	**Shashank Shrikurshana Maske (NR)**							
48	48	**Shreeram Gajanan Dad**							
49	49	**Shreyash Yashwant Rambhad (NR)**							
50	50	**Siddhant Dilip Madavi (NR)**							
51	51	**Suchit Shankarrao Shendre**							
52	52	**Suraj Dilip Dhote**							
53	53	**Swapnil Ramesh Surankar (NR)**							
54	54	**Tejas Sadanand Nagrale (NR)**							
55	55	**Tejaskumar Nitin Pohare (NR)**							
56	56	**Tharun Iragavarapu**							
57	57	**Vaibhav Krishna Neware (NR)**							

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58	58	**Vikas Ramdas Telse (NR)**							
59	59	**Vrushabh Vishwas Virkar**							
60	60	**Yashwant Ankush Lohande**							
61	61	**Yash Gulab Charpe**							

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MARKS FOR INTERNAL PRACTICAL EXAMINATION 2021-22:

SECTION: B

SR NO	Roll NO	NAME OF THE STUDENT	Total (Out of 25)
1	1	Dhillon Jasleen Kaur Rakhbir Singh	
2	2	Divya Anil Bhagat (NR)	
3	3	Jyoti Mahagilal Tileshwar (NR)	
4	4	Khushi Arvind Damahe	
5	5	Lila Namdeo Rokade (NR)	
6	6	Madhuri Bandu Kamble (NR)	
7	7	Pragati Arun Mahalle (NR)	
8	8	Pooja Chandrakant Shriwas	
9	9	Ravishi Rajendra Tembhare	
10	10	Riya Shashikant Bang	
11	11	Rohini Pandhree Zilpe (NR)	
12	12	Sayyad Maivish parvin Alim (NR)	
13	13	Shrutika Kishor Wadibhasme	
14	14	Sneha Kacharu Jagtap (NR)	
15	15	Samiksha Umrao Bhagat	
16	16	Sheikh Feeza Zaki (NR)	
17	17	Sheikh Rohma Arshin Mohd Sayeed	
18	18	Shruti Pravin Kolhe	
19	19	Vaishnavi RajeshChute	
20	20	Akash Gopal Mohurle (NR)	
21	21	Aniket Umashankar Tiwari (NR)	
22	22	Bhavesh Sampat Sahu	
23	23	1. Danish Khan Ahmadullah Khan (NR)	
24	24	Dhammadip Nilesh Gondane	
25	25	Ganesh Sureshrao Paunikar (NR)	

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26	26	**Gaurav Madhukar Palkar (NR)**	
27	27	**Harshal Gulabrao Nagpure**	
28	28	**Harshal Nilkanth Thakre (NR)**	
29	29	**Kranti Dhanraj Choudhary (NR)**	
30	30	**Lokesh Khushal Sable**	
31	31	**Manish Suresh Katre (NR)**	
32	32	**Nikesh Sukhram Khobragade (NR)**	
33	33	**Nikhil Keshorao Bhoskar (NR)**	
34	34	**Nikhil Nareshrao Balanse**	
35	35	**Om Vijay Uttarwar**	
36	36	**Pankaj Ajayrao Kale (NR)**	
37	37	**Prajwal Chaitram Fulzele**	
38	38	**Ritik Vinodkumar Harinkhede (NR)**	
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49	49	**Shreyash Yashwant Rambhad (NR)**	
50	50	**Siddhant Dilip Madavi (NR)**	
51	51	**Suchit Shankarrao Shendre**	
52	52	**Suraj Dilip Dhote**	
53	53	**Swapnil Ramesh Surankar (NR)**	
54	54	**Tejas Sadanand Nagrale (NR)**	
55	55	**Tejaskumar Nitin Pohare (NR)**	
56	56	**Tharun Iragavarapu**	
57	57	**Vaibhav Krishna Neware (NR)**	
58	58	**Vikas Ramdas Telse (NR)**	
59	59	**Vrushabh Vishwas Virkar**	
60	60	**Yashwant Ankush Lohande**	
61	61	**Yash Gulab Charpe**	

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ATTENDANCE DEFAULTERS:

Section –A & Section B

ROLL NO.	NAME	SECTION SECTION	PERCENTAGE %
		A	
	Samiksha bhagat		
	Damini Hiralal Gautam	B	

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Contents of Lab Course File:

Sr. No.	Item Description	DATE OF VERIFICATION BY HOD		
1	Course Objective			
2	Time Table			
3	RTMNU Syllabus			
4	Guidelines to students			
5	List of Experiments			
6	Allotment of Practical Section wise & Group wise			
7	Date wise performance			
8	Practical Marks Valuation Sheet			
9	Internal Examination Valuation Sheet			
10	Attendance Defaulters			
11	Books/ Materials			

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
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GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY

APPROVED BY AICTE, DTE & AFFILIATED TO RTM NAGPUR UNIVERSITY, NAGPUR

Dahegaon, Opp. IOC Petrol Pump, Kalmeshwar Road, Nagpur – 441501 Ph. 07118-661400

Website: www.gniet.ac.in Email: gnietnagpur@gmail.com

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY

Dahegaon, Kalmeshwar Road, Nagpur-441 50

Time Table (B. Tech. SECOND SEMESTER)

w.e.f. 09/05/2022

Day	Time	10.00 am - 10.50 am	10.50 am - 11.40 am	11.40 am - 12.30 pm	12.30 pm-01.10 pm	01.10pm-02.00 pm	02.00 pm-02.50 pm	02.50pm-03.00 pm	03.00 pm-04.00 pm	04.00 pm- 05.00 pm
MON	A	M-II (SB)	AEM (SG)	AC (SS)	LONG BREAK/STUDENT SECTION	CS (AP)	BEE (PB) T	SHORT BREAK	WP -PR.(A1) / CS-PR.(A2)	
	B	AC (SS)	EM (BR)	M-II (SB)		EM (BR)	CS (AP)		AEM -PR.(B1) / AC -PR. (B2)	
TUE	A	AC (SS)	M-II (SB)	AEM (SG)		AEM- PR.(A1) / AC- PR. (A2)			EM (BR)	Library/Query Session
	B	AEM (SG)	CS (AP)	AC (SS)		WP -PR.(B2) / CS- PR.(B1)			M-II (SB) T	
WED	A	EM (BR)	M-II (SB)	AC (SS) T		CS (AP)	BEE (PB)		AEM- PR.(A2) / AC- PR. (A1)	
	B	AC (SS)	EM (BR) T	AEM (SG)		BEE (PB) T	M-II (SB)		WP- PR. (B1) / CS- PR. (B2)	
THU	A	AC (SS)	AEM (SG) T	M-II (SB)		EM (BR) T	ICC (PN)		WP -PR. (A2) / CS- PR. (A1)	
	B	M-II (SB)	CS (AP) T	AC (SS)		AEM (SG)	BEE (PB)		AC- P(B1) / AEM -PR. (B2)	
FRI	A	M-II (SB) T	AC (SS)	AEM (SG)		BEE (PB)	ICC (PN)		CS (AP) T	Sports
	B	AEM (SG) T	BEE (PB)	ICC (PN)		AC (SS) T	M-II (SB)		ICC (PN)	

Sr. No.	Name of Faculty	Subject	Abbreviation	Section
1	Prof. Sadaf Gauhar	AEM (TH+PR)	AEM(SG)	A, B In Batches: A1, A2, B1, B2
2	Prof. Kishor Wagh	WP (PR)	WP (KW)	A, B
2	Prof. Sandeep Bhongade	M-II (TH)	M-II (SB)	A, B
3	Prof. Suharshana Somkuwar	AC (TH+PR)	AC (SS)	A, B In Batches: A1, A2, B1, B2
4	Prof. Pallavi Barekar	BEE (TH)	BEE (PB)	A, B
5	Prof. Pooja Nagpure	ICC (AUDIT)	ICC (PN)	A, B
6	Prof. Aditya Parate	CS (TH+PR)	CS (AP)	A, B In Batches: A1, A2, B1, B2
7	Prof. B. N. Ramteke	EM (TH)	EM (BR)	A, B

Copy To :
1. Principal, GNIET
2. Vice Principal, GNIET
3. Circulate among First year Faculty Students
4. Notice Board

Prof. Sandeep Bhongade
Time Table Incharge, ASH

Prof. Sadaf Gauhar
HOD, ASH, GNIET

Dr. Hemant Hajare
Principal, GNIET

RTMNU Syllabus

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY
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Unit - 1: Band theory of solids (6 Hrs) 14 Marks

Basic idea of free electron theory of metals, expression of conductivity of a metal. Formation of energy bands in Solids, Fermi energy and Fermi level.

Classification of solids on the basis of energy band diagram: Conductors, Semiconductors and Insulators, concept of Fermi energy.

Unit-2: Semiconductor Devices (7 Hrs) 14 Marks

Types of Semiconductor diodes, P-N junction Diode: Characteristics of P-N junction Diode, Tunnel Diode, Zener Diode, LED, Photodiode.

Transistors . Hall effect, Hall voltage and Hall coefficient; its applications,

Unit 3: Magnetic and Superconducting Materials (10 Hrs) 14 Marks

Diamagnetic, Paramagnetic, Ferromagnetic, Ferri-magnetic and anti ferromagnetic materials: Explanation on the basis of domain. Hysteresis curve, Characteristics of ferromagnetic, diamagnetic and paramagnetic materials and their applications.

_Superconductors: Basics of superconductivity: Zero electrical resistance, Persistent current Effect of Temperature, Effect of Magnetic Field, Critical Current; The Meissner Effect.Type-I and type-II superconductors, London Equation: The penetration depth, Bardeen-Cooper-Schrieffer (BCS) theory.

Unit 4: Lasers (7 Hrs) 14 Marks

Quantum Transitions: Absorption, Spontaneous emission & stimulated Emission, Metastable states, Principle of laser, Laser characteristics, Coherence length and coherence time, Pumping schemes: Three level and Four level.

Optical Resonator, Construction & working of Ruby laser and He-Ne laser, Applications of laser.

Unit 5: Nanoscience and Nanomaterials (6 Hrs) 14 Marks

Introduction to Nanoscience, Classification of nano materials, Types of Synthesis of Nanomaterials, Comparison of properties of nanomaterials with bulk materials,

Some special nanomaterials: 1) Zeolites, 2) Graphine, Application of nanomaterials in engineering.

Course Outcomes

Students will be able to

CO1. Learn the concept of formation of energy bands and to classify solids on its basis.

CO2. Identify and explain different types of diodes, transistors and its applications

CO3. Learn the concepts of magnetism and superconductivity, classify and analyze various types of magnetic and superconducting materials.

CO4. Learn and explain quantum transitions and apply it to working of lasers.

CO5. Learn the concept of nano materials and compare its properties with those of bulk materials.

Suggested Text Books &Reference Books

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501

Guru Nanak Institute Of Engineering & Technology, Nagpur

Department of Management Studies

Business Research

M.B.A – Semester-I

Academic Year 2022-2023 (ODD)

Dr. Jonathan Joseph

Assistant Professor

Subject In charge

Results Target:

Total Strength of the Class: 51

SR. No.	Class / Division	No. Of Students
a.	First Class With Distinction	25
b.	First Class	20
c.	Pass Class	06

Course Plan :

SR. No.	Plan	Brief Description
a.	Class Lectures	30 Lectures
b.	Design Issues	--
c.	Presentations	--
d.	Demonstration	--
e.	Models / Mini Projects	--
f.	Guest Lectures	-

Commencement of Class work : 05.12.2022
Instruction period : 05.12.2022 to 15.02.2023
: ---
: ---
: ---
End Examinations : First week of March 2023

Method of Evaluation:

a.	Internal Examination	Sessional-1, Sessional-2, PUT **05 Marks**
b.	Unit Wise Assignments	**05 Marks**
c.	Attendance	**05 Marks**
d.	Performance	**05 Marks**

Course Objective:

CO1 In context of research, the student will be able to define business research problems and will also able to formulate an abbreviated version of Research Proposal

CO2 The student will be able to describe and choose appropriate sampling design and will also be able to estimate appropriate sample size.

CO3 The student will be able to develop measurement tools and construct appropriate scales therein.

CO4 The student will be able to select suitable method of data collection and will be able to make questionnaire/e-questionnaire

CO5 The student will be able to derive inferences by applying various techniques and write various types of research reports**.**

Subject Scheme:

1T3	**Business Research**	**L = 3**	**T = 0**	**P = 0**	**Credits = 3**
Examination Scheme	College Assessment	University Examination	Total	Total Univ. Exam Duration	
	20	80	100	3 hrs	

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RTM Nagpur University Syllabus

MBA Semester-1

Business Research	
Module1	Theory Building and Research Proposal - Meaning and nature of Theory, Nature of proposition, Scientific Method, Verifying Theory, Inductive and Deductive Reasoning, Nature of business problem, importance of problem definition, the process of problem definition, research questions and research objectives, research proposal, anticipating outcomes, Literature Review
Module2	Sampling Design - Census and Sample Survey, Implication of Sample Design, Steps in Sample Design, Sampling Procedure, Different Types of Sampling Designs, How to select a random sample, Random sample from infinite universe, Sample size calculation.
Module3	Measurement and Scaling Techniques - Measurement in research, Measurement Scales, Source of errors in measurement, Test for sound measurement, Techniques for developing measurement tools, Scaling - Meaning, Scale classification bases, Important Scaling Techniques, Scale construction techniques
Module4	Methods of Data Collection - Collection of Primary Data (Observation, Interview, Questionnaire, Schedules), Other methods of data collection, Collection of Secondary Data (Reliability, Suitability and Adequacy), Selection of appropriate method for data collection, Constructing Questionnaire/e-questionnaire/Schedule
Module5	Interpretation and Report Writing - Meaning and Techniques of Interpretation, Significance and Steps of Report Writing, Layout of research reports, types of reports, Mechanics and Precautions for writing a research report.

Guidelines to Students:

1 Students must be regular and punctual in the class.

2 Attendance is compulsory.

3 Read the syllabus and other class material.

4 Students will be getting notes relating to the subject.

5 However, few more text-books will be used for everything that will be covered in the class.

6 Class test will be taken from time to time

7 Timely submission of assignments is essential.

8 Students must pass in sessional exams.

9 Read the syllabus and other online class material.

Books / Material:

Text Books (to be acquired by the Students):	
Book 1	Research Methodologies , Methods and Techniques- CR Kothari
Book 2	New Age International(P) Ltd Publisher
Book 3	Business Research Methods- William G Zikmund
Reference Books:	
Book 4	Panneerselvam, Research Methodology Prentice Hall India
Book 5	Donald Cooper and Pamela Schindler, Business Research methods by Tata McGraw Hill
Book 6	Alan Bryman and Emma Bell, Business Research Methods, Oxford Publication
Book 7	Krishnaswami & Ranganatham, Methodology of Research, Himalaya Publication House

Web Sites :	
a.	http://www.netmba.com
b.	http://businessdictionary.com/
c.	www.scribd.com

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Course Schedule:

Unit	Topic	Chapters			No of Classes
		Book 1	Book 2	Book 3	
I	Theory Building & Research Proposal	Unit I			08
II	Sampling Design	Unit II	Unit II		08
III	Measurement and Scaling Techniques	Unit III	Unit III		08
IV	Methods of Data Collection	Unit IV	Unit IV	Unit IV	08
V	Interpretation and Report Writing	Unit V		Unit V	08
	Contact classes for Syllabus coverage				**40**
Contact classes for Syllabus coverage: 40 : Tutorial Classes : 00 : Online Exams : 02 ; Descriptive Tests : 01 ; Revision classes :00 ; Subjective Tests :00 ; Classes for Subject coverage above curriculum : **Total Classes**					**40**

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Lecture Plan (Topic wise Coverage):

Unit – 1

Lecture No.	Date	Reference Book	Topic
1.	06/12/22	Research Methodology CR Kothari	Meaning and Nature of Theory
2.	07/12/22	,,	Nature of proposition
3.	08/12/22	,,	Scientific Method Verifying Theory
4.	09/12/22	,,	Inductive and Deductive Reasoning
5.	13/12/22	,,	Nature of business problem
6.	14/12/22	,,	Importance of problem definition
7.	15/12/22	,,	Process of problem definition
8.	16/12/22	,,	Research questions
9.	20/12/22	,,	Research objectives
10.	21/12/22	,,	Research proposal
11.	22/12/22	,,	Anticipating outcomes
12.	23/12/22	,,	Literature Review

Unit – 2

Lecture No.	Date	Reference Book	Topic
13.	27/12/22	Research Methodology CR Kothari	Sampling Design - Census and Sample Survey
14.	28/12/22	,,	Implication of Sample Design
15.	29/12/22	,,	Steps in Sample Design
16.	30/12/22	,,	Sampling Procedure
17.	03/01/23	,,	Different Types of Sampling Designs
18.	04/01/23	,,	How to select a random sample
19.	05/01/23	,,	Random sample from infinite universe
20.	06/01/23	,,	Sample Size Calculation

Unit – 3

Lecture No.	Date	Reference Book	Topic
21.	10/01/23	New Age International Ltd Publisher	Measurement and Scaling Techniques - Measurement in research
22.	11/01/23	,,	Measurement Scale
23.	12/01/23	,,	Sources of errors in measurement
24.	13/01/23	,,	Test of Sound Measurement
25.	17/01/23	,,	Techniques for developing measurement tools
26.	18/01/23	,,	Scaling Meaning, Scale classification bases
27.	19/01/23	,,	Important Scaling Techniques
28.	20/01/23	,,	Scale construction techniques

Unit – 4

Lecture No.	Date	Reference Book	Topic
29.	24/01/23	Business Research Methods- William G Zikmund	Methods of Data Collection
30.	25/01/23	,,	Methods of Data Collection - Collection of Primary Data
31.	27/01/23	,,	Methods of Data Collection - Collection of Primary Data
32.	31/01/23	,,	Methods of Data Collection - Collection of Secondary Data
33.	01/02/23	,,	Methods of Data Collection - Collection of Secondary Data
34.	02/02/23	,,	Other Methods of data collection
35.	03/02/23	,,	Selection of appropriate method for data collection
36.	07/02/23	,,	Constructing Questionnaire/e-questionnaire/Schedule

Unit – 5

Lecture No.	Date	Reference Book	Topic
37.	08/02/23	Business Research Methods- William G Zikmund	Meaning and Techniques of Interpretation
38.	09/02/23	,,	Significance and steps of Report Writing
39.	10/02/23	,,	Layouts of Research Reports
40.	14/02/23	,,	Types of Reports
41.	15/02/23	,,	Precautions for writing a Research Report
42.	16/02/23	,,	Mechanics for writing a Research Report

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501

Assignment

Unit – 1		
Date of Assignment	:	23/12/2023
Q1.Give the importance of Problem Definition Q2. Define Deductive Reasoning.		
Date of Submission: 27/12/2023		

Unit – 2		
Date of Assignment	:	06/01/2023
Q1.What do you mean by Sampling Procedure? Q2.How to select a Random Sample?		
Date of Submission: 10/01/2023		

Unit – 3		
Date of Assignment	:	28/01/2023
Q1.Explain the concept of Measurement in Research. Q2. What are the different techniques for developing measurement tools?		
Date of Submission: 22/02/2022		

Unit – 4		
Date of Assignment	:	07/02/2023
Q1.Give the importance of Data in Research Q2. Differentiate between Primary Data and Secondary Data		
Date of Submission: 10/02/2023		

Unit – 5		
Date of Assignment	:	16/02/2023
1. Q1. Give the meaning of Interpretation 2. Q2.Give the significance of Report Writing.		
Date of Submission: 17/02/2023		

Principal
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Assignments:

Unit – 1	
	1. What do you mean by Research Proposal? 2. Define Literature Review. 3. Explain Inductive. 4. Give the importance of Problem Definition 5. Explain the process of Problem Definition 6. Explain the meaning of Research Objectives 7. Define Nature of Business Problem. 8. Define Deductive Reasoning.
Unit – 2	
	1. What do you mean by Sampling Procedure? 2. What are the different types of Sampling Designs? 3. How to calculate Sample Size? 4. What are the different steps in Sample Design? 5. Define a Sample Design. 6. What do you mean by Random Sample? 7. How to select a Random Sample? 8. Define Census.
Unit – 3	
.	1. Explain the concept of Measurement in Research. 2. What are the different sources of errors in Measurement? 3. Enlist various tests of Sound Measurement 4. What are the different techniques for developing measurement tools? 5. What are the different Scaling Techniques 6. Give various Scale construction Techniques 7. What is a Measurement Scale?
Unit – 4	
	1. Give the importance of Data in Research. 2. Differentiate between Primary Data and Secondary Data 3. Explain various sources of collection of Primary Data 4. Explain various sources of collection of Secondary Data 5. Explain Questionnaire 6. What is a Schedule? 7. Explain the concept of E- Questionnaire. 8. What are the appropriate methods used for Data Collection.
Unit –5	
	1.Give the meaning of Interpretation 2.Give the significance of Report Writing 3. What are the different types of Report 4. What precautions are taken for writing a Research Report? 5. Give different layouts for Report Writing 6. What are the mechanics for writing a Research Report? 7. Explain various Techniques of Interpretation.

Actual Date of Unit Completion & Remarks

Unit – 1		
Date	:	23 / 12 / 2022
Remarks:		

Unit – 2		
Date	:	06 / 01 / 2023
Remarks:		

Unit – 3		
Date	:	28/01/2023
Remarks:		

Unit – 4		
Date	:	07/02/2023
Remarks:		

Unit – 5		
Date	:	16/02/2023
Remarks:		

Assignment Valuation Sheet:

SR NO	NAME OF THE STUDENT	1	2	3	4	5	Total
1	Achal Pradeep						
2	Akansha Devchand Gore						
3	Aniket Vasntrao Juwar						
4	Ankit Vijay Jambhulkar						
5	Atish Avinash Tighare						
6	Bharati Sureshgi Dongre						
7	Bhushan Mahesh						
8	Chetankumar Balubhai						
9	Diksha Dilip Jambhulkar						
10	Dimpal Mukundarao						
11	Harshada Purushottam						
12	Komal Manoj Mudholkar						
13	Kunal Ramesh Makode						
14	Lina Prabhakar Chanpure						
15	Madhavi Dhanaraj						
16	Manali Namdeo Ganvir						
17	Manisha Janak Nakve						
18	Mithilesh Dhanraj						
19	Mohit Lalchand Raut						
20	Mukta Rajendra						
21	Neha Kantik Badole						
22	Neha Shivram Mannase						
23	Nikita Shailendra Mool						
24	Nitin Kashinath Barve						
25	Pallavi Arun Gadage						
26	Pavan Rangraoji Kale						
27	Pragati Sajay Sonkavde						
28	Prajakta Manikrao Patil						
29	Prajakta Ravindra						
30	Pranay Khemdeo Raipure						
31	Priti Motilal Brahmne						

32	Punam Gajanan Girhale						
33	Purva Rajesh Bagde						
34	Rahul Lakshamnrao						
35	Rohan Bandu Gajbhiye						
36	Sagar Ravindra Kashti						
37	Samiksha Sunil Borkar						
38	Sana Kausar Ateeq Ur						
39	Sanraj Sanjay Subhekar						
40	Sarita Sewakram Mankar						
41	Satish Keshao Kale						
42	Satish Vishvnath Natkar						
43	Shalini Ganesh Yadav						
44	Shraddha Shobhalal						
45	Shubhangi Ramesh						
46	Siddrath Keru Palwe						
47	Suraj youraj Shelare						
48	Tanvi Mahadev Mahure						
49	Vaishnavi Lakshmanrao						
50	Vinay Anil Waghmare						
51	Yash Sanjay Kathale						
52							

Marks for Internal Theory Examination

Roll NO	NAME OF THE STUDENT	1	2	3	4	5
1	Achal Pradeep Khobragade					
2	Akansha Devchand Gore					
3	Aniket Vasntrao Juwar					
4	Ankit Vijay Jambhulkar					
5	Atish Avinash Tighare					
6	Bharati Sureshgi Dongre					
7	Bhushan Mahesh Madhavi					
8	Chetankumar Balubhai Patil					
9	Diksha Dilip Jambhulkar					
10	Dimpal Mukundarao Lasne					
11	Harshada Purushottam					
12	Komal Manoj Mudholkar					
13	Kunal Ramesh Makode					
14	Lina Prabhakar Channure					
15	Madhavi Dhanaraj					
16	Manali Namdeo Ganvir					
17	Manisha Janak Nakve					
18	Mithilesh Dhanraj Gaibhive					
19	Mohit Lalchand Raut					
20	Mukta Rajendra Deshmukh					
21	Neha Kantik Badole					
22	Neha Shivram Mannase					
23	Nikita Shailendra Mool					
24	Nitin Kashinath Barve					
25	Pallavi Arun Gadage					
26	Pavan Rangraoji Kale					
27	Pragati Sajay Sonkavde					
28	Prajakta Manikrao Patil					
29	Prajakta Ravindra Kamble					
30	Pranay Khemdeo Rajpure					
31	Priti Motilal Brahmne					
32	Punam Gajanan Girhale					
33	Purva Rajesh Bagde					
34	Rahul Lakshamnrao					
35	Rohan Bandu Gaibhive					
36	Sagar Ravindra Kashti					
37	Samiksha Sunil Borkar					
38	Sana Kausar Ateeq Ur					
39	Sanraj Sanjay Subhekar					
40	Sarita Sewakram Mankar					
41	Satish Keshao Kale					
42	Satish Vishvnath Natkar					

43	Shalini Ganesh Yadav					
44	Shraddha Shobhalal Samrit					
45	Shubhangi Ramesh Sangode					
46	Siddrath Keru Palwe					
47	Surai vourai Shelare					
48	Tanvi Mahadev Mahure					
49	Vaishnavi Lakshmanrao					
50	Vinay Anil Waghmare					
51	Yash Sanjay Kathale					

Attendance as per Internal

Roll NO	NAME OF THE STUDENT	1	2	3	4	5
1	Achal Pradeep Khobragade					
2	Akansha Devchand Gore					
3	Aniket Vasntrao Juwar					
4	Ankit Vijay Jambhulkar					
5	Atish Avinash Tighare					
6	Bharati Sureshgi Dongre					
7	Bhushan Mahesh Madhavi					
8	Chetankumar Balubhai Patil					
9	Diksha Dilip Jambhulkar					
10	Dimpal Mukundarao Lasne					
11	Harshada Purushottam					
12	Komal Manoj Mudholkar					
13	Kunal Ramesh Makode					
14	Lina Prabhakar Channure					
15	Madhavi Dhanaraj					
16	Manali Namdeo Ganvir					
17	Manisha Janak Nakve					
18	Mithilesh Dhanraj Gaibhive					
19	Mohit Lalchand Raut					
20	Mukta Rajendra Deshmukh					
21	Neha Kantik Badole					
22	Neha Shivram Mannase					
23	Nikita Shailendra Mool					
24	Nitin Kashinath Barve					
25	Pallavi Arun Gadage					
26	Pavan Rangraoji Kale					
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28	Prajakta Manikrao Patil					
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33	Purva Rajesh Bagde					
34	Rahul Lakshamnrao					
35	Rohan Bandu Gaibhive					
36	Sagar Ravindra Kashti					
37	Samiksha Sunil Borkar					
38	Sana Kausar Ateeq Ur					
39	Sanraj Sanjay Subhekar					
40	Sarita Sewakram Mankar					
41	Satish Keshao Kale					
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43	Shalini Ganesh Yadav					
44	Shraddha Shobhalal Samrit					
45	Shubhangi Ramesh Sangode					
46	Siddrath Keru Palwe					
47	Surai vourai Shelare					
48	Tanvi Mahadev Mahure					
49	Vaishnavi Lakshmanrao					
50	Vinay Anil Waghmare					
51	Yash Sanjay Kathale					

Descriptive Exam Valuation Sheet

Roll NO	NAME OF THE STUDENT	Sessional 1	Sessional 2	Prelims 3
1	Achal Pradeep Khobragade			
2	Akansha Devchand Gore			
3	Aniket Vasntrao Juwar			
4	Ankit Vijay Jambhulkar			
5	Atish Avinash Tighare			
6	Bharati Sureshgi Dongre			
7	Bhushan Mahesh Madhavi			
8	Chetankumar Balubhai			
9	Diksha Dilip Jambhulkar			
10	Dimpal Mukundarao Lasne			
11	Harshada Purushottam			
12	Komal Manoj Mudholkar			
13	Kunal Ramesh Makode			
14	Lina Prabhakar Channure			
15	Madhavi Dhanaraj			
16	Manali Namdeo Ganvir			
17	Manisha Janak Nakve			
18	Mithilesh Dhanraj Gaibhive			
19	Mohit Lalchand Raut			
20	Mukta Rajendra Deshmukh			
21	Neha Kantik Badole			
22	Neha Shivram Mannase			
23	Nikita Shailendra Mool			
24	Nitin Kashinath Barve			
25	Pallavi Arun Gadage			
26	Pavan Rangraoji Kale			
27	Pragati Sajay Sonkavde			
28	Prajakta Manikrao Patil			
29	Prajakta Ravindra Kamble			
30	Pranay Khemdeo Rajpure			
31	Priti Motilal Brahmne			
32	Punam Gajanan Girhale			
33	Purva Rajesh Bagde			
34	Rahul Lakshamnrao			
35	Rohan Bandu Gaibhive			
36	Sagar Ravindra Kashti			
37	Samiksha Sunil Borkar			
38	Sana Kausar Ateeq Ur			
39	Sanraj Sanjay Subhekar			
40	Sarita Sewakram Mankar			
41	Satish Keshao Kale			
42	Satish Vishvnath Natkar			

43	Shalini Ganesh Yadav			
44	Shraddha Shobhalal Samrit			
45	Shubhangi Ramesh			
46	Siddrath Keru Palwe			
47	Surai vourai Shelare			
48	Tanvi Mahadev Mahure			
49	Vaishnavi Lakshmanrao			
50	Vinay Anil Waghmare			
51	Yash Sanjay Kathale			

Weak Students As per RTM

Roll No	Name	%

Guest Lecture: NIL

Weak Students List

1.

Attendance Defaulter List

1.

Revision Topic:

1. Measurement in Research
2. Techniques of Interpretation

Advance Topics:

1. Simulation Research
2. Derived Research
3. Mixed Research

Tutorials

1. Research Proposal
2. Sampling
3. Scaling Techniques
4. Data Collection
5. Report Writing

GURU NANAK INSTITUTE OF ENGINEERING & TECHNOLOGY, NAGPUR

DEPARTMENT OF MANAGEMENT STUDIES

M.B.A SEMESTER- I Session 2022-23

TIME TABLE

	1	2	3	12 :45- 1:30	4	5	6
Time	**9.45 10:45**	**10:45 - 11:45**	**11:45- 12:45**		**01:30- 02:30**	**02:30. 03.30**	**03:30- 04:30**
MON	L&BE	MSE	FRS& A	**Lunch/ Problem Solving / Internet/ Library/ Sports/ Hobby Club**	OB	ME	MIS
TUE	L&BE	BR	BS&AD		OB	ME	FRS& A
WED	L&BE	BR	BS&AD		OB	ME	FRS& A
THU	L&BE	BR	BS&AD		MIS	ME	FRS& A
FRI	BS	BR	BS&AD		MSE	MIS	FRS& A

TEACHING FACULTY

Sr. No.	Name of Subject	Theory	Abbreviation	Name of Faculty
1	1T1- Managerial Economics	Theory	SM	Dr. Sanjay Uttarwar
2	1T2 -Management Information System	Theory	SIP	Prof. Nayan Shambharkar
3	1T3- Business Research	Theory	BR	Dr. Jonathan Joseph JJ
4	1T4- Organizational Behavior	Theory	S&DM	Prof. Puja Wasnik
5	1T5- Financial Reporting, Statement & Analysis	Theory	IMC&BM	Prof. Nikhita Khadgi
6	1T6-Business Statistics & Analytics for Decision Making	Theory	BS&AD	Prof. Rukmini Basiwar
–	1T7- Legal & Business Environment	Theory	SP&RM	Prof. Manish Hedau
–	1T8- Managerial Skill for Effectiveness	Theory	PM&C	Prof. Puja Nagpure
	ACTIVITY:- Presentations; Group Discussion; Case Study; Guest Lecture; Role Play; Management Games; Seminars; Job Interview Technique; Add Mad Show.			

Department of Electronics & Telecommunication Engineering

Internet of Things

B. TECH. –VI Semester [Branch: ETC]
SESSION: 2022-23 (Even)

Guru Nanak Institute of Engineering & Technology

Dahegaon, Kalmeshwar Road, Nagpur– 441501 (M.S.)

In-charge **HOD** **Principal**

Prepared by:	Approved & Reviewed by:	Issued by:	w.e.f Date:
Prof. Soniya Milmile	Dr. Sushma Telrandhe	Dr. Hemant Hajare	16/01/2023

CONTENTS OF COURSE FILE

SR.NO	ITEM DISCRIPTION	DATE OF VARIFICATION BY HOD		
01	Result Target			
02	Course Plan			
03	Method of Evaluation			
04	Course Objective			
05	RTMNU Syllabus			
06	Guidelines to students			
07	Books/materials			
08	Course Schedule			
09	Lecture Plan			
10	Actual date of unit completion			
11	Assignment Problem			
12	Tutorials			
13	Question bank for university exam			
14	Class Test & Sessional Valuation			
15	Assignments valuation sheet			
16	Marks for internal theory Examination			
17	Revision topics			
18	Guest lecture			
19	Weak student List (as per Class Test)			
20	Attendance Defaulters			
21	Advance Topics			
22	Time Table			

Results Target:

Total Strength of the Class: 58

S. No	Class / Division	No. of Students
a.	First Class with Distinction	17
b.	First Class	29
c.	Pass Class	12

Course Plan:

S. No	Plan	Brief Description
a.	Class Lectures	60
b.	Tutorials	10
c.	Presentations	-
d.	Demonstration	-
e.	Models / Mini Projects	-
f.	Guest Lectures	-

Commencement of Class work : 16/01/2023
Instruction period – I :
Intra Semester break :
Instruction period – II :
Preparation and practical :
End Examinations : 02/5/2023

Method of Evaluation:

a.	Internal Examination	Sessional I, Sessional II, PUT- 5M
b.	Unit Wise Assignments	5M
c.	Attendance	10M
d.	Performance	10M

Course Objective:

The course objectives are:

1. To understand the fundamentals of Internet of Things
2. To learn about the basics of IoT protocols
3. To build a small low cost embedded system using Arduino/Raspberry Pi.
4. To apply the concept of Internet of Things in the real world scenario.

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Electronics and Communication/ Electronics & Telecommunication Engineering/Electronics Engineering
B.Tech. 6th Semester

Subject: Internet of Things **L :2 T :0 P:0** **Credit: 2**

Course Objectives:

1. To understand the fundamentals of Internet of Things
2. To learn about the basics of IOT protocols
3. To build a small low cost embedded system using Arduino/Raspberry Pi.
4. To apply the concept of Internet of Things in the real world scenario.

Course Outcome:

Upon completion of this course, the students should be able to:

1. Analyze different design levels of IoT
2. Analyse IOT Architecture
3. Understand network and communication aspects
4. Design a portable IoT using Raspberry Pi and Aurdino
5. Analyze applications of IoT in real time scenario

Unit I : Introduction to IoT (04)

IoT definition & Characteristics, Advantages and disadvantages, IoT functional blocks, sensing, actuation , Physical design of IoT, Logical design of IoT, Constraints affecting design in IoT.

Unit II :IOT Architecture:- (05)

Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, IoT reference model.

Unit III: M2M to IOT (05)

Introduction, Basic Concepts, Difference between IoT and M2M, M2M Value Chains, IoT Value Chains, Machine to Machine Communication, M2M to IoT- Architecture, Design principles and capabilities.

Unit IV: Network and Communication Aspects (05)

Wireless medium access issues, MAC protocol, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination, service model, service management and security.

Unit V: Introduction to different IoT tools (05)

Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi & Its Programming.

Case Study on Health care and Agriculture

Text/Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015 .

2. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence: By Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 1st Edition, Academic Press, 2014.

3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.

4. Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.

5. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012.

6. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, 1st Edition, Apress Publications, 2013

Guidelines to Students:

- Read the syllabus and other online class material.
- HOWEVER, some other text-books related to the subject and/or topic should be referred for the detail coverage of the syllabus.
- Lecture attendance is important.
- Timely submission of assignments is essential.

Name Of Books Recommended:

- 1. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015 .
- 2. Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.

Books / Material

Text Books (to be acquired by the Students)	
Book 1	Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015.
Book 2	Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
Reference Books	
Book 3	Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
Book 4	Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012.

Web Sites	
a.	NPTEL notes
b.	nprcet.org

Course Schedule:

Distribution of Hours Unit – Wise

Subject	INTERNET OF THINGS					
Faculty	Prof. Soniya Milmile					
Unit	Topic	Chapters				No of Classes
		Book 1	Book 2	Book 3	Book 4	
I	Introduction to IoT	CH II				16
II	IOT Architecture	CH IV				10
III	M2M to IOT	CH VI	CH III			09
IV	Network and Communication Aspects			CH II	CH IV	09
V	Introduction to different IoT tools		CH VII		CH I	16
	Contact classes for Syllabus coverage					60
Contact classes for Syllabus coverage: 60 Tutorial Classes : 10 Descriptive Tests : 02 Revision classes :02 Subjective Tests :02 Classes for Subject coverage above curriculum :01 Total Classes: 60						60

GURU NANAK INSTITUTE OF ENGINEERING AND TECHNOLOGY, NAGPUR

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

SESSION: 2022-23 (EVEN)

TEACHING PLAN

Branch: ETC **Name of the Faculty: Prof. Soniya Milmile**

Semester: VI **Subject: INTERNET OF THINGS**

Lecture no.	Date	Reference Book	Unit	Topics to be covered
Unit-1: Introduction to IoT				
1	27/01/2023	Book- 1	1	IoT definition & Characteristics
2	27/01/2023	Book-1		Advantages and disadvantages
3	2701/2023	Book-1		IoT functional blocks
4	30/01/2023	Book-1		IoT functional blocks
5	30/01/2023	Book-1		Sensing in IoT
6	30/01/2023	Book-1		Actuation in IoT
7	31/01/2023	Book-1		Physical design of IoT
8	31/01/2023	Book- 1		Physical design of IoT
9	31/01/2023	Book-1		Logical design of IoT
10	01/02/2023	Book-1		Constraints affecting design in IoT
11	02/02/2023	Book-1		Doubt clearing session 1
12	03/02/2023	Book-1		Revision of Unit 1
13	06/02/2023	Book-1		Class Test on unit I
14	06/02/2023	Book-1		Doubt clearing session 2

Unit-2:IOT Architecture:				
17	08/02/2023	Book-2	**2**	Introduction
18	08/02/2023	Book-2		Architecture of IoT
19	08/02/2023	Book-2		4 layer IoT Architecture
20	09/02/2023	Book-2		5 layer Design of IoT Architecture
21	09/02/2023	NPTEL Notes		IoT Reference Model
22	10/02/2023	NPTEL Notes		Real-World Design Constraints- Introduction
23	10/02/2023	NPTEL Notes		Functional View
24	10/02/2023	NPTEL Notes		Information View
25	13/02/2023	NPTEL Notes		Doubt clearing session
26	13/02/2023	Book-2 & NPTEL Notes		Revision of unit 2
27	13/02/2023	Book-2 & NPTEL Notes		Class Test unit 2
Unit-3: M2M to IOT				
28	14/02/2023	Book-3	**3**	Introduction
29	14/02/2023	Book-3		Basic Concepts
30	24/03/2023	Book-3		Difference between IoT and M2M
31	27/03/2023	Book-3		M2M Value Chains
32	27/03/2023	Book-3		IoT Value Chains
33	28/03/2023	Book-3		Machine to Machine Communication,
34	28/03/2023	Book-3		M2M to IoT- Architecture
35	29/03/2023	Book-3		Design principles and capabilities
36	03/04/2023	Book-3 & NPTEL Notes		Doubt clearing session
37	03/04/2023	Book-3		Revision of unit 3
38	06/03/2023	Book-3 & NPTEL Notes		Class Test unit 3

Unit-4: Network and Communication Aspects				
39	07/03/2023	Book-4	**4**	Wireless medium access issues
40	08/03/2023	Book-4		MAC protocol
41	09/03/2023	Book-4		Survey routing protocols
42	10/03/2023	Book-4		Sensor deployment & Node discovery
43	15/03/2023	Book-4		Data aggregation & dissemination
44	16/03/2023	Book-4		service model
45	16/03/2023	Book-4		service management and security
46	17/03/2023	Book-4		Doubt clearing session
47	20/03/2023	Book-4		Revision of unit 4
48	21/03/2023	Book-4		Class Test unit 4
Unit-5:Introduction to different IoT tools				
49	22/03/2023	NPTEL Notes & nprcet.org	**5**	Introduction to different IoT tools
50	23/03/2023	NPTEL Notes & nprcet.org		Introduction to Arduino and Raspberry Pi & Its Programming
51	24/03/2023	NPTEL Notes & nprcet.org		Introduction to Arduino and Raspberry Pi & Its Programming
52	27/03/2023	NPTEL Notes & nprcet.org		Case Study on Health care and Agriculture
53	28/03/2023	NPTEL Notes & nprcet.org		Case Study on Health care and Agriculture
54	29/03/2023	NPTEL Notes & nprcet.org		Doubt clearing session
55	30/03/2023	NPTEL Notes & nprcet.org		Revision of unit 5
56	31/03/2023	Book & Notes		Class Test on unit 5
57	03/04/2023	Book & Notes		Question Bank Discussion
58	04/04/2023	Book & Notes		PUT paper on I to III unit
59	05/04/2023	Book & Notes		PUT paper on IV & V unit
60	06/04/2023	Book & Notes		Mock PUT Exam

Name Of Books Recommended:

- 1. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015 .
- 2. Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.

Text Books (to be acquired by the Students)	
Book 1	Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015.
Book 2	Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
Reference Books	
Book 3	Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
Book 4	Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012.

Web Sites	
c.	NPTEL notes
d.	nprcet.org

Prof. Soniya Milmile
Subject Teacher

Dr. Sushama Telrandhe
HOD, ETC

DEPARTMENT OF MANAGEMENT STUDIES

FINANCIAL MANAGEMENT

M.B.A– II Semester

VINITA DIGHORIKAR
Assistant Professor

Guru Nanak Institute of Engineering & Technology, Nagpur

Results Target:

Total Strength of the Class: 63

Sr. No.	Class / Division	No. of Students
a.	First Class with Distinction	26
b.	First Class	27
c.	Pass Class	10

Course Plan:

Sr. No.	Plan	Brief Description
a.	Class Lectures	49 Lectures
b.	Design Issues	--
c.	Presentations	00 Classes
d.	Demonstration	--
e.	Models / Mini Projects	--
f.	Guest Lectures	--

Commencement of Class work	:	04.05.2022
Instruction period – I	:	04.05.2022 to 30.08.2022
Intra Semester break	:	---
Instruction period – II	:	---
Preparation and practical	:	
End Examinations	:	10.08.2022 to 19.08.2022

Method of Evaluation:

a.	Internal Examination	---
b.	Unit Wise Assignments	03
c.	Descriptive Exam	02
d.	Final Examination	01

Course Objective:

- **CO1** Given financial cost parameters, the future manager will be able to calculate specific cost of capital (i.e. Cost of debt, preference, equity and retained earnings) and the weighted average cost of capital for any specific given firm.
- **CO2** Given different financing options, the future manager will be able to analyze the effect of operating and financial leverage on EPS and recommend a suitable long term financing mix for an organization by applying EBIT-EPS analysis, Indifference Level of EBIT and Financial Break-even Analysis for given financing options.
- **CO3** Given the cash-flows pertaining to a project, the future manager will be able to estimate projects' cash flows to distinguish between value creating and value destroying investments using time-value intensive DCF techniques (viz. NPV, IRR, discounted payback period, profitability index) and Non-DCF techniques (i.e. Payback Period and Average rate of return approach)
- **CO4** Given the details pertaining to elements of working capital for a given level of activity, the future manager will be able to ascertain the components of current assets and current liabilities and determine the gross and net operating working capital requirement.
- **CO5** Given the expected dividends, future price of shares, investor expectations and funding requirements; the future manager will be able to compute the value of a share using various dividend discount models and illustrate whether dividend is relevant for firm valuation or not.

M.B.A. II SEMESTER

FINANCIAL MANAGEMENT

Module -1	Cost of Capital: Concept and Importance; Measurement of Specific Costs – Redeemable and Irredeemable Debt, Redeemable and Irredeemable Preference shares, Equity and Retained Earnings; Computation of Overall Cost of Capital using book value and market value weights.
Module -2	Leverage: Operating, Financial and Combined Leverage; EBIT-EPS Analysis; Indifference Level of EBIT and Financial Break-even Analysis.
Module -3	Capital Budgeting: Concept of Capital budgeting, Discounted and Non-discounted Cash Flow Techniques – NPV, IRR, PI, Discounted PBP, ARR & PBP.
Module -4	Working Capital Management: Concept of Gross and Net Working Capital, Working Capital Approaches, Estimation and Calculations of Working Capital requirements

Module -5	Dividend Policy: Walter's Model; Gordon's Model and MM Hypothesis for Dividend Policy and Firm Valuation, Determinants and constraints of dividend decision

Guidelines to Students:

- Students must be regular and punctual in the class.
- Attendance is compulsory.
- Read the syllabus and other class material.
- Students will be getting notes relating to the subject.
- However, few more text-books will be used for everything that will be covered in the class.
- Presentations must be given by the students on important topics.
- Timely submission of assignments is essential.
- Class test will be taken from time to time.
- Students must pass in sessional exams.
- Viva will be conducted after the completion of the syllabus.
- Read the syllabus and other on line class material.

Books / Material:-

Text Books (to be acquired by the Students)	
Book 1	Financial Management, Theory Concepts and Problems, 5 th Revised Edition, R.P. Rustagi, Taxmann Pulication, ISBN- 9878171949311 Chapter – 10
Book 2	Financial Management, Theory Concepts and Problems, 5 th Revised Edition, R.P. Rustagi, Taxmann Pulication, ISBN- 9878171949311 Chapter – 11&12
Book 3	Financial Management, Theory Concepts and Problems, 5 th Revised Edition, R.P. Rustagi, Taxmann Pulication, ISBN- 9878171949311 Chapter – 7
Book 4	Financial Management, Theory Concepts and Problems, 5 th Revised Edition, R.P. Rustagi, Taxmann Pulication, ISBN- 9878171949311 Chapter – 17&18
Book 5	Financial Management, Theory Concepts and Problems, 5 th Revised Edition, R.P. Rustagi, Taxmann Pulication, ISBN- 9878171949311 Chapter – 15&16

Course Schedule

Distribution of Hours Unit – Wise

Subject	FINANCIAL MANAGEMENT				
Faculty	Prof. Vinita Dighorikar				
Unit	Topic	Chapters			
		Book 1	Book 2	Book 3	
I	Cost of Capital	Unit 1			17
II	Leverage:	Unit 1	Unit 1	Unit 2	16
III	Capital Budgeting	Unit 2	Unit 2	Unit 3	18
IV	Working Capital Management	Unit 3	Unit 4	Unit 4	13
V	Dividend Policy	Unit 5			
	Contact classes for Syllabus coverage	55			
Contact classes for Syllabus coverage:63 Presentation : 00 **Total Classes**	55				

Lecture Plan (Topic wise Coverage)

Lecture No.	Date	Topic	[Book – 1]
1	02-05-22	**Unit-I: : Introduction Cost of Capital**	Unit 1
2	03-05-22	Concept and Importance	Unit 1
3	04-05-22	Measurement of Specific Costs	Unit 1
4	05-05-22	Redeemable and Irredeemable Debt	Unit 1
5	06-05-22	Redeemable and Irredeemable Preference shares	Unit 1
6	09-05-22	Redeemable and Irredeemable Preference shares	Unit 1
7	10-05-22	Equity and Retained Earnings	Unit 1
8	11-05-22	Computation of Overall Cost of Capital using book value and market value weights	Unit 1
9	12-05-22	Computation of Overall Cost of Capital using book value and market value weights	Unit 1
11	13-05-22	**Unit II: Introduction, Leverage**	Unit 2
12	16-05-22	Operating Leverage	Unit 2
13	17-05-22	Financial Leverage	Unit 2
14	18-05-22	Combined Leverage	Unit 2
15	19-05-22	EBIT-EPS Analysis	Unit 2
16	20-05-22	Indifference Level of EBIT	Unit 2
17	23-05-22	Indifference Level of EBIT	Unit 2
18	24-05-22	Financial Break-even Analysis.	Unit 2
26	25-05-22	**Unit III: Introduction Capital Budgeting**	Unit 3
27	26-05-22	Concept of Capital budgeting	Unit 3
28	27-05-22	Discounted and Non-discounted Cash	Unit 3
29	30-05-22	Discounted and Non-discounted Cash	Unit 3
30	31-05-22	Flow Techniques – NPV, IRR, PI	Unit 3
31	01-06-22	Flow Techniques – NPV, IRR, PI	Unit 3
32	02-06-22	Discounted PBP	Unit 3
33	03-06-22	ARR & PBP	Unit 3
34	06-06-22	**Unit IV: Introduction Working Capital Management**	Unit 4
35	07-06-22	Concept of Gross and Net Working Capital	Unit 4
36	08-06-22	Working Capital Approaches	Unit 4
37	09-06-22	Estimation and Calculations of Working Capital requirements	Unit 4
38	10-06-22	Estimation and Calculations of Working Capital requirements	Unit 4
42	13-06-22	**Unit V :Introduction Dividend Policy**	Unit 5
43	14-06-22	Walter's Model	Unit 5
44	15-06-22	Gordon's Model	Unit 5

45	16-06-22	MM Hypothesis for Dividend Policy and Firm Valuation	Unit 5
46	17-06-22	Determinants and constraints of dividend decision	Unit 5

Actual Date of Unit Completion &Remarks:

Unit – 1		
Date	:	12-05-22
Remarks:		

Unit – 2		
Date	:	24-05-22
Remarks:		

Unit – 3		
Date	:	03-06-22
Remarks:		

Unit – 4		
Date	:	10-06-22
Remarks:		

Unit – 5		
Date	:	17-06-22
Remarks:		

Assignments

Financial Management	
Unit – 1	
1	
Unit – 2	
Unit – 3	
	.
Unit – 4	
Unit – 5	

Assignments [minimum of one per unit]:

Unit – 1		
Date of Submission	:	
Date of Valuation of Assignments	:	
Unit – 2		
Date of Submission	:	
Date of Valuation of Assignments	:	
Unit – 3		
Date of Submission	:	
Date of Valuation of Assignments	:	
Unit – 4		
Date of Submission	:	
Date of Valuation of Assignments	:	

Unit – 5		
Date of Submission	:	
Date of Valuation of Assignments	:	

1. Assignment Valuation Sheet:

SR NO	NAME OF THE STUDENT	123	123	123	123	123	123
1	ABHA DHORE						
2	ABHISHEK KAMAL						
3	AHUJA JAGRITI SHISHUPAL						
4	APEKSHA MORESHWAR						
5	AVINASH RAMBHAU						
6	BALKHANDE GAUTAM SONBA						
7	BHASARKAR HIMANI GIRISH						
8	BHOJVI VISHWANATH						
9	BHOTMANGE SURAJ SURDAS						
10	BOBADE SONALI SURENDRA						
11	BORKAR ANKITA GAJANAN						
12	CHANGOLE ROHIT NILKANTH						
13	CHATUR RUCHIKA CHANDU						
14	CHETAN KATOLE						
15	CHHEDAIYA SANGITA HIRAMA						
16	CHIKATE BIPIN NIRANJAN						
17	DAMINI PRDIP GUHE						
18	DEVGADE SAMIKSHA RAVINDR						
19	DHAWALE MANISH DHANPAL						
20	GADGE RINA NILKANTHARAO						
21	GAIKWAD ASMITA MANOHAR						
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26	HARSH VIJAY SATHAWANE						
27	ILAMKAR PRIYANKA UMRAO						
28	KHAPARDE SWAPNIL SURESH						
29	KISHORI DAYARAM DHARMIK						
30	LANDGE AKASH PRAKASHRAO						
31	MANKAR ANIKET DNYANESHW						
32	MESHRAM KUNAL KISHOR						
33	MRINALI SUNIL MANDALE						

34	MUKESH SHANKAR MENDHEKA						
35	NANDESHWAR MINAL MUKUN						
36	NEHA WANDEO BARMASE						
37	NEWATIA RICHA RAJESHKUMA						
38	NIKAY GEDAM						
39	NIKHADE DAMINI MANOHAR						
40	NIKOSE RAKESH JITENDRAJI						
41	NIRMAL RENUKA VATANRAO						
42	PANCHADHARE ANAND ASHOK						
43	PATIL PRACHI TUKARAM						
44	PATIL PRIYANKA HARISHCHAN						
45	PILAWAN SWAPNIL DIWAKAR						
46	POHANKAR TEJASWINI KUMAR						
47	PRANJAL BALKRISHNA WANJA						
48	PRIYA SURESH MANE						
49	PRIYANKA RAVISHANKAR SHA						
50	RAMTEKE PRAJAKTA SANTOSH						
51	RAUT ASHWINI RAMESH						
52	SAKHARE AMRAPALI ASHOK						
53	SAKHARE MANISHA SHIVCHAR						
54	SAKODE VAIBHAV RAMESH						
55	SHETE ACHAL DIWAKARRAO						
56	SHUBHANGI SITARAMJI CHOUD						
57	SIDHANT BHIMRAO GOTE						
58	SONONE ASMITA RAMESH						
59	SONTAKKE NEHA AVIN						
60	SONTAKKE RANI KHUSHAL						
61	UPARE TRUPTI SUDHAKAR						
62	VARMA POOJA PAWAN						
63	SWATI WAKODE						

Descriptive Exam Valuation Sheet:

SR NO	NAME OF THE STUDENT	MARKS	MARKS	MARKS
1	ABHA DHORE			
2	ABHISHEK KAMAL			
3	AHUJA JAGRITI SHISHUPAL			
4	APEKSHA MORESHWAR			
5	AVINASH RAMBHAU			
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16	CHIKATE BIPIN NIRANJAN			
17	DAMINI PRDIP GUHE			
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24	GHARDE RIYA MANOJ			
25	GONDANE APRAJITA PRADIP			
26	HARSH VIJAY SATHAWANE			
27	ILAMKAR PRIYANKA UMRAO			
28	KHAPARDE SWAPNIL SURESH			

29	KISHORI DAYARAM DHARMIK			
30	LANDGE AKASH PRAKASHRAO			
31	MANKAR ANIKET DNYANESHW			
32	MESHRAM KUNAL KISHOR			
33	MRINALI SUNIL MANDALE			
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55	SHETE ACHAL DIWAKARRAO			
56	SHUBHANGI SITARAMJI CHOUD			
57	SIDHANT BHIMRAO GOTE			
58	SONONE ASMITA RAMESH			
59	SONTAKKE NEHA AVIN			
60	SONTAKKE RANI KHUSHAL			
61	UPARE TRUPTI SUDHAKAR			
62	VARMA POOJA PAWAN			

Attendance as per Internal:

SN NO	NAME OF THE STUDENT	123	123	123	123	123	123
1	ABHA DHORE						
2	ABHISHEK KAMAL						
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58	SONONE ASMITA RAMESH						
59	SONTAKKE NEHA AVIN						
60	SONTAKKE RANI KHUSHAL						
61	UPARE TRUPTI SUDHAKAR						
62	VARMA POOJA PAWAN						

Marks for Internal Theory Examination:

SR NO	NAME OF THE STUDENT	123	123	123	123	123	123
1	ABHA DHORE						
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60	SONTAKKE RANI KHUSHAL						
61	UPARE TRUPTI SUDHAKAR						
62	VARMA POOJA PAWAN						

Revision Topics:

Guest Lectures:

Weak Students as Per Descriptive Exam:

Weak Students as Per RTM Nagpur University:

Roll No	Name	%

Attendance Defaulters:

Principal
Guru Nanak Institute of Engineering & Technology Nagpur- 441501