Sant Gadge Baba Amravati University, Amravati

Scheme of Implementation for

Four Year Undergraduate Degree Programme in Engineering and Technology

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B.E. (Bachelor of Engineering) in

Computer Science and Engineering

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in the faculty of Science and Technology

ACADEMIC EVALUATION SCHEME/CREDIT SYSTEM

Year: 2024-25

(Scheme of Teaching, Learning and Examination & Evaluation w.e.f. 2024-2025 and onwards)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Science and Engineering - Semester - I												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics I (BSC)	1AL100BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Physics (BSC)	1AL101BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Programming (ESC)	1AL102ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Mechanics (ESC)	1AL103ES	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Engineering Physics Lab (BSC)	1AL104BS	0	2	0	2	1			25	25	50	
6	Computer Programming Lab (ESC)	1AL105ES	0	2	0	2	1			25	25	50	
7	Engineering Mechanics Lab (ESC)	1AL106ES	0	2	0	2	1			25	25	50	
8	Workshop (ESC)	1AL107ES	0	2	0	2	1			25	25	50	
	Vocational and Skill Enhancement Courses (VSEC)												
9	Introduction to Web Technology (VSEC-I)	1CS108VS	1	2	0	3	2			50	-	50	
	Ability Enhancement Courses(AEC)												
10	Professional Communication	1SH109AE	1	2	0	3	2			25	25	50	
	Co-curricular Course (CC)												
11	Co-curricular Course (CC)	1SH110CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		14	16	0	30	**22**					**750**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Science and Engineering - Semester - II												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics II (BSC)	2AL111BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Chemistry (BSC)	2AL112BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Basic Electrical Engineering (ESC)	2AL113ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Graphics (ESC)	2AL114ES	2	0	0	2	2	40	60			100	3 Hrs.
	Laboratory Courses												
5	Engineering Chemistry Lab (BSC)	2AL115BS	0	2	0	2	1			25	25	50	
6	Basic Electrical Engineering Lab (ESC)	2AL116ES	0	2	0	2	1			25	25	50	
7	Engineering Graphics Lab (ESC)	2AL117ES	0	2	0	2	1			25	25	50	
	Vocational and Skill Enhancement Courses (VSEC)												
8	Computer Hardware & Networking (VSEC-II)	2CS118VS	1	2	0	3	2			50	-	50	
	Programme Core Course (PCC)												
9	Computer Fundamentals	2CS119PC	2	0	0	2	2	20	30			50	2 Hrs.
	Indian Knowledge System (IKS)												
10	Indian Traditional Knowledge	2SH120IK	2	0	0	2	2	20	30			50	2 Hrs
	Co-curricular Course (CC)												
11	Co-curricular Course (CC)	2SH121CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		16	12	0	28	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L4.5): Award of UG Certificate in Major with 44 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	3CS241EC	*Certificate Course on Assembly & Maintenance of Personal Computer	Online/offline certification Course	**4**
AND				
2	3CS242EC	*Certificate Course on Office tools (Like Word Processing / Spreadsheet / Presentations etc)		**4**
OR				
3	3CS404EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

The long forms of the Abbreviations in the Scheme of Semester I/II common to all the branches of Engineering & Technology are as under:

AL – All (Common for all branches) **BS** – Basic Science Course **ES** - Engineering Science Course

VS – vocational & Skill Enhancement **CC** - Co-curricular Course **PC** – Program Core Course

AE – Ability Enhancement Course **IK** - Indian Knowledge System

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - III												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Discrete Structure & Graph Theory	3CS200PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Object Oriented Programming	3CS201PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Data Structures	3CS202PC	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
4	Comm. Engag. Project/ Field Project	3CS400EL	0	4	0	4	2			25	25	50	
5	Object Oriented Programming	3CS203PC	0	2	0	2	1			25	25	50	
6	Data Structure	3CS204PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
7	* Multi-disciplinary Minor#1 (MDM#1)	3CS205MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Open Elective other than a particular Program												
8	Open Elective I	3CS206OE1/2	3	0	0	3	3	40	60	-	-	100	3 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Entrepreneurship Development	3CS207EM	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Value Education Course (VEC)												
10	Environmental Science	3SH208VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**700**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Open Elective I - 3CS206OE1: Basics of Computing for Engineers | 3CS206OE2: E-Commerce

* MDM#1 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - IV												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Data Communication & Networking	4CS209PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Operating System	4CS210PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Theory of Computation	4CS211PC	3	0	0	3	2	40	60			100	3 Hrs.
	Laboratory Courses												
4	Data Communication & Networking	4CS212PC	0	2	0	2	1			25	25	50	
5	Operating System	4CS213PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
6	* Multi-disciplinary Minor#2 (MDM#2)	4CS214MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Vocational and Skill Enhancement Courses												
7	Computing Skill #1 (VSEC-III)	4CS215VS	0	2	0	2	2			50	-	50	
	Open Elective other than a particular Program												
8	Open Elective II	4CS216OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Social Science & Engineering Economics	4CS217EM	2	0	0	2	2	20	30			50	2 Hrs.
	Ability Enhancement Course (AEC)												
10	Modern Indian Language	4SH218AE	2	0	0	2	2			25	25	50	
	Value Education Course (VEC)												
11	Universal Humans Values & Ethics	4SH219VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		19	06	0	25	**22**					**700**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Open Elective II – 4CS216OE1: Intellectual Property Rights | 4CS216OE2: Information Systems for Engineers

* MDM#2 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L 5): Award of UG Diploma in Major with 88 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	5CS243EC	*Network Configuration and Maintenance	Online/offline certification Course	**4**
AND				
2	5CS244EC	*Full Stack Web Development		**4**
OR				
3	5CS405EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - V												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Database Management Systems	5CS220PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Compiler Design	5CS221PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Architecture & Organization	5CS222PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Programme Elective Course I	5CS223PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Database Management Systems	5CS224PC	0	2	0	2	1			25	25	50	
6	Compiler Design	5CS225PC	0	2	0	2	1			25	25	50	
7	Programme Elective Course I	5CS226PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#3 (MDM#3)	5CS227MD	2	0	0	2	2	20	30			50	2 Hrs.
9	* Multi-disciplinary Minor#4 (MDM#4)	5CS228MD	2	0	0	2	2	20	30			50	2 Hrs.
10	* Multi-disciplinary Minor#5 (MDM#5)	5CS229ML	0	2	0	2	1			25	25	50	
	Open Elective other than a particular Program												
11	Open Elective III	5CS230OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

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Programme Elective Course -I : Data Science and Statistics | Internet of Things | Introduction to Cyber Security

Open Elective – III : 5CS230OE1: Cyber Law & Ethics | 5CS230OE2: Introduction to Data Analytics

* MDM#3, MDM#4 & MDM#5 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - VI												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Security Policy & Governance	6CS231PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Design & Analysis of Algorithm	6CS232PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Cloud Computing	6CS233PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course II	6CS234PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course III	6CS235PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
6	Design & Analysis of Algorithm	6CS236PC	0	2	0	2	1			25	25	50	
7	Cloud Computing	6CS237PC	0	2	0	2	1			25	25	50	
8	Programme Elective Course II	6CS238PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
9	* Multi-disciplinary Minor#6 (MDM#6)	6CS239MD	2	0	0	2	2	20	30			50	2 Hrs.
	Vocational and Skill Enhancement Courses												
10	Computing Skill # 2 (VSEC IV)	6CS240VS	1	2	0	3	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Programme Elective Course -II : Natural Language Processing | Big Data Analytics | Cryptography
Programme Elective Course -III : Data Warehousing & Mining | Image Processing | Digital Forensics

* MDM#6 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -3 (L5.5): Award of bachelor's degree in Vocation (B.Voc.) in Major with 132 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	7CS310EC	*Database Engineer/Database Administrator	Online/offline certification Course	**4**
AND				
2	7CS311EC	*Cloud Engineer/Cloud Administrator		**4**
OR				
3	7CS406EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - VII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Software Engineering	7CS300PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Professional Ethics & Management	7CS301PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Program Elective Course IV	7CS302PE	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course V	7CS303PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course VI	7CS304PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
6	Programme Elective Course IV	7CS305PE	0	2	0	2	1			25	25	50	
7	Programme Elective Course V	7CS306PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#7 (MDM#7)	7CS307MD	2	0	0	2	2	20	30			50	2 Hrs.
9	* Multi-disciplinary Minor#8 (MDM#8)	7CS308ML	0	2	0	2	1			25	25	50	
	Project												
10	Project	7CS401PR	0	4	0	4	2			50	50	100	
DGH Revised on 29.07.2025	TOTAL		17	10	0	27	**22**					**800**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Programme Elective Course -IV : Machine Learning | Virtual & Augmented Reality | Wireless Sensor Networks
Programme Elective Course -V : Block chain Fundamentals | Data Storage & Network | Distributed Ledger Technology
Programme Elective Course -VI : Optimization Techniques | Cloud System & Infrastructure | Modelling & Simulation

* MDM#7 & MDM#8 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering - Semester - VIII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Research Methodology	8CS309RM	4*	0	0	4	4	40	60			100	3 Hrs.
2	Industry Internship	8CS402EL	0	24	0	24	12			100	200	300	--
3	Project	8CS403PR	0	4	0	4	2			50	50	100	3 Hrs.
DGH Revised on 29.07.2025	TOTAL		4	28	0	32	18					**500**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

***The course on Research Methodology may be completed by the student in Online mode (Swayam, MOOC's, any other platform approved by AICTE or on the LMS platform offered by the Institute).**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

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Note:

1. The Multi-Disciplinary Minors (MDMs) offered by the Computer Science and Engineering discipline are open to students from all engineering disciplines **except** the: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. (**Annexure I**: MDM Basket offered by CSE)
2. Students enrolled in : i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. are eligible to opt for MDMs offered by all other engineering disciplines. (**Refer the scheme of respective disciplines**)
3. The Baskets of Multi-Disciplinary Double Minors offered by Computer Science and Engineering discipline are listed under **Annexure II.**
4. Detailed guidelines for **Honors with Research** option is listed under **Annexure III.**
5. To promote the adoption and use of Open-Source Software (OSS), a subject-wise suggestive list of OSS tools is provided as part of this scheme. These tools can be effectively utilized for conducting practical sessions and demonstrations. Please note that this list is dynamic and may evolve with advancements in technology and the introduction of new tools or versions. **(Annexure IV:** List of suggested OSS**)**

Annexure I

Multidisciplinary Minors Subjects offered by Computer Science and Engineering

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3CS205MD / 3KE205MD / 3DS205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4CS214MD	Data Structures and Problem Solving	Theory	2
MDM#3	V	5CS227MD	Database Management Systems	Theory	2
MDM#4	V	5CS228MD	Web Technologies & Development	Theory	2
MDM#5	V	5CS229ML	Web Technologies Lab	Practical	1
MDM#6	VI	6CS239MD	Cloud Computing & Virtualization	Theory	2
MDM#7	VII	7CS307MD	Computational Thinking & Algorithmic Problem Solving	Theory	2
MDM#8	VII	7CS308ML	Interdisciplinary Computing Project Lab	Practical	1

Note: Above is the list of Multi-Disciplinary Minors (MDMs) offered by Computer Science and Engineering discipline. These minors are open to students from all engineering disciplines except the following: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines.

Annexure II

Multidisciplinary Double Minors Subjects offered by Computer Science and Engineering

Track: Cyber Security (Honours / Double Minor)				
Semester	**Subject Code**	**Subject Title**	**Credits**	**T/P**
III	3CS245DH1	Fundamentals of Cyber Security	4	Theory
IV	4CS246DH1	Network & Web Application Security	4	Theory
V	5CS247DH1	Digital Forensics & Incident Response	4	Theory
VI	6CS248DH1	Advanced Topics in Cryptography	4	Theory
VII	7CS407DH1	Cyber Security Practice Lab	2	Lab

Track: Data Science (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3CS245DH2	Introduction to Data Science	4	Theory
IV	4CS246DH2	Statistical Methods for Data Analysis	4	Theory
V	5CS247DH2	Machine Learning Techniques	4	Theory
VI	6CS248DH2	Big Data Systems & Tools	4	Theory
VII	7CS407DH2	Data Science Lab with Python & R	2	Lab

Note: The subjects offered by Computer Science and Engineering discipline as Double Minor for students of other major disciplines, shall also be applicable and treated as Honours subjects for students pursuing a major in Computer Science and Engineering.

Annexure III
Honors with Research

Semester	**Subject Code**	Subject Title	Credits	T/P
VII	7CS408HR	Research Project (Part#1) Problem Identification & Definition Literature Review Experimental Work	9	P
VIII	8CS409HR	Research Project (Part#2) Prototype Development Data Analysis Publication(s)	9	P

Note: Students intending to pursue a degree with Honours with Research must undertake and successfully complete a dedicated research project during Semesters VII and VIII, as outlined in the curriculum and in accordance with the guidelines issued by the respective department from time to time. This research project shall be distinct and independent from the regular final year project (7CS401PR & 8CS403PR).

Annexure IV

Suggestive Subject-Wise list Open-Source Tools

Name of Subject	Open-Source Tools	Name of Subject	Open-Source Tools
Object-Oriented Programming	Eclipse, NetBeans, IntelliJ IDEA (Community Edition), BlueJ	**Sensors & Actuators**	Arduino IDE, Raspberry Pi OS
Data Structure	Code::Blocks, Visual Studio Code, GDB Debugger	**Cryptography**	OpenSSL, GPG
Data Communication & Networking	Wireshark, Mininet, Cisco Packet Tracer (free educational license), NS-3	**Computer Architecture & Organization**	Gem5, Logisim
Operating System	QEMU, VirtualBox, Unix/Linux Shell, FreeDOS	**Information Retrieval**	Apache Solr, Elasticsearch
Artificial Intelligence	TensorFlow, PyTorch, OpenCV, Scikit-learn	**Supervised Machine Learning**	TensorFlow, Scikit-learn
Programming Methodology using Python	Jupyter Notebook, Anaconda, PyCharm (Community Edition), VS Code	**Digital Forensics**	Autopsy, Sleuth Kit, Volatility
Probability & Statistics for Data Science	R, RStudio, NumPy, SciPy, Matplotlib	**Internet of Everything**	Node-RED, ThingsBoard, Kaa IoT
Cognitive Technologies	IBM Watson (free tier), TensorFlow, spaCy	**Image & Video Processing**	OpenCV, GIMP, FFmpeg
Data Science and Statistics	R, Jupyter Notebook, KNIME	**Augmented & Virtual Reality**	Blender, Godot Engine
Internet of Things	Arduino IDE, Node-RED, ThingsBoard	**Usability Engineering**	Axure RP (free for students), Figma
Introduction to Cyber Security	Kali Linux, Metasploit Framework, OpenVAS	**Cryptography & Security**	Wireshark, OpenSSL, VeraCrypt
Database Management Systems	MySQL, PostgreSQL, SQLite, MongoDB	**Wireless Sensor Networks**	Cooja, NS-3
Compiler Design	LLVM, GCC, Flex, Bison	**System & Software Security**	Metasploit, Snort
Numerical Methods	Octave, SciPy, NumPy	**Blockchain Fundamentals**	Ethereum, Hyperledger, Ganache
Microprocessor & Assembly Language Programming	Keil uVision, GNUSim8085, Logisim	**Data Storage & Network**	FreeNAS, OpenFiler
Design & Analysis of Algorithm	Gephi, NetworkX	**Distributed Ledger Technology**	Hyperledger Fabric, Corda
Cloud Computing	OpenStack, CloudStack, Apache Hadoop	**Deep Learning**	Keras, TensorFlow, PyTorch
Natural Language Processing	NLTK, spaCy, Hugging Face Transformers	**Data Visualization**	Tableau Public, Matplotlib, D3.js
Big Data Analytics	Apache Hadoop, Apache Spark, Dask	**Data Warehousing**	Apache Hive, Pentaho

Sant Gadge Baba Amravati University, Amravati

Scheme of Implementation for

Four Year Undergraduate Degree Programme in Engineering and Technology

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B.E. (Bachelor of Engineering) in

Computer Science and Engineering (Data Science)

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in the faculty of Science and Technology

ACADEMIC EVALUATION SCHEME/CREDIT SYSTEM

Year: 2024-25

(Scheme of Teaching, Learning and Examination & Evaluation w.e.f. 2024-2025 and onwards)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Science and Engineering (Data Science) - Semester - I												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics I (BSC)	1AL100BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Physics (BSC)	1AL101BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Programming (ESC)	1AL102ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Mechanics (ESC)	1AL103ES	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Engineering Physics Lab (BSC)	1AL104BS	0	2	0	2	1			25	25	50	3 Hrs.
6	Computer Programming Lab (ESC)	1AL105ES	0	2	0	2	1			25	25	50	3 Hrs.
7	Engineering Mechanics Lab (ESC)	1AL106ES	0	2	0	2	1			25	25	50	3 Hrs.
8	Workshop (ESC)	1AL107ES	0	2	0	2	1			25	25	50	3 Hrs.
	Vocational and Skill Enhancement Courses (VSEC)												
9	Introduction to Web Technology (VSEC I)	1DS108VS	1	2	0	3	2			50	-	50	
	Ability Enhancement Courses(AEC)												
10	Professional Communication	1SH109AE	1	2	0	3	2			25	25	50	3 Hrs.
	Co-curricular Course (CC)												
11	Co-curricular Course (CC)	1SH110CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		14	16	0	30	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Science and Engineering (Data Science) - Semester - II												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
						Core Courses							
1	Applied Mathematics II (BSC)	2AL111BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Chemistry (BSC)	2AL112BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Basic Electrical Engineering (ESC)	2AL113ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Graphics (ESC)	2AL114ES	2	0	0	2	2	40	60			100	3 Hrs.
						Laboratory Courses							
5	Engineering Chemistry Lab (BSC)	2AL115BS	0	2	0	2	1			25	25	50	3 Hrs.
6	Basic Electrical Engineering Lab (ESC)	2AL116ES	0	2	0	2	1			25	25	50	3 Hrs.
7	Engineering Graphics Lab (ESC)	2AL117ES	0	2	0	2	1			25	25	50	3 Hrs.
						Vocational and Skill Enhancement Courses (VSEC)							
8	Computer Hardware & Networking (VSEC II)	2DS118VS	1	2	0	3	2			50	-	50	
						Programme Core Course (PCC)							
9	Computer Fundamentals	2DS119PC	2	0	0	2	2	20	30			50	2 Hrs.
						Indian Knowledge System (IKS)							
10	Indian Traditional Knowledge	2SH120IK	2	0	0	2	2	20	30			50	2 Hrs
						Co-curricular Course (CC)							
11	Co-curricular Course (CC)	2SH121CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		16	12	0	28	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L4.5): Award of UG Certificate in Major with 44 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	3DS241EC	*Certificate Course on Assembly & Maintenance of Personal Computer	Online/offline certification Course	**4**
AND				
2	3DS242EC	*Certificate Course on Office tools (Like Word Processing / Spreadsheet / Presentations etc)		**4**
OR				
3	3DS404EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

The long forms of the Abbreviations in the Scheme of Semester I/II common to all the branches of Engineering & Technology are as under:

AL – All (Common for all branches)
BS – Basic Science Course
ES - Engineering Science Course
VS – vocational & Skill Enhancement
CC - Co-curricular Course
PC – Program Core Course
AE – Ability Enhancement Course
IK - Indian Knowledge System

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - III												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			I	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Discrete Structure & Graph Theory	3DS200PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Programming Methodology using Python	3DS201PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Data Structures	3DS202PC	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
4	Comm. Engag. Project/ Field Project	3DS400EL	0	4	0	4	2			25	25	50	
5	Programming Methodology using Python	3DS203PC	0	2	0	2	1			25	25	50	
6	Data Structure	3DS204PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
7	* Multi-disciplinary Minor#1 (MDM#1)	3DS205MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Open Elective other than a particular Program												
8	Open Elective I	3DS206OE1/2	3	0	0	3	3	40	60	-	-	100	3 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Entrepreneurship Development	3DS207EM	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Value Education Course (VEC)												
10	Environmental Science	3SH208VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**700**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Open Elective I - 3DS206OE1: Basics of Computing for Engineers | 3DS206OE2: E-Commerce

* MDM#1 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure#1**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - IV												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Data Communication & Networking	4DS209PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Operating System	4DS210PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Probability & Statistics for Data Science	4DS211PC	3	0	0	3	2	40	60			100	3 Hrs.
	Laboratory Courses												
4	Data Communication & Networking	4DS212PC	0	2	0	2	1			25	25	50	
5	Operating System	4DS213PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
6	* Multi-disciplinary Minor#2 (MDM#2)	4DS214MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Vocational and Skill Enhancement Courses												
7	Computing Skill #1 (VSEC III)	4DS215VS	0	2	0	2	2			50	-	50	
	Open Elective other than a particular Program												
8	Open Elective II	DS216OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Social Science & Engineering Economics	4DS217EM	2	0	0	2	2	20	30			50	2Hrs.
	(Ability Enhancement Course (AEC)												
10	Modern Indian Language	4SH218AE	2	0	0	2	2			25	25	50	
	Value Education Course (VEC)												
11	Universal Humans Values & Ethics	4SH219VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		19	06	0	25	**22**					**700**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Open Elective II – DS216OE1: Intellectual Property Rights | DS216OE2: Information Systems for Engineers

* MDM#2 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure#1**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L 5): Award of UG Diploma in Major with 88 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	5DS243EC	*Network Configuration and Maintenance	Online/offline certification Course	**4**
AND				
2	5DS244EC	*Full Stack Web Development		**4**
OR				
3	5DS405EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - V												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Database Management Systems	5DS220PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Compiler Design	5DS221PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Architecture & Organization	5DS222PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Programme Elective Course I	5DS223PC	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Database Management Systems	5DS224PC	0	2	0	2	1			25	25	50	
6	Compiler Design	5DS225PC	0	2	0	2	1			25	25	50	
7	Programme Elective Course I	5DS226PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#3 (MDM#3)	5DS227MD	2	0	0	2	2	20	30			50	2 Hrs.
9	* Multi-disciplinary Minor#4 (MDM#4)	5DS228MD	2	0	0	2	2	20	30			50	2 Hrs.
10	* Multi-disciplinary Minor#5 (MDM#5)	5DS229ML	0	2	0	2	1			25	25	50	
	Open Elective other than a particular Program												
11	Open Elective III	5DS230OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course -I : Data Science and Statistics | Cognitive Technologies

Open Elective – III : 5DS230OE1: Cyber Law & Ethics | 5DS230OE2: Introduction to Data Analytics

* MDM#3, MDM#4 & MDM#5 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure#1**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - VI												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Security Policy & Governance	6DS231PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Design & Analysis of Algorithm	6DS232PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Cloud Computing	6DS233PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course II	6DS234PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course III	6DS235PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
6	Design & Analysis of Algorithm	6DS236PC	0	2	0	2	1			25	25	50	
7	Cloud Computing	6DS237PC	0	2	0	2	1			25	25	50	
8	Programme Elective Course II	6DS238PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
9	* Multi-disciplinary Minor#6 (MDM#6)	6DS239MD	2	0	0	2	2	20	30			50	2 Hrs.
	Vocational and Skill Enhancement Courses												
10	Computing Skill # 2 (VSEC IV)	6DS240VS	1	2	0	3	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Programme Elective Course -II : Natural Language Processing | Big Data Analytics
Programme Elective Course -III : Machine Learning | Wireless Sensor Network

* MDM#6 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure#1**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -3 (L5.5): Award of bachelor's degree in Vocation (B.Voc.) in Major with 132 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	7DS310EC	*Database Engineer/Database Administrator	Online/offline certification Course	**4**
AND				
2	7DS311EC	*Cloud Engineer/Cloud Administrator		**4**
OR				
3	7DS406EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - VII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Software Engineering	7DS300PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Professional Ethics & Management	7DS301PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Program Elective Course IV	7DS302PE	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course V	7DS303PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course VI	7DS304PE	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
6	Programme Elective Course IV	7DS305PE	0	2	0	2	1			25	25	50	
7	Programme Elective Course V	7DS306PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#7 (MDM#7)	7DS307MD	2	0	0	2	2	20	30			50	2Hrs.
9	* Multi-disciplinary Minor#8 (MDM#8)	7DS308ML	0	2	0	2	1			25	25	50	
	Project												
10	Project	7DS401PR	0	4	0	4	2			50	50	100	3 Hrs.
DGH Revised on 29.07.2025	TOTAL		17	10	0	27	**22**					**800**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course -IV: Deep Learning | Digital Forensics
Programme Elective Course -V: Data Visualization | Data Warehousing
Programme Elective Course -VI: Block chain Fundamentals | Optimization Techniques

* MDM#7 & MDM#8 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure#1**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Science and Engineering (Data Science) - Semester - VIII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Research Methodology	8DS309RM	4*	0	0	4	4	40	60			100	3 Hrs.
2	Industry Internship	8DS402EL	0	24	0	24	12			100	200	300	
3	Project	8DS403PR	0	4	0	4	2			50	50	100	3 Hrs
DGH Revised on 29.07.2025	TOTAL		4	28	0	32	18					**500**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

***The course on Research Methodology may be completed by the student in Online mode (Swayam, MOOC's, any other platform approved by AICTE or on the LMS platform offered by the Institute).**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

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Note:

1. The Multi-Disciplinary Minors (MDMs) offered by the Computer Science and Engineering (Data Science) discipline are open to students from all engineering disciplines **except** the: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. (**Annexure I**: MDM Basket offered by CSE)
2. Students enrolled in : i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. are eligible to opt for MDMs offered by all other engineering disciplines. (**Refer the scheme of respective discipline**)
3. The Baskets of Multi-Disciplinary Double Minors offered by Computer Science and Engineering (Data Science) discipline are listed under **Annexure II.**
4. Detailed guidelines for **Honors with Research** option is listed under **Annexure III.**
5. To promote the adoption and use of Open-Source Software (OSS), a subject-wise suggestive list of OSS tools is provided as part of this scheme. These tools can be effectively utilized for conducting practical sessions and demonstrations. Please note that this list is dynamic and may evolve with advancements in technology and the introduction of new tools or versions. **(Annexure IV:** List of suggested OSS**)**

Annexure I

Multidisciplinary Minors Subjects offered by Computer Science and Engineering (Data Science)

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3DS205MD / 3CS205MD / 3KE205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4DS214MD	Foundations of Data Science & Statistics	Theory	2
MDM#3	V	5DS227MD	Data Wrangling & Preprocessing Techniques	Theory	2
MDM#4	V	5DS228MD	Data Visualization Techniques	Theory	2
MDM#5	V	5DS229ML	Data Analytics Lab	Practical	1
MDM#6	VI	6DS239MD	Applied Machine Learning for Engineers	Theory	2
MDM#7	VII	7DS307MD	Predictive Analytics & Decision Support	Theory	2
MDM#8	VII	7DS308ML	Data Science Project Lab	Practical	1

Note: Above is the list of Multi-Disciplinary Minors (MDMs) offered by Computer Science and Engineering (Data Science) discipline. These minors are open to students from all engineering disciplines except the following: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines.

Annexure II

Multidisciplinary Double Minors Subjects offered by Computer Science and Engineering (Data Science)

Track: Artificial Intelligence (AI) (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3DS245DH1	Fundamentals of Artificial Intelligence	4	Theory
IV	4DS246DH1	Intelligent Systems and Applications	4	Theory
V	5DS247DH1	Neural Networks and Cognitive Computing	4	Theory
VI	6DS248DH1	Ethical and Explainable AI	4	Theory
VII	7DS407DH1	AI Implementation Lab (Using TensorFlow/PyTorch)	2	Lab

Track: Data Science (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3DS245DH2	Data Science Foundations and Tools	4	Theory
IV	4DS246DH2	Statistical Data Modelling and Inference	4	Theory
V	5DS247DH2	Machine Learning and Applications	4	Theory
VI	6DS248DH2	Scalable Data Systems and Analytics	4	Theory
VII	7DS407DH2	Applied Data Science Lab (Spark/NoSQL/MLFlow)	2	Lab

Note: The subjects offered by Computer Science and Engineering (Data Science) discipline as Double Minor for students of other major disciplines, shall also be applicable and treated as Honours subjects for students pursuing a major in Computer Science and Engineering (Data Science).

Annexure III
Honors with Research

Semester	**Subject Code**	Subject Title	Credits	T/P
VII	7DS408HR	Research Project (Part#1) Problem Identification & Definition Literature Review Experimental Work	9	P
VIII	8DS409HR	Research Project (Part#2) Prototype Development Data Analysis Publication(s)	9	P

Note: Students intending to pursue a degree with Honours with Research must undertake and successfully complete a dedicated research project during Semesters VII and VIII, as outlined in the curriculum and in accordance with the guidelines issued by the respective department from time to time. This research project shall be distinct and independent from the regular final year project (7DS401PR & 8DS403PR).

Annexure IV

Suggestive Subject-Wise list Open-Source Tools

Name of Subject	Open-Source Tools	Name of Subject	Open-Source Tools
Object-Oriented Programming	Eclipse, NetBeans, IntelliJ IDEA (Community Edition), BlueJ	**Sensors & Actuators**	Arduino IDE, Raspberry Pi OS
Data Structure	Code::Blocks, Visual Studio Code, GDB Debugger	**Cryptography**	OpenSSL, GPG
Data Communication & Networking	Wireshark, Mininet, Cisco Packet Tracer (free educational license), NS-3	**Computer Architecture & Organization**	Gem5, Logisim
Operating System	QEMU, VirtualBox, Unix/Linux Shell, FreeDOS	**Information Retrieval**	Apache Solr, Elasticsearch
Artificial Intelligence	TensorFlow, PyTorch, OpenCV, Scikit-learn	**Supervised Machine Learning**	TensorFlow, Scikit-learn
Programming Methodology using Python	Jupyter Notebook, Anaconda, PyCharm (Community Edition), VS Code	**Digital Forensics**	Autopsy, Sleuth Kit, Volatility
Probability & Statistics for Data Science	R, RStudio, NumPy, SciPy, Matplotlib	**Internet of Everything**	Node-RED, ThingsBoard, Kaa IoT
Cognitive Technologies	IBM Watson (free tier), TensorFlow, spaCy	**Image & Video Processing**	OpenCV, GIMP, FFmpeg
Data Science and Statistics	R, Jupyter Notebook, KNIME	**Augmented & Virtual Reality**	Blender, Godot Engine
Internet of Things	Arduino IDE, Node-RED, ThingsBoard	**Usability Engineering**	Axure RP (free for students), Figma
Introduction to Cyber Security	Kali Linux, Metasploit Framework, OpenVAS	**Cryptography & Security**	Wireshark, OpenSSL, VeraCrypt
Database Management Systems	MySQL, PostgreSQL, SQLite, MongoDB	**Wireless Sensor Networks**	Cooja, NS-3
Compiler Design	LLVM, GCC, Flex, Bison	**System & Software Security**	Metasploit, Snort
Numerical Methods	Octave, SciPy, NumPy	**Blockchain Fundamentals**	Ethereum, Hyperledger, Ganache
Microprocessor & Assembly Language Programming	Keil uVision, GNUSim8085, Logisim	**Data Storage & Network**	FreeNAS, OpenFiler
Design & Analysis of Algorithm	Gephi, NetworkX	**Distributed Ledger Technology**	Hyperledger Fabric, Corda
Cloud Computing	OpenStack, CloudStack, Apache Hadoop	**Deep Learning**	Keras, TensorFlow, PyTorch
Natural Language Processing	NLTK, spaCy, Hugging Face Transformers	**Data Visualization**	Tableau Public, Matplotlib, D3.js
Big Data Analytics	Apache Hadoop, Apache Spark, Dask	**Data Warehousing**	Apache Hive, Pentaho

Sant Gadge Baba Amravati University, Amravati

Scheme of Implementation for

Four Year Undergraduate Degree Programme in Engineering and Technology

B.E. (Bachelor of Engineering) in

Artificial Intelligence and Data Science

in the faculty of Science and Technology

ACADEMIC EVALUATION SCHEME/CREDIT SYSTEM

Year: 2024-25

(Scheme of Teaching, Learning and Examination & Evaluation w.e.f. 2024-2025 and onwards)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- I												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics I (BSC)	1AL100BS	3	0	0	3	3	40	60			100	3Hrs.
2	Engineering Physics (BSC)	1AL101BS	3	0	0	3	3	40	60			100	3Hrs.
3	Computer Programming (ESC)	1AL102ES	3	0	0	3	3	40	60			100	3Hrs.
4	Engineering Mechanics (ESC)	1AL103ES	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
5	Engineering Physics Lab (BSC)	1AL104BS	0	2	0	2	1			25	25	50	3Hrs.
6	Computer Programming Lab (ESC)	1AL105ES	0	2	0	2	1			25	25	50	3Hrs.
7	Engineering Mechanics Lab (ESC)	1AL106ES	0	2	0	2	1			25	25	50	3Hrs.
8	Workshop (ESC)	1AL107ES	0	2	0	2	1			25	25	50	3Hrs.
	Vocational and Skill Enhancement Courses (VSEC)												
9	Introduction to Web Technology (VSEC-I)	1AD108VS	1	2	0	3	2			50	-	50	
	Ability Enhancement Courses(AEC)												
10	Professional Communication	1SH109AE	1	2	0	3	2			25	25	50	3 Hrs.
	Co-curricular Course(CC)												
11	Co-Curricular Course (CC)	1SH110CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		14	16	0	30	**22**					**750**	

L:Lecture	**P:Practical**	**T:Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- II												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics II (BSC)	2AL111BS	3	0	0	3	3	40	60			100	3Hrs.
2	Engineering Chemistry (BSC)	2AL112BS	3	0	0	3	3	40	60			100	3Hrs.
3	Basic Electrical Engineering (ESC)	2AL113ES	3	0	0	3	3	40	60			100	3Hrs.
4	Engineering Graphics (ESC)	2AL114ES	2	0	0	2	2	40	60			100	3Hrs.
	Laboratory Courses												
5	Engineering Chemistry Lab (BSC)	2AL115BS	0	2	0	2	1			25	25	50	3Hrs.
6	Basic Electrical Engineering Lab (ESC)	2AL116ES	0	2	0	2	1			25	25	50	3Hrs.
7	Engineering Graphics Lab (ESC)	2AL117ES	0	2	0	2	1			25	25	50	3Hrs.
	Vocational and Skill Enhancement Courses(VSEC)												
8	Computer Hardware & Networking (VSEC-II)	2AD118VS	1	2	0	3	2			50	-	50	
	Programme Core Course(PCC)												
9	Computer Fundamentals	2AD119PC	2	0	0	2	2	20	30			50	2Hrs.
	Indian Knowledge System (IKS)												
10	Indian Traditional Knowledge	2SH120IK	2	0	0	2	2	20	30			50	3Hrs.
	Co-curricular Course(CC)												
11	Co-curricular Course (CC)	2SH121CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		16	12	0	28	**22**					**750**	

L:Lecture	**P:Practical**	**T:Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

<table>
<tr><th colspan="5">Exit option -1 (L4.5): Award of UG Certificate in Major with 44 credits and an additional 8 credits</th></tr>
<tr><th colspan="5">EXIT Courses</th></tr>
<tr><th>S.N.</th><th>Course Code</th><th>Course Name/Type</th><th>Mode / Duration</th><th>Credits</th></tr>
<tr><td>1</td><td>3AD241EC</td><td>*Certificate Course on Assembly & Maintenance of Personal Computer</td><td rowspan="3">Online/offline certification Course</td><td>4</td></tr>
<tr><td colspan="3">AND</td></tr>
<tr><td>2</td><td>3AD242EC</td><td>*Certificate Course on Office tools (Like Word Processing / Spreadsheet / Presentations etc)</td><td>4</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>3</td><td>3AD404EL</td><td>Internship at IT Related Industry</td><td>Two Months
(288-320 Hrs.)</td><td>8</td></tr>
</table>

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

The long forms of the Abbreviations in the Scheme of Semester I/II common to all the branches of Engineering & Technology are as under:

AL – All (Common for all branches)
BS – Basic Science Course
ES - Engineering Science Course
VS – vocational & Skill Enhancement
CC - Co-curricular Course
PC – Program Core Course
AE – Ability Enhancement Course
IK - Indian Knowledge System

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- III												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Discrete Structure & Graph Theory	3AD200PC	3	0	0	3	3	40	60			100	3Hrs.
2	Object Oriented Programming	3AD201PC	3	0	0	3	3	40	60			100	3Hrs.
3	Data Structures	3AD202PC	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
4	Comm. Engg. Project / Field Project	3AD400EL	0	4	0	4	2			25	25	50	
5	Object Oriented Programming	3AD203PC	0	2	0	2	1			25	25	50	
6	Data Structure	3AD204PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
7	* Multi-disciplinary Minor#1 (MDM#1)	3AD205MD	2	0	0	2	2	20	30	-	-	50	2Hrs.
	Open Elective other than a particular Program												
8	Open Elective-I	3AD206OE1/2	3	0	0	3	3	40	60	-	-	100	3Hrs.
	HSSMC (Entrepreneurship/Economics/Management Course)												
9	Entrepreneurship Development	3AD207EM	2	0	0	2	2	20	30	-	-	50	2Hrs.
	Value Education Course (VEC)												
10	Environmental Science	3SH208VE	2	0	0	2	2	20	30			50	2Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**700**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Open Elective I - 3AD206OE1: Basics of Computing for Engineers | 3AD206OE2: E-Commerce

* MDM#1 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- IV												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Data Communication & Networking	4AD209PC	3	0	0	3	3	40	60			100	3Hrs.
2	Operating System	4AD210PC	3	0	0	3	3	40	60			100	3Hrs.
3	Probability & Statistics for Data Science	4AD211PC	3	0	0	3	2	40	60			100	3Hrs.
	Laboratory Courses												
4	Data Communication & Networking	4AD212PC	0	2	0	2	1			25	25	50	3Hrs.
5	Operating System	4AD213PC	0	2	0	2	1			25	25	50	3Hrs.
	Multidisciplinary Minor												
6	* Multi-disciplinary Minor#2 (MDM#2)	4AD214MD	2	0	0	2	2	20	30	-	-	50	2Hrs.
	Vocational and Skill Enhancement Courses												
7	Computing Skill #1 (VSEC-III)	4AD215VS	0	2	0	2	2			50	-	50	
	Open Elective other than a particular Program												
8	Open Elective II	4AD216OE1/2	2	0	0	2	2	20	30			50	2Hrs.
	HSSMC (Entrepreneurship/Economics/Management Course)												
9	Social Science & Engineering Economics	4AD217EM	2	0	0	2	2	20	30			50	2Hrs.
	(Ability Enhancement Course(AEC)												
10	Modern Indian Language	4SH218AE	2	0	0	2	2			25	25	50	.
	Value Education Course(VEC)												
11	Universal Humans Values (UHV)	4SH219VE	2	0	0	2	2	20	30			50	2Hrs.
DGH Revised on 29.07.2025	TOTAL		19	06	0	25	**22**					**700**	

L:Lecture	**P:Practical**	**T:Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Open Elective II – 4AD216OE1: Intellectual Property Rights | 4AD216OE2: Information Systems for Engineers

* MDM#2 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

<table>
<tr><th colspan="5">Exit option -1 (L 5): Award of UG Diploma in Major with 88 credits and an additional 8 credits</th></tr>
<tr><th colspan="5">EXIT Courses</th></tr>
<tr><th>S.N.</th><th>Course Code</th><th>Course Name/Type</th><th>Mode / Duration</th><th>Credits</th></tr>
<tr><td>1</td><td>5AD243EC</td><td>*Network Configuration and Maintenance</td><td rowspan="3">Online/offline certification Course</td><td>4</td></tr>
<tr><td colspan="3">AND</td><td rowspan="2">4</td></tr>
<tr><td>2</td><td>5AD244EC</td><td>*Full Stack Web Development</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>3</td><td>5AD405EL</td><td>Internship at IT Related Industry</td><td>Two Months (288-320 Hrs.)</td><td>8</td></tr>
</table>

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- V												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Database Management Systems	5AD220PC	3	0	0	3	3	40	60			100	3Hrs.
2	Machine Learning Techniques	5AD221PC	3	0	0	3	3	40	60			100	3Hrs.
3	Data Science	5AD222PC	3	0	0	3	3	40	60			100	3Hrs.
4	Programme Elective Course I	5AD223PE	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
5	Database Management Systems	5AD224PC	0	2	0	2	1			25	25	50	3Hrs.
6	Compiler Design	5AD225PC	0	2	0	2	1			25	25	50	3Hrs.
7	Programme Elective Course I	5AD226PE	0	2	0	2	1			25	25	50	3Hrs.
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#4 (MDM#4)	5AD227MD	2	0	0	2	2	20	30			50	2Hrs.
9	* Multi-disciplinary Minor#5 (MDM#5)	5AD228MD	2	0	0	2	2	20	30			50	2Hrs.
10	* Multi-disciplinary Minor#6 (MDM#6)	5AD229ML	0	2	0	2	1			25	25	50	3Hrs.
	Open Elective other than a particular Program												
11	Open Elective III	5AD230OE1/2	2	0	0	2	2	20	30			50	2Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L:Lecture	P:Practical	T:Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Programme Elective Course-I : Business Intelligence | Introduction to Cyber Security

Open Elective – III : 5AD230OE1: Cyber Law & Ethics | 5AD230OE2: Introduction to Data Analytics

* MDM#3, MDM#4 & MDM#5 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- VI												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Data Analytics	6AD231PC	3	0	0	3	3	40	60			100	3Hrs.
2	Design & Analysis of Algorithm	6AD232PC	3	0	0	3	3	40	60			100	3Hrs.
3	Cloud Computing	6AD233PC	3	0	0	3	3	40	60			100	3Hrs.
4	Program Elective Course II	6AD234PE	3	0	0	3	3	40	60			100	3Hrs.
5	Program Elective Course III	6AD235PE	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
6	Design & Analysis of Algorithm	6AD236PC	0	2	0	2	1			25	25	50	3Hrs.
7	Cloud Computing	6AD237PC	0	2	0	2	1			25	25	50	3Hrs.
8	Programme Elective Course II	6AD238PE	0	2	0	2	1			25	25	50	3Hrs.
	Multidisciplinary Minor												
9	* Multi-disciplinary Minor#6 (MDM#6)	6AD239MD	2	0	0	2	2	20	30			50	2Hrs.
	Vocational and Skill Enhancement Courses												
10	Computing Skill # 2 (VSEC-IV)	6AD240VS	1	2	0	3	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L:Lecture	**P:Practical**	**T:Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course-II : Natural Language Processing | Digital Forensics
Programme Elective Course-III : Blockchain Technology | Data Visualization Techniques

* MDM#6 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -3 (L5.5): Award of bachelor's degree in Vocation (B.Voc.) in Major with 132 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	7AD310EC	*Database Engineer/Database Administrator	Online/offline certification Course	**4**
AND				
2	7AD311EC	*Cloud Engineer/Cloud Administrator		**4**
OR				
3	7AD406EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- VII												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Deep Learning	7AD300PC	3	0	0	3	3	40	60			100	3Hrs.
2	Professional Ethics & Management	7AD301PC	3	0	0	3	3	40	60			100	3Hrs.
3	Program Elective Course IV	7AD302PE	3	0	0	3	3	40	60			100	3Hrs.
4	Program Elective Course V	7AD303PE	3	0	0	3	3	40	60			100	3Hrs.
5	Program Elective Course VI	7AD304PE	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
6	Programme Elective Course IV	7AD305PE	0	2	0	2	1			25	25	50	3 Hrs.
7	Programme Elective Course V	7AD306PE	0	2	0	2	1			25	25	50	3 Hrs.
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#7 (MDM#7)	7AD307MD	2	0	0	2	2	20	30			50	2Hrs.
9	* Multi-disciplinary Minor#8 (MDM#8)	7AD308ML	0	2	0	2	1			25	25	50	3Hrs.
	Project												
10	Project	7AD401PR	0	4	0	4	2			50	50	100	
DGH Revised on 29.07.2025	TOTAL		17	10	0	27	**22**					**800**	

L:Lecture	**P:Practical**	**T:Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course-IV : Virtual & Augmented Reality | System & Software Security
Programme Elective Course-V : Human Computer Interaction | Optimization Techniques
Programme Elective Course-VI : Distributed Ledger Technology | Cloud System & Infrastructure

* MDM#7 & MDM#8 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Artificial Intelligence and Data Science - Semester- VIII												
S.N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Research Methodology	8AD309RM	4*	0	0	4	4	40	60			100	3Hrs.
2	Industry Internship`	8AD402EL	0	24	0	24	12			100	200	300	--
3	Project	8AD403PR	0	4	0	4	2			50	50	100	3Hrs.
DGH Revised on 29.07.2025	TOTAL		4	28	0	32	18					**500**	

L:Lecture	P:Practical	T:Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

***The course on Research Methodology may be completed by the student in Online mode (Swayam, MOOC's, any other platform approved by AICTE or on the LMS platform offered by the Institute).**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

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Note:

1. The Multi-Disciplinary Minors (MDMs) offered by the Artificial Intelligence and Data Science discipline are open to students from all engineering disciplines **except** the: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. (**Annexure I**: MDM Basket offered by CSE)
2. Students enrolled in : i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. are eligible to opt for MDMs offered by all other engineering disciplines. (**Refer the scheme of respective disciplines**)
3. The Baskets of Multi-Disciplinary Double Minors offered by Artificial Intelligence and Data Science discipline are listed under **Annexure II.**
4. Detailed guidelines for **Honors with Research** option is listed under **Annexure III.**
5. To promote the adoption and use of Open-Source Software (OSS), a subject-wise suggestive list of OSS tools is provided as part of this scheme. These tools can be effectively utilized for conducting practical sessions and demonstrations. Please note that this list is dynamic and may evolve with advancements in technology and the introduction of new tools or versions. **(Annexure IV:** List of suggested OSS**)**

Annexure I

Multidisciplinary Minors Subjects offered by Artificial Intelligence and Data Science

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3AD205MD / 3CS205MD / 3KE205MD / 3DS205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4AD214MD	Essentials of Artificial Intelligence	Theory	2
MDM#3	V	5AD227MD	Introduction to Machine Learning	Theory	2
MDM#4	V	5AD228MD	AI for Engineering Applications	Theory	2
MDM#5	V	5AD229ML	Machine Learning Lab	Practical	1
MDM#6	VI	6AD239MD	Deep Learning Foundations	Theory	2
MDM#7	VII	7AD307MD	AI in Robotics, Healthcare, and Smart Systems	Theory	2
MDM#8	VII	7AD308ML	AI Tools and Frameworks Lab	Practical	1

Note: Above is the list of Multi-Disciplinary Minors (MDMs) offered by Artificial Intelligence and Data Science discipline. These minors are open to students from all engineering disciplines except the following: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines.

Annexure II

Multidisciplinary Double Minors Subjects offered by Artificial Intelligence and Data Science

Track: Blockchain Technologies (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3AD245DH1	Foundations of Blockchain	Theory	4
IV	4AD246DH1	Smart Contracts and DApps	Theory	4
V	5AD247DH1	Blockchain Protocols & Architecture	Theory	4
VI	6AD248DH1	Decentralized Identity and Tokenomics	Theory	4
VII	7AD407DH1	Blockchain Implementation Lab	Practical	2

Track: Generative AI (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3AD245DH2	Introduction to Generative AI	Theory	4
IV	4AD246DH2	Foundation Models and Transfer Learning	Theory	4
V	5AD247DH2	Multimodal Generative Models	Theory	4
VI	6AD248DH2	Explainability & Deployment of GenAI Models	Theory	4
VII	7AD407DH2	Generative AI Model Development Lab	Practical	2

Note: The subjects offered by Artificial Intelligence and Data Science discipline as Double Minor for students of other major disciplines, shall also be applicable and treated as Honours subjects for students pursuing a major in Artificial Intelligence and Data Science.

Annexure III
Honors with Research

Semester	**Subject Code**	Subject Title	Credits	T/P
VII	7AD408HR	Research Project (Part#1) Problem Identification & Definition Literature Review Experimental Work	9	P
VIII	8AD409HR	Research Project (Part#2) Prototype Development Data Analysis Publication(s)	9	P

Note: Students intending to pursue a degree with Honours with Research must undertake and successfully complete a dedicated research project during Semesters VII and VIII, as outlined in the curriculum and in accordance with the guidelines issued by the respective department from time to time. This research project shall be distinct and independent from the regular final year project (7AD401PR & 8AD403PR).

Annexure IV

Suggestive Subject-Wise list Open-Source Tools

Name of Subject	Open-Source Tools	Name of Subject	Open-Source Tools
Object-Oriented Programming	Eclipse, NetBeans, IntelliJ IDEA (Community Edition), BlueJ	**Sensors & Actuators**	Arduino IDE, Raspberry Pi OS
Data Structure	Code::Blocks, Visual Studio Code, GDB Debugger	**Cryptography**	OpenSSL, GPG
Data Communication & Networking	Wireshark, Mininet, Cisco Packet Tracer (free educational license), NS-3	**Computer Architecture & Organization**	Gem5, Logisim
Operating System	QEMU, VirtualBox, Unix/Linux Shell, FreeDOS	**Information Retrieval**	Apache Solr, Elasticsearch
Artificial Intelligence	TensorFlow, PyTorch, OpenCV, Scikit-learn	**Supervised Machine Learning**	TensorFlow, Scikit-learn
Programming Methodology using Python	Jupyter Notebook, Anaconda, PyCharm (Community Edition), VS Code	**Digital Forensics**	Autopsy, Sleuth Kit, Volatility
Probability & Statistics for Data Science	R, RStudio, NumPy, SciPy, Matplotlib	**Internet of Everything**	Node-RED, ThingsBoard, Kaa IoT
Cognitive Technologies	IBM Watson (free tier), TensorFlow, spaCy	**Image & Video Processing**	OpenCV, GIMP, FFmpeg
Data Science and Statistics	R, Jupyter Notebook, KNIME	**Augmented & Virtual Reality**	Blender, Godot Engine
Internet of Things	Arduino IDE, Node-RED, ThingsBoard	**Usability Engineering**	Axure RP (free for students), Figma
Introduction to Cyber Security	Kali Linux, Metasploit Framework, OpenVAS	**Cryptography & Security**	Wireshark, OpenSSL, VeraCrypt
Database Management Systems	MySQL, PostgreSQL, SQLite, MongoDB	**Wireless Sensor Networks**	Cooja, NS-3
Compiler Design	LLVM, GCC, Flex, Bison	**System & Software Security**	Metasploit, Snort
Numerical Methods	Octave, SciPy, NumPy	**Blockchain Fundamentals**	Ethereum, Hyperledger, Ganache
Microprocessor & Assembly Language Programming	Keil uVision, GNUSim8085, Logisim	**Data Storage & Network**	FreeNAS, OpenFiler
Design & Analysis of Algorithm	Gephi, NetworkX	**Distributed Ledger Technology**	Hyperledger Fabric, Corda
Cloud Computing	OpenStack, CloudStack, Apache Hadoop	**Deep Learning**	Keras, TensorFlow, PyTorch
Natural Language Processing	NLTK, spaCy, Hugging Face Transformers	**Data Visualization**	Tableau Public, Matplotlib, D3.js
Big Data Analytics	Apache Hadoop, Apache Spark, Dask	**Data Warehousing**	Apache Hive, Pentaho

Sant Gadge Baba Amravati University, Amravati

Scheme of Implementation for

Four Year Undergraduate Degree Programme in Engineering and Technology

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B.E. (Bachelor of Engineering) in

Computer Engineering

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in the faculty of Science and Technology

ACADEMIC EVALUATION SCHEME/CREDIT SYSTEM

Year: 2024-25

(Scheme of Teaching, Learning and Examination & Evaluation w.e.f. 2024-2025 and onwards)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Engineering - Semester - I												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics I (BSC)	1AL100BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Physics (BSC)	1AL101BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Programming (ESC)	1AL102ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Mechanics (ESC)	1AL103ES	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Engineering Physics Lab (BSC)	1AL104BS	0	2	0	2	1			25	25	50	3 Hrs.
6	Computer Programming Lab (ESC)	1AL105ES	0	2	0	2	1			25	25	50	3 Hrs.
7	Engineering Mechanics Lab (ESC)	1AL106ES	0	2	0	2	1			25	25	50	3 Hrs.
8	Workshop (ESC)	1AL107ES	0	2	0	2	1			25	25	50	3 Hrs.
	Vocational and Skill Enhancement Courses (VSEC)												
9	Introduction to Web Technology (VSEC-I)	1KE108VS	1	2	0	3	2			50	-	50	
	Ability Enhancement Courses(AEC)												
10	Professional Communication	1SH109AE	1	2	0	3	2			25	25	50	3 Hrs.
	Co-curricular Course (CC)												
11	Co-curricular Course (CC)	1SH110CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		14	16	0	30	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for First Year Four Year Undergraduate Engineering Degree Programme Computer Engineering - Semester - II												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Applied Mathematics II (BSC)	2AL111BS	3	0	0	3	3	40	60			100	3 Hrs.
2	Engineering Chemistry (BSC)	2AL112BS	3	0	0	3	3	40	60			100	3 Hrs.
3	Basic Electrical Engineering (ESC)	2AL113ES	3	0	0	3	3	40	60			100	3 Hrs.
4	Engineering Graphics (ESC)	2AL114ES	2	0	0	2	2	40	60			100	3 Hrs.
	Laboratory Courses												
5	Engineering Chemistry Lab (BSC)	2AL115BS	0	2	0	2	1			25	25	50	3 Hrs.
6	Basic Electrical Engineering Lab (ESC)	2AL116ES	0	2	0	2	1			25	25	50	3 Hrs.
7	Engineering Graphics Lab (ESC)	2AL117ES	0	2	0	2	1			25	25	50	3 Hrs.
	Vocational and Skill Enhancement Courses (VSEC)												
8	Computer Hardware & Networking (VSEC-II)	2KE118VS	1	2	0	3	2			50	-	50	
	Programme Core Course (PCC)												
9	Computer Fundamentals	2KE119PC	2	0	0	2	2	20	30			50	2 Hrs.
	Indian Knowledge System (IKS)												
10	Indian Traditional Knowledge	2SH120IK	2	0	0	2	2	20	30			50	2 Hrs
	Co-curricular Course (CC)												
11	Co-curricular Course (CC)	2SH121CC	0	4	0	4	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		16	12	0	28	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L4.5): Award of UG Certificate in Major with 44 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	3KE241EC	*Certificate Course on Assembly & Maintenance of Personal Computer	Online/offline certification Course	**4**
AND				
2	3KE242EC	*Certificate Course on Office tools (Like Word Processing / Spreadsheet / Presentations etc)		**4**
OR				
3	3KE404EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

The long forms of the Abbreviations in the Scheme of Semester I/II common to all the branches of Engineering & Technology are as under:

AL – All (Common for all branches)
BS – Basic Science Course
ES - Engineering Science Course
VS – vocational & Skill Enhancement
CC - Co-curricular Course
PC – Program Core Course
AE – Ability Enhancement Course
IK - Indian Knowledge System

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - III												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Discrete Structure & Graph Theory	3KE200PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Programming Methodology Using Python	3KE201PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Data Structures	3KE202PC	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
4	Comm. Engag. Project/ Field Project	3KE400EL	0	4	0	4	2			25	25	50	
5	Programming Methodology Using Python	3KE203PC	0	2	0	2	1			25	25	50	
6	Data Structure	3KE204PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
7	* Multi-disciplinary Minor#1 (MDM#1)	3KE205MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Open Elective other than a particular Program												
8	Open Elective I	3KE206OE1/2	3	0	0	3	3	40	60	-	-	100	3 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Entrepreneurship Development	3KE207HS	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Value Education Course (VEC)												
10	Environmental Science	3SH208VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**700**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

Open Elective I - 3KE206OE1: Basics of Computing for Engineers | 3KE206OE2: E-Commerce

* MDM#1 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - IV												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Data Communication & Networking	4KE209PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Operating System	4KE210PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Theory of Computation	4KE211PC	3	0	0	3	2	40	60			100	3 Hrs.
	Laboratory Courses												
4	Data Communication & Networking	4KE212PC	0	2	0	2	1			25	25	50	
5	Operating System	4KE213PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
6	* Multi-disciplinary Minor#2 (MDM#2)	4KE214MD	2	0	0	2	2	20	30	-	-	50	2 Hrs.
	Vocational and Skill Enhancement Courses												
7	Computing Skill #1 (VSEC-III)	4KE215VS	0	2	0	2	2			50	-	50	
	Open Elective other than a particular Program												
8	Open Elective II	4KE216OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
	HSSMC (Entrepreneurship/ Economics/ Management Course)												
9	Social Science & Engineering Economics	4KE217EM	2	0	0	2	2	20	30			50	2 Hrs.
	(Ability Enhancement Course (AEC)												
10	Modern Indian Language	4SH218AE	2	0	0	2	2			25	25	50	3 Hrs
	Value Education Course (VEC)												
11	Universal Humans Values (UHV)	4SH219VE	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		19	06	0	25	**22**					**700**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Open Elective II – 4KE216OE1: Intellectual Property Rights | 4KE216OE2: Information Systems for Engineers

* MDM#2 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -1 (L 5): Award of UG Diploma in Major with 88 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	5KE243EC	*Network Configuration and Maintenance	Online/offline certification Course	**4**
AND				
2	5KE244EC	*Full Stack Web Development		**4**
OR				
3	5KE405EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - V												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Database Management Systems	5KE220PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Compiler Design	5KE221PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Computer Architecture & Organization	5KE222PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Programme Elective Course I	5KE223PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
5	Database Management Systems	5KE224PC	0	2	0	2	1			25	25	50	
6	Compiler Design	5KE225PC	0	2	0	2	1			25	25	50	
7	Programme Elective Course I	5KE226PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#3 (MDM#3)	5KE227MD	2	0	0	2	2	20	30			50	2 Hrs.
9	* Multi-disciplinary Minor#4 (MDM#4)	5KE228MD	2	0	0	2	2	20	30			50	2 Hrs.
10	* Multi-disciplinary Minor#5 (MDM#5)	5KE229ML	0	2	0	2	1			25	25	50	
	Open Elective other than a particular Program												
11	Open Elective III	5KE230OE1/2	2	0	0	2	2	20	30			50	2 Hrs.
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course -I : Internet of Everything | Augmented & Virtual Reality | Introduction to Cyber Security

Open Elective – III : 5KE230OE1: Cyber Law & Ethics | 5KE230OE2: Introduction to Data Analytics

* MDM#3, MDM#4 & MDM#5 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - VI												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Security Policy & Governance	6KE231PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Design & Analysis of Algorithm	6KE232PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Cloud Computing	6KE233PC	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course II	6KE234PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course III	6KE235PE	3	0	0	3	3	40	60			100	3 Hrs.
	Laboratory Courses												
6	Design & Analysis of Algorithm	6KE236PC	0	2	0	2	1			25	25	50	
7	Cloud Computing	6KE237PC	0	2	0	2	1			25	25	50	
8	Programme Elective Course II	6KE238PE	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
9	* Multi-disciplinary Minor#6 (MDM#6)	6KE239MD	2	0	0	2	2	20	30			50	2 Hrs.
	Vocational and Skill Enhancement Courses												
10	Computing Skill # 2 (VSEC -IV)	6KE240VS	1	2	0	3	2			50	-	50	
DGH Revised on 29.07.2025	TOTAL		18	08	0	26	**22**					**750**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course -II : Big Data Analytics | Natural Language Processing | Cryptography & Security
Programme Elective Course -III : Wireless Technology and 5G| Computer Vision | Digital Forensics

* MDM#6 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).
Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

Scheme for Multiple Entry and Multiple Exit

Exit option -3 (L5.5): Award of bachelor's degree in Vocation (B.Voc.) in Major with 132 credits and an additional 8 credits				
EXIT Courses				
S.N.	**Course Code**	**Course Name/Type**	**Mode / Duration**	**Credits**
1	7KE310EC	*Database Engineer/Database Administrator	Online/offline certification Course	**4**
AND				
2	7KE311EC	*Cloud Engineer/Cloud Administrator		**4**
OR				
3	7KE406EL	Internship at IT Related Industry	Two Months (288-320 Hrs.)	**8**

Note: The above exit courses may or may not be offered /available to students during that academic session hence it is the discretion of the department/institute to evaluate the exit course by considering either certification courses or internship from IT related Registered Industry. Students will have a choice to go for (Option 1 AND Option 2) OR (Option 3) for the exit courses.

* Certificate course shall be proposed by BoS after curetting available courses offered by the technological based industries and renowned training-cum-certification providers. These Proposed courses shall meet the skill set requirements which student must acquire. The list of curetted courses may vary as per the requirements of the employment market. These Certificate courses to be evaluated at both level i.e. Internal & External (Evaluation guidelines will be given by concerned authority in the form of SOP)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - VII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Software Engineering	7KE300PC	3	0	0	3	3	40	60			100	3 Hrs.
2	Professional Ethics & Management	7KE301PC	3	0	0	3	3	40	60			100	3 Hrs.
3	Program Elective Course IV	7KE302PE	3	0	0	3	3	40	60			100	3 Hrs.
4	Program Elective Course V	7KE303PE	3	0	0	3	3	40	60			100	3 Hrs.
5	Program Elective Course VI	7KE304PE	3	0	0	3	3	40	60			100	3Hrs.
	Laboratory Courses												
6	Programme Elective Course IV	7KE305PC	0	2	0	2	1			25	25	50	
7	Programme Elective Course V	7KE306PC	0	2	0	2	1			25	25	50	
	Multidisciplinary Minor												
8	* Multi-disciplinary Minor#7 (MDM#7)	7KE307MD	2	0	0	2	2	20	30			50	2 Hrs.
9	* Multi-disciplinary Minor#8 (MDM#8)	7KE308ML	0	2	0	2	1			25	25	50	
	Project												
10	Project	7KE401PR	0	4	0	4	2			50	50	100	
DGH Revised on 29.07.2025	TOTAL		17	10	0	27	**22**					**800**	

L: Lecture	**P: Practical**	**T: Tutorial**	**ESE: End Semester Exam**	**IE: Internal Evaluation**	**INT: Internal**	**EXT: External**

Programme Elective Course -IV : Penetration Testing | Genetic Algorithms and Fuzzy Systems | Software Testing & Quality Assurance
Programme Elective Course -V : Block chain Fundamentals | Real Time Systems | Quantum Computing
Programme Elective Course -VI : Optimization Techniques | Human Computer Interaction | Cloud System & Infrastructure

* MDM#7 & MDM#8 - Please refer the list of Multi-disciplinary Minor courses attached separately at the end (**Annexure I**).

Note: Appropriate nos. of hour per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

	Scheme for Four Year Undergraduate Engineering Degree Programme B.E. in Computer Engineering - Semester - VIII												
S. N.	**Course Name**	**Code**	**Course Plan per Week (Hrs.)**				**Credits**	**Theory Evaluation**		**Practical Evaluation**		**Total Marks**	**ESE (Time Hrs.)**
			L	**P**	**T**	**Hrs.**		**IE**	**ESE**	**INT**	**EXT**		
	Core Courses												
1	Research Methodology	8KE309RM	4*	0	0	4	4	40	60			100	3 Hrs.
2	Industry Internship	8KE402EL	0	24	0	24	12			100	200	300	--
3	Project	8KE403PR	0	4	0	4	2			50	50	100	3 Hrs.
DGH Revised on 29.07.2025	TOTAL		4	28	0	32	18					**500**	

L: Lecture	P: Practical	T: Tutorial	ESE: End Semester Exam	IE: Internal Evaluation	INT: Internal	EXT: External

***The course on Research Methodology may be completed by the student in Online mode (Swayam, MOOC's, any other platform approved by AICTE or on the LMS platform offered by the Institute).**

Note: Appropriate nos. of hours per week are allotted for continuous evaluation process for the above subjects. (Total contact hours per week = 42 Hours)

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Note:

1. The Multi-Disciplinary Minors (MDMs) offered by the Computer Engineering discipline are open to students from all engineering disciplines **except** the: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. (**Annexure I**: MDM Basket offered by CSE)
2. Students enrolled in : i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines. are eligible to opt for MDMs offered by all other engineering disciplines. (**Refer the scheme of respective disciplines**)
3. The Baskets of Multi-Disciplinary Double Minors offered by Computer Engineering discipline are listed under **Annexure II.**
4. Detailed guidelines for **Honors with Research** option is listed under **Annexure III.**
5. To promote the adoption and use of Open-Source Software (OSS), a subject-wise suggestive list of OSS tools is provided as part of this scheme. These tools can be effectively utilized for conducting practical sessions and demonstrations. Please note that this list is dynamic and may evolve with advancements in technology and the introduction of new tools or versions. **(Annexure IV:** List of suggested OSS**)**

Annexure I

Multidisciplinary Minors Subjects offered by Computer Engineering

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3KE205MD / 3CS205MD / 3DS205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4KE214MD	Operating Systems Fundamentals	Theory	2
MDM#3	V	5KE227MD	Software Engineering Principles	Theory	2
MDM#4	V	5KE228MD	Mobile Application Development	Theory	2
MDM#5	V	5KE229ML	Mobile App Development Lab	Practical	1
MDM#6	VI	6KE239MD	DevOps and Software Deployment Practices	Theory	2
MDM#7	VII	7KE307MD	Full Stack Web Development	Theory	2
MDM#8	VII	7KE308ML	Software Project Lab	Practical	1

Note: Above is the list of Multi-Disciplinary Minors (MDMs) offered by Computer Engineering discipline. These minors are open to students from all engineering disciplines except the following: i. Computer Science and Engineering, ii. Computer Engineering, iii. Artificial Intelligence and Data Science iv. Artificial Intelligence (AI) and Data Science, v. Computer Science and Engineering (IoT), vi. Computer Science and Engineering (Artificial Intelligence and Machine Learning), vii. Computer Science and Information Technology, viii. Computer Science and Engineering (Data Science), ix. Information Technology and allied disciplines.

Annexure II

Multidisciplinary Double Minors Subjects offered by Computer Engineering

Track: Internet of Things (IoT) (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3KE245DH1	Fundamentals of IoT and Smart Devices	4	Theory
IV	4KE246DH1	IoT Architectures and Communication Protocols	4	Theory
V	5KE247DH1	IoT Data Management and Edge Integration	4	Theory
VI	6KE248DH1	IoT Security and Ethical Design	4	Theory
VII	7KE407DH1	Smart IoT Lab: Projects and Prototyping	2	Lab

Track: Edge Computing (Honours / Double Minor)				
Semester	**Subject Code**	Subject Title	Credits	T/P
III	3KE245DH2	Introduction to Edge and Fog Computing	4	Theory
IV	4KE246DH2	Edge Devices and Embedded Systems	4	Theory
V	5KE247DH2	Real-Time Data Processing at the Edge	4	Theory
VI	6KE248DH2	Scalable Edge Architectures and Microservices	4	Theory
VII	7KE407DH2	Edge Computing Lab: Deployment and Simulation	2	Lab

Note: The subjects offered by Computer Engineering discipline as Double Minor for students of other major disciplines, shall also be applicable and treated as Honours subjects for students pursuing a major in Computer Engineering.

Annexure III
Honors with Research

Semester	**Subject Code**	Subject Title	Credits	T/P
VII	7KE408HR	Research Project (Part#1) Problem Identification & Definition Literature Review Experimental Work	9	P
VIII	8KE409HR	Research Project (Part#2) Prototype Development Data Analysis Publication(s)	9	P

Note: Students intending to pursue a degree with Honours with Research must undertake and successfully complete a dedicated research project during Semesters VII and VIII, as outlined in the curriculum and in accordance with the guidelines issued by the respective department from time to time. This research project shall be distinct and independent from the regular final year project (7KE401PR & 8KE403PR).

Annexure IV

Suggestive Subject-Wise list Open-Source Tools

Name of Subject	Open-Source Tools	Name of Subject	Open-Source Tools
Object-Oriented Programming	Eclipse, NetBeans, IntelliJ IDEA (Community Edition), BlueJ	**Sensors & Actuators**	Arduino IDE, Raspberry Pi OS
Data Structure	Code::Blocks, Visual Studio Code, GDB Debugger	**Cryptography**	OpenSSL, GPG
Data Communication & Networking	Wireshark, Mininet, Cisco Packet Tracer (free educational license), NS-3	**Computer Architecture & Organization**	Gem5, Logisim
Operating System	QEMU, VirtualBox, Unix/Linux Shell, FreeDOS	**Information Retrieval**	Apache Solr, Elasticsearch
Artificial Intelligence	TensorFlow, PyTorch, OpenCV, Scikit-learn	**Supervised Machine Learning**	TensorFlow, Scikit-learn
Programming Methodology using Python	Jupyter Notebook, Anaconda, PyCharm (Community Edition), VS Code	**Digital Forensics**	Autopsy, Sleuth Kit, Volatility
Probability & Statistics for Data Science	R, RStudio, NumPy, SciPy, Matplotlib	**Internet of Everything**	Node-RED, ThingsBoard, Kaa IoT
Cognitive Technologies	IBM Watson (free tier), TensorFlow, spaCy	**Image & Video Processing**	OpenCV, GIMP, FFmpeg
Data Science and Statistics	R, Jupyter Notebook, KNIME	**Augmented & Virtual Reality**	Blender, Godot Engine
Internet of Things	Arduino IDE, Node-RED, ThingsBoard	**Usability Engineering**	Axure RP (free for students), Figma
Introduction to Cyber Security	Kali Linux, Metasploit Framework, OpenVAS	**Cryptography & Security**	Wireshark, OpenSSL, VeraCrypt
Database Management Systems	MySQL, PostgreSQL, SQLite, MongoDB	**Wireless Sensor Networks**	Cooja, NS-3
Compiler Design	LLVM, GCC, Flex, Bison	**System & Software Security**	Metasploit, Snort
Numerical Methods	Octave, SciPy, NumPy	**Blockchain Fundamentals**	Ethereum, Hyperledger, Ganache
Microprocessor & Assembly Language Programming	Keil uVision, GNUSim8085, Logisim	**Data Storage & Network**	FreeNAS, OpenFiler
Design & Analysis of Algorithm	Gephi, NetworkX	**Distributed Ledger Technology**	Hyperledger Fabric, Corda
Cloud Computing	OpenStack, CloudStack, Apache Hadoop	**Deep Learning**	Keras, TensorFlow, PyTorch
Natural Language Processing	NLTK, spaCy, Hugging Face Transformers	**Data Visualization**	Tableau Public, Matplotlib, D3.js
Big Data Analytics	Apache Hadoop, Apache Spark, Dask	**Data Warehousing**	Apache Hive, Pentaho

Syllabus – Sem III and Sem IV

- ❖ Computer Science and Engineering (CS)
- ❖ Computer Engineering (KE)
- ❖ Artificial Intelligence & Data Science (AIDS)
- ❖ Computer Science and Engineering (Data Science) (DS)

SEM III

3CS200PC/3DS200PC/3AD200PC/3KE200PC

DISCRETE STRUCTURE AND GRAPH THEORY

Course Pre-requisite:
Basic knowledge of Mathematics

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of Discrete Structure by being able to do each of the following:

- Use mathematically correct terminology and notation.
- Constructs correct direct and indirect proofs.
- Apply logical reasoning to solve a variety of problems

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Analyze and express logic sentences in terms of predicates, quantifiers, and logical connectives.
2. Derive the solution for a given problem using deductive logic and prove the solution based on logical inference.
3. Classify algebraic structure for a given mathematical problem.
4. Perform combinatorial analysis to solve counting problems.
5. Perform operation on trees data structures.
6. Develop the given problem as graph networks and solve with techniques of graph theory

Syllabus:

Unit I: The Foundations: Logic and Proofs (Hours: 07)
Propositions, Truth Tables, Compound Propositions, Logical Operators, Logic and Bit Operations; Logical Equivalences, Normal Forms, De Morgan's Laws, Satisfiability: Applications and Solving Problems; Predicates, Quantifiers: Restricted Domains, Precedence, Logical Equivalences; Rules of Inference for Propositional Logic.

Unit II: Sets, Functions and Relation (Hours: 07)
Introduction, Venn Diagrams, Subsets, Size of a Set, Power Sets, Cartesian Products, Set Notation with Quantifiers, Truth Sets and Quantifiers, Set Operations ,Functions, Inverse

Functions, Compositions and Graphs of Functions ,Partial Functions; Sequences, Summations; Countable Sets, An Uncountable Set; Functions as Relations, Relations on a Set, Properties of Relations, Combining Relations; Representing Relations Using Matrices; Representing Relations, Closures of Relations, Equivalence Relations.

Unit III: Algebraic Structures (Hours: 07)

Algebraic Systems: Examples and General Properties; Semigroups and Monoids: Homomorphism of Semigroups and Monoids, Subsemigroups and Submonoids; Groups: Definitions, Subgroups and Homomorphisms, Cosets and Lagrange's Theorem, Normal Subgroups, algebraic Systems with Two Binary Operations; Group Codes: The Communication Model and Basic Notions of Error Correction, Hamming Distance.

Unit IV: Boolean Algebra (Hours: 07)

Lattices, Boolean Algebra: Boolean Functions, Representing Boolean Functions, sum of product expansions, Product of sum expansion Functional Completeness, Logic Gates, Combinations of Gate, Minimization of Circuits, Karnaugh Maps.

Unit V: Tree (Hours: 07)

Introduction, Rooted Tree, ordered rooted tree, tree as model, Properties of Trees, Applications of tree, Binary Search Trees, Decision Trees, Prefix Codes, Huffman Coding, Game Trees, Tree traversal, Preorder Traversing, Inorder Traversing, Post order Traversing, Spanning Tree, Minimum spanning tree

Unit VI: Graph (Hours: 07)

Graph Models; Basic Terminology, Special Simple Graphs, Bipartite Graphs, Matchings, Applications of Special Types of Graphs, New Graphs from Old; Graph Representation, Adjacency and Incidence Matrices, Isomorphism of Graphs, Determining Isomorphism; Paths, Connectedness in Undirected Graphs and Directed Graphs, Paths and Isomorphism, Counting Paths Between Vertices; Euler Paths and Circuits, Hamilton Paths and Circuits, Applications of Hamilton Circuits; Planar Graphs: Euler's Formula, Kuratowski's Theorem; Graph Coloring: Introduction, Applications of Graph Coloring

Text Books:

1. Kenneth H. Rosen: Discrete Mathematics and Its Applications, 7th Edition, McGraw-Hill.
2. J. P. Tremblay and R. Manohar: Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill Edition, McGraw-Hill.

Reference Books:

1. Norman L. Biggs: Discrete Mathematics, 2nd Edition, Oxford University Press.
2. Seymour Lipschutz and Marc Lars Lipson: Schaum's Outline of Theory and Problems of Discrete Mathematics, 3rd Edition, Schaum's Outlines Series, McGraw-Hill.
3. C. L. Liu and D. P. Mohapatra: Elements of Discrete Mathematics: A Computer Oriented Approach, 3rd Edition, Tata McGraw-Hill, McGraw-Hill.

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3CS201PC/3AD201PC

OBJECT ORIENTED PROGRAMMING

Course Prerequisite:
Computer Programming

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding:

- To explore the principles of Object Oriented Programming (OOP) such as data abstraction, encapsulation, inheritance and polymorphism.
- To use the object-oriented paradigm in program design.
- To Provide programming insight using OOP constructs.
- To lay a foundation for advanced programming

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to

1. Apply Object Oriented approach to design software.
2. Implement programs using classes and objects.
3. Specify the forms of inheritance and use them in programs.
4. Analyze polymorphic behavior of objects.
5. Design and develop GUI programs.
6. Develop Applets for web applications

Syllabus:

Unit I: Introduction to Object Oriented Programming: (Hours:07)
Introduction, Need of OOP, Principles of Object-Oriented Languages, Procedural Language Vs OOP, Application of OOP, Java Virtual Machine, Java features, Program Structures. Java Programming Constructs: Variables, Primitive data types, Identifier, Literals, Operators, Expressions, Precedence Rules and Associativity, Primitive Type Conversion and Casting, Flow of Control.

Unit II: Classes and Objects: (Hours:07)
Classes, Objects, Creating Objects, Methods, Constructors, Cleaning up Unused Objects, Class Variable and Methods, this keyword, Arrays, Command Line Arguments.

Unit III: Inheritance, Interfaces and Packages: (Hours:07)
Inheritance: Inheritance vs. Aggregation, Method Overriding, super keyword, final keyword, Abstract class. Interfaces: Defining interfaces, Implementing interfaces, Accessing interface variables, Extending interfaces. Packages: Packages, java.lang package

Unit IV: Exception handling and Input/Output: (Hours:07)
Exception: Introduction, Exception handling Techniques, User-defind exception, Exception Encapsulation and Enrichment. Input/Output: The java.io.file Class, Reading

and Writing data, Randomly Accessing a file, Reading and Writing Files using I/O Package.

Unit V: Applets: (Hours:07)
Introduction, Applet Class, Applet structure, Applet Life cycle, Common Methods used in displaying the output, paint (), update () and repaint (), More about applet tag, getDocumentBase() and getCodeBase () methods, Applet Context Interface, Audio clip, Graphic Class, Color, Font, Font Metrics.

Unit VI: Event Handling: (Hours:07)
Introduction, Event delegation Model, java.awt.event Description, Sources of events, Event Listeners, Adapter classes, Inner Classes. Abstract Window Toolkit: Introduction, Components and Containers, Button, Label, Checkbox, Radio Buttons, List Boxes, Choice Boxes, Textfield and Textarea, Container Class, Layouts, Menu, Scrollbar.

Text Books:
1. Sachin Malhotra and Saurabh Choudhary: Programming in Java, Oxford University Press 2010.
2. Herbert Schildt: Java Complete References (McGraw Hill)

Reference Books:
1. H.M.Dietel and P.J.Dietel, "Java How to Program" Pearson Education/PHI, Sixth Edition.
2. E. Balagurusamy: Programming with Java (McGraw Hill)
3. Dr. R. NageswaraRao: Core Java An Integrated Approach (Dreamtech)
4. Khalid Mughal: A Programmer"s Guide to Java Certification, 3rdEdition (Pearson)
5. Sharnam Shah and Vaishali Shah: Core Java for Beginners,(SPD),2010.

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3DS201PC/3KE201PC

PROGRAMMING METHODOLOGY USING PYTHON

Course Pre-requisites:
Basic Knowledge of Programming fundamentals

Course Objective:
Throughout the course, students will be expected to demonstrate their understanding of: Programming Methodology Using Python by being able to do each of the following:
- Describe the core syntax and semantics of Python programming language.
- Discover the need for working with the strings and functions.
- Illustrate the process of structuring the data using lists, dictionaries, tuples and sets.
- Indicate the use of modules, packages and built-in functions to navigate the file system.
- Infer the Object-oriented Programming concepts in Python.
- To develop the ability to write database applications in Python.

Course Outcomes:

On completion of the course, the students will be able to

1. Apply various fundamentals for problem solving using python
2. Develop proficiency in creating applications using the Python programming Language.
3. Understand the various data structures available in Python programming language and apply them in solving computational problems.
4. Draw various kinds of plots.

Syllabus:

Unit I: Introduction: (Hours:07)

Basic concepts of Python- Variables, Data Types, Operators: Arithmetic, Logical, Relational, Conditional Statements: if, if-else, elif, Looping Statements: for, while, Control Statements: break, continue, pass.

Unit II : Strings and Functions: (Hours:07)

String Manipulation-Accessing Strings- Basic Operations-String slices- Function and Methods Functions Defining a function- Calling a function- Types of functions Function Arguments-Anonymous functions- Global and local variables

Unit III: Data Structures in Python: (08 Hrs)

Lists-Introduction - Accessing list -Operations - Working with lists - Function and Method Tuple -Introduction Accessing – Tuples – Operations – Working - Functions and Methods Dictionaries -Introduction - Accessing values in dictionaries - Working with dictionaries Properties - Functions.

Unit IV : Classes and objects: (Hours:07)

Overview of OOP, Class Definition, Creating Objects, Objects as Arguments, Objects as Return Values, Built-in Class Attributes, Inheritance- Overloading- Overriding- Data hiding.

Unit V: Modules and Packages: (Hours:07)

Standard modules-Importing own module as well as external modules Understanding Packages, Powerful Lamda function in python Programming using functions, modules and external packages.

Unit VI : Working with Data in Python: (Hours:07)

Printing on screen- Reading data from keyboard- Opening and closing file- Reading and writing files Functions Loading Data with Pandas-Numpy

Text Book:

Martin C Brown, “Python: The Complete Reference”, MCGraw Hill

Reference Books:

1. Larry Lutz, “Python for Beginners: Step-By-Step Guide to Learning Python Programming”, CreateSpace Independent Publishing Platform, First edition, ISBN-1717410588, 9781717410580, 2018
2. Nicholas Ayden, “Python Programming”, Independently Published, First Edition, ISBN- 1707051933, 9781707051939, 2019.
3. MichałJaworski, Tarek Ziadé, “Expert Python Programming”, Packt Publishing Ltd., Third Edition, ISBN-9781789808896, 2019.

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3CS202PC/3DS202PC/3AD202PC/3KE202PC

DATA STRUCTURES

Course Pre-requisite:
Fundamentals of programming Language & Logic Building Skills

Course Objectives:

- To understand the linear and nonlinear data Structures and its memory representations.
- To perform different operations on data structures such as insertion, deletion, searching and
- traversing.
- To understand various data searching and sorting methods with its complexity.
- To introduce various techniques for representation of the data in the real world.

Course Outcomes:
On completion of the course, the students will be able to
1. Apply various linear and nonlinear data structures
2. Demonstrate operations like insertion, deletion, searching and traversing on various data structures
3. Examine the usage of various structures in approaching the problem solution.
4. Choose appropriate data structure for specified problem domain

Syllabus:

Unit I: Introduction to Data Structures: (Hours:07)
Introduction to Data structures, Data Structure Operations, Algorithmic Notation, Complexity of algorithms. String processing: storing strings, character data type, string operations, word processing, and pattern matching algorithms.

Unit II: Array& Record Structure: (Hours: 07)
Linear arrays: Memory Representation of arrays, traversing linear arrays, insertion & deletion operations, Bubble sort, Linear search and Binary search algorithms. Multi-dimensional arrays, Pointer arrays. Record structures.

Unit III: Linked lists: (Hours: 07)
Linked lists: Memory Representation of Linked List, traversing a linked list, searching a linked list. Memory allocation & garbage collection. Insertion & deletion operations on linked lists. Header linked lists, Two- way linked lists.

Unit IV: Stack & Queue: (Hours: 07)
Stacks: Sequential Memory Representation of Stack, Arithmetic expressions: Polish notation. Quick sort, Recursion, Tower of Hanoi. Queues: Sequential Memory Representation of Queue, DeQueue, Priority queues.

Unit V: Trees: (Hours: 07)
Introduction to Trees, Binary trees, Memory Representation of Binary Tree, Traversing binary trees, Header nodes, Binary Search Tree, Heap and heap sort, Path length & Huffman's algorithm.

Unit VI: Graphs & Sorting Algorithms: (Hours; 07)
Introduction to Graphs, Memory representation of graphs, Warshalls' algorithm, operations on Graphs, Breadth First Search, Depth First Search. Sorting : Insertion Sort, Selection Sort, Radix sort, Merge Sort.

Text Books:

1. Seymour Lipschutz: Data Structures, Schaum's Outline Series, McGraw-Hill, International Editions.
2. Trembley, Sorenson: An Introduction to Data Structures with Applications, McGraw Hill.

Reference Books:

1. Ellis Horowitz, Sartaj Sahni: Fundamentals of Data Structures, CBS Publications.
2. Data Structure Using C, Balagurusamy.
3. Standish: Data Structures in Java, Pearson Education.

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3CS400EL / 3KE400EL /3DS400EL /3AD400EL

COMMUNITY ENGAGEMENT PROJECT / FIELD PROJECT

Suggested Activities for Community Engagement/ Field Project

1. Digital Empowerment & Awareness

📌 **Bridging the Digital Divide:**

- Train villagers on **mobile banking**, UPI payments, and accessing government e-services (ration card, Aadhaar updates, PM-KISAN).
- Conduct **awareness workshops** on the **Digital India** mission and help locals register for online services.
- Develop **multilingual video tutorials** on digital literacy, mobile safety, and secure online transactions.

- Provide **training on using government portals** like eNAM (National Agricultural Market) and GeM (Government e-Marketplace).

📌 **Smart Village Initiative:**

- Set up **public Wi-Fi hotspots** in collaboration with local authorities.
- Assist in **digitizing local businesses**, helping small vendors and farmers list their products online.
- Train rural students in **basic coding and website development** for local business promotion.

2. Smart Agriculture & Technology Adoption

📌 **Tech-Driven Farming Solutions:**

- Develop an **AI-based chatbot** in regional languages to assist farmers with crop-related queries.
- Install **IoT-based soil sensors** and educate farmers on precision farming techniques.
- Train farmers in **disease detection using AI-based mobile apps** for plant health monitoring.
- Introduce **solar-powered irrigation systems** to reduce dependency on grid electricity.

📌 **Sustainable Agricultural Practices:**

- Conduct **vermicomposting and organic farming workshops** to reduce chemical usage.
- Set up **bio-fertilizer production units** using locally available waste.
- Promote **agroforestry** as a long-term sustainable practice.

3. Water & Resource Management

📌 **Water Conservation & Management:**

- Conduct **rainwater harvesting awareness** campaigns.
- Develop a **low-cost water filtration system** for villages facing potable water issues.
- Implement **drip irrigation systems** for water conservation in farming.
- Map and revive **traditional water bodies** in the region.

📌 **Energy-Efficient Practices:**

- Promote the use of **solar lamps and bio-gas units** in rural households.
- Conduct workshops on **converting agricultural waste into biomass energy**.

4. E-Commerce & Rural Entrepreneurship Development

📌 **Market Linkage & Skill Development:**

- Assist farmers in selling their products on **e-commerce platforms** like Amazon Kisan Store, Flipkart Krishi, and eNAM.
- Conduct training on **branding, packaging, and direct farm-to-market sales** strategies.
- Develop an **online directory of rural artisans** to promote handicrafts through social media.

📌 **Rural Women Empowerment:**

- Train rural women in **handicraft-based digital entrepreneurship** (e.g., selling products on Etsy, Meesho).

- Organize workshops on **self-help groups (SHGs)** and micro-financing opportunities.
- Introduce women to **low-cost, home-based business ideas** like making organic soaps, candles, or eco-friendly bags.

5. Health & Hygiene Awareness

📌 **Basic Healthcare Services:**

- Conduct **free medical check-up camps** with local health professionals.
- Develop an **AI-powered mobile application** to spread verified medical information in local languages.
- Train rural women on **maternal health, child nutrition, and menstrual hygiene management**.

📌 **Sanitation & Waste Management:**

- Organize **waste segregation drives** and teach villagers about composting.
- Introduce **biodegradable waste recycling** to generate biogas and organic manure.
- Develop **low-cost water purification units** for households.

6. Education & Skill Development

📌 **STEM Awareness Programs:**

- Conduct **STEM (Science, Technology, Engineering, and Mathematics) workshops** in rural schools.
- Develop **interactive STEM kits** for students to experiment with physics and engineering principles.
- Train rural students in **3D printing and CAD software** for technical skill enhancement.

📌 **Career & Competitive Exam Guidance:**

- Offer **guidance sessions for competitive exams** like JEE, NEET, UPSC, and MPSC for rural students.
- Organize **spoken English and communication skill development programs**.
- Help students with **resume writing, online job portals, and freelancing opportunities**.

7. Cyber Security & Online Safety

📌 **Safe Digital Practices:**

- Conduct **cybersecurity awareness workshops** on recognizing fraud, scams, and phishing attacks.
- Train rural youth on **secure online transactions** and social media privacy settings.
- Provide **hands-on training on data encryption and password management**.

8. Renewable Energy & Sustainability

📌 **Eco-Friendly Energy Solutions:**

- Promote **solar-powered microgrids** for electrification in remote areas.
- Educate villagers on **alternative energy sources** like wind and hydro power.
- Develop and implement **low-cost biogas plants** for households.

📌 **Green Village Initiative:**

- Organize **tree plantation drives** in deforested areas.

- Conduct **sustainability workshops** focusing on reducing carbon footprints.

9. Waste Management & Circular Economy

📌 **Plastic-Free Village Campaign:**

- Conduct **awareness programs on plastic pollution and alternatives**.
- Organize **recycling drives and upcycling workshops** for students and villagers.
- Train women-led SHGs in **eco-friendly bag and paper product manufacturing**.

📌 **Low-Cost Housing Solutions:**

- Develop a model for **affordable, sustainable housing** using locally available materials.
- Promote the use of **mud bricks, bamboo, and recycled materials** for low-cost homes.

10. Smart Infrastructure & Community Development

📌 **Smart Village Concept:**

- Develop a **GIS-based village mapping system** for better resource allocation.
- Set up **community radio stations** to disseminate important information.
- Install **smart lighting solutions** (solar-powered street lights) for energy efficiency.

📌 **Community-Driven Innovation:**

- Encourage students to develop **innovative low-cost solutions** to local problems.
- Facilitate **co-creation workshops** where villagers and students collaborate on ideas.

Impact of These Activities

✅ **Bridges the gap between classroom learning and real-world challenges**.
✅ **Encourages students to develop AI/IoT-based solutions for rural challenges**.
✅ **Promotes sustainability and digital literacy among rural communities**.
✅ **Fosters a sense of social responsibility and entrepreneurship in students**.

This course emphasizes experiential learning through community-based projects where students will apply computing knowledge and emerging technologies to solve real-world problems faced by society. Students will actively engage with local communities, identify challenges, and develop technology-driven solutions that foster social development and digital empowerment.

Course Objectives:

- Provide students with practical exposure to how computer science and digital technologies can address societal challenges.
- Enable students to design and deploy small-scale ICT/AI/IoT-based solutions in real community contexts.
- Develop digital awareness, problem-solving, and teamwork skills through field-based activities.
- Encourage social responsibility and ethical use of technology.

Course Outcomes:

After completing the course, students will be able to:

1. Identify societal and community problems that can be addressed through computer science applications.
2. Design small-scale prototypes or awareness modules leveraging ICT, AI, IoT, or data science.
3. Demonstrate hands-on application of emerging technologies in community settings.
4. Collaborate with local stakeholders to deploy and evaluate solutions.
5. Document outcomes of field projects and reflect on experiential learning.

Details of Syllabus / Suggested Activities:

Perform 5 - 6 Practical activities (or equivalent projects) from the list should be performed.

1. **Basic Computer Literacy Sessions** – Teach elderly or underprivileged groups how to use smartphones, send SMS/WhatsApp messages, or browse the internet safely.
2. **Digital Document Assistance** – Help community members create and manage Aadhaar-linked services, PAN, ration card updates, or digital health IDs.
3. **Awareness on Cyber Frauds** – Design and distribute pamphlets/posters on avoiding phishing calls, OTP fraud, and fake links.
4. **Assist Farmers in Using Kisan Apps** – Demonstrate the use of government agriculture apps like *PM-Kisan*, *IFFCO Kisan*, or *Kisan Suvidha*.
5. **Energy Saving Awareness Drive** – Conduct a door-to-door survey and create posters on saving electricity, switching to LED bulbs, and responsible usage.
6. **Plastic-Free Awareness Campaign** – Develop posters or short plays/skits to educate the community on reducing single-use plastics.
7. **Help in Using E-Rickshaw / EV Charging Apps** – Guide local drivers or users in using digital payment methods for EV charging stations.
8. **Community Survey on Waste Management** – Collect data about how households dispose of waste and suggest better segregation methods.
9. **Health Awareness Posters** – Prepare easy-to-understand visual guides about vaccination schedules, nutrition charts, or basic hygiene practices.
10. **Promote Local Library Digitization** – Help libraries or schools catalog their books using Excel or simple databases.
11. **Assist Shopkeepers in Using QR Codes** – Help small vendors adopt UPI/QR code payments and train them in transaction safety.
12. **Create a Local Bus/Transport Timetable** – Collect schedules from local bus stations and prepare a digital or printed timetable for commuters.
13. **Assist in Online Railway / Bus Ticket Booking** – Train rural residents in booking affordable tickets safely through apps/portals.
14. **Organize an "E-Waste Awareness Camp"** – Collect old gadgets/e-waste and educate people about proper disposal/recycling.
15. **Create Safety Awareness Charts** – For road safety, emergency contacts, and first aid—distribute in schools and community centers.
16. **Promote Rainwater Harvesting Practices** – Conduct awareness sessions and create models/demos of small harvesting systems.
17. **Awareness on Social Media Usage** – Teach responsible use of Instagram, Facebook, WhatsApp to school students; warn against oversharing personal data.

18. **Assist Local NGOs** – Help them in preparing basic presentations, brochures, or email communication for their causes.
19. **Basic Typing and Resume Help** – Help unemployed youth learn typing, create email IDs, and prepare resumes using MS Word.
20. **Digital Health Awareness** – Guide villagers in using *Aarogya Setu*, *ABHA Digital Health Card*, or booking doctor appointments online.
21. **Water Conservation Awareness** – Create charts and posters with tips on saving water at household level.
22. **Awareness on Government Scholarships** – Collect and distribute information about scholarships available for students in rural areas.
23. **Assist Schools in Online Examination Practice** – Help students get familiar with mock online tests using simple quiz apps.
24. **Digital Maps for Locality** – Create simple Google Maps entries for important community landmarks (clinics, schools, ATMs).
25. **Conduct a Poster-Making or Slogan Competition** in schools on themes like *Digital India*, *Green Energy*, or *Cyber Safety*.
26. Conduct a **digital literacy workshop** in a rural/urban community: train locals on safe mobile banking, UPI payments, and accessing government portals.
27. Develop and demonstrate a **basic Android app** for local needs (e.g., crop calendar, community notice board, health reminders).
28. Create **AI/ML-based awareness tools** (e.g., chatbot for agricultural queries or student career guidance).
29. Field visit to a rural school to conduct **STEM awareness sessions** using simple coding and robotics kits.
30. Develop a **website or e-commerce page** for local artisans, SHGs, or farmers to promote their products.
31. Implement an **IoT prototype** (e.g., soil moisture sensor, smart street lighting demo) and explain its community utility.
32. Survey local cybercafés/educational institutes to study **cybersecurity practices** and conduct awareness drives on online safety.
33. Develop and present **data-driven insights** on a local issue (e.g., water usage, electricity consumption, health trends) using open datasets.
34. Assist schools/NGOs in digitizing their records using **databases or cloud storage** and provide basic training.
35. Create and distribute **digital awareness content** (videos, infographics) on health, hygiene, and safe technology practices.

And similar relevant activities /projects on the same lines: curated and approved by the concerned Authority from time to time.

Tentative Report Template for Community Engagement Project

Title Page

- Project Title:
- Student Name & Roll Number:
- Faculty Guide Name:
- Date of Submission:

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1. Introduction
   - Brief overview of the selected activity.
   - Why this issue was chosen.
2. Objectives
   - Clear statement of objectives (What problem is being addressed?).
3. Methodology
   - Approach taken (Survey, Workshops, Development of Solutions, etc.).
   - Tools and Technologies used (if applicable).
4. Execution & Implementation
   - Step-by-step description of how the activity was conducted.
   - Challenges faced and how they were overcome.
5. Observations & Impact Assessment
   - Community response and engagement levels.
   - Quantitative & qualitative impact (e.g., number of farmers trained, improved efficiency, awareness raised).
6. Learnings & Outcomes
   - Key takeaways for students.
   - Skills developed and knowledge gained.
7. Suggestions & Future Scope
   - Recommendations for scaling up the project.
   - How technology can further enhance the solution.
8. References & Acknowledgments
   - Any research material, websites, or experts consulted.
   - Acknowledgment of community members or organizations who contributed.

Evaluation Criteria (Total: 50 Marks)

Evaluation Parameter	Marks (Int)	Marks (Ext)
Problem Identification & Understanding	05	05
Implementation & Execution	05	05
Innovation & Use of Technology	05	05
Community Engagement & Feedback	05	05
Report Quality, Presentation, Future Scope & Recommendations.	05	05

3CS203PC/3AD203PC

OBJECT ORIENTED PROGRAMMING LAB

Course Pre-requisite:
Basic Computer Programming

Course Objectives:
Design, implement, test, and debug simple programs in an object-oriented programming language.

- To develop the knowledge of object-oriented paradigm in the Java programming language.
- To evaluate classical problems using java programming.
- To develop software development skills using java programming for real world applications.

Course Outcomes :
On completion of the course, the students will be able to

1. Design, implement, test, and debug simple programs in an object-oriented programming language.
2. Interpret the basics of object-oriented design and the concepts of encapsulation, abstraction, inheritance, and polymorphism
3. Build applications in Java by applying concepts like interfaces, packages and exception handling.
4. Make use of Java concepts like API, Applets, AWT.

List of Experiments:
This is a sample list of Experiments; **minimum 12 experiments** are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

1. Introduction to Object Oriented Programming and installation of JDK. Write a program to print a message "Hello World…"
2. Develop a program to explain use of Operators in java.
3. Develop a Program to study and implement Looping Statements belonging to Java**.**
4. Develop a Program to study and implement Selection Statements belonging to Java**.**
5. Develop a program to study and implement some Pyramid.
6. Develop a program to demonstrate the concept of Class, Method and Object.
7. Develop a program to study and implement the concept of Method Overloading.
8. Develop a program to study and implement concept of Constructor in Java.
9. Develop a program to study and implement concept of Constructor Overloading in Java.
10. Develop a program to study and implement the Array in Java.
11. Develop a Program on various ways to accept data through keyboard(Command Line Argument)
12. Develop a program to study and implement the concept of Inheritance.
13. Develop a program to study and implement the concept of Method Overriding.
14. Develop a program to study and implement the Abstract Class.
15. Develop a program to study and implement the concept of Interface in Java.
16. Develop a program to study and implement Exception Handling Mechanism in Java.
17. Develop a program to study and implement Java I/O.
18. Develop a program to study and implement simple Applet in java.
19. Develop a program on Applet to demonstrate Graphics, Font and Color class.
20. Develop a Program on passing parameters to applets
21. Develop a Program to create GUI application without event handling using AWT controls

22. Develop a Program to create GUI application with event handling using AWT controls
23. Develop a program on Multithreading
24. Develop a Program to create GUI application with event handling using Swing controls
25. Mini Project based on content of the syllabus. (Group of 2-3 students)

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3DS203PC/3KE203PC

PROGRAMMING METHODOLOGY USING PYTHON LAB

Course Prerequisite:
Basics of programming Language

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of Programming Methodology using Python Lab by being able to do each of the following:

- Interpret the use of procedural statements like assignments, conditional statements, loops and function calls. Learn the syntax and semantics and create the functions in Python.
- Infer the supported data structures like lists, dictionaries and tuples in Python.
- Illustrate the application of matrices and regular expressions in building the Python programs.
- Discover the use of external modules in creating excel files and navigating the file systems.
- Describe the need for Object-oriented programming concepts in Python.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Apply the Python language syntax including control statements, loops and functions.
2. Understand the core data structures like lists, dictionaries, tuples and sets in Python to store, process and sort the data.
3. Interpret the concepts of Object-oriented programming as used in Python
4. Identify the external modules for creating and writing data to excel files and inspect the file operations to navigate the file systems.

List of Experiments:
Minimum 12 Experiments based on each concept are to be performed covering the entire syllabus.
At least two experiments should be beyond syllabi based on learning of syllabi, This list is for reference only one can prepare a list according to the syllabus.

1. Write a program to understand basic Python interpreter
2. Write a program to perform String Manipulation and Functions
3. Write a program to implement Python Data structures
4. Implement Classes and Objects using Python
5. Design a program to understand Overloading in Python
6. Design a program to understand Overriding in Python

7. Implement Inheritance using Python
8. Develop a Python code for Information hiding
9. Implement Python's Modules and Packages
10. Writ a program to illustrate concept of File handling
11. Write a code to load Data with library such as Pandas-Numpy.

Text Book:
Martin C Brown, "Python: The Complete Reference", McGraw Hill

Reference Books:

1. Larry Lutz, "Python for Beginners: Step-By-Step Guide to Learning Python Programming",
   CreateSpace Independent Publishing Platform, First edition, ISBN- 1717410588, 9781717410580, 2018
2. Nicholas Ayden, "Python Programming", Independently Published, First Edition, ISBN-
   1707051933, 9781707051939, 2019.
3. Michał Jaworski, Tarek Ziadé, "Expert Python Programming", Packt Publishing Ltd., Third Edition, ISBN-9781789808896, 2019.

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3CS204PC/3DS204PC/3AD204PC/3KE204PC

DATA STRUCTURE LAB

Course Pre-requisite:
Basics of programming Language & Logic Building Skills

Course Objectives:
- To understand the linear and nonlinear data Structures and its memory representations.
- To perform different operations on data structures such as insertion, deletion, searching and traversing.
- To understand various data searching and sorting methods with its complexity.
- To introduce various techniques for representation of the data in the real world.

Course Outcomes:
On completion of the course, the students will be able to
1. Apply various linear and nonlinear data structure.
2. Demonstrate operations like insertion, deletion, searching and traversing on various data structures
3. Examine the usage of various structures in approaching the problem solution.
4. Choose appropriate data structure for specified problem domain

List of Experiments:
This is a sample list of Experiments; **minimum 12 experiments** are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

1. Write a program to find out largest number from the array and also find it's location.

2. Write a program to traverse an array and find the sum and average of data elements from an array.
3. Write a Program to a) insert an element in an array b) delete an element from an array.
4. To study and execute the Linear search method
5. To study and execute the Binary Search method
6. To study and execute the Pattern matching Algorithms (Slow and Fast)
7. To study and execute Bubble sort method.
8. To study and implement various operations on singly linked list
    a. Traversing the linked list.
    b. Insert a node at the front of the linked list.
    c. Delete a last node of the linked list.
    d. Searching a Linked list.
9. To study and implement following operations on the doubly linked list.
    a. Insert a node at the front of the linked list.
    b. Insert a node at the end of the linked list.
    c. Delete a last node of the linked list.
    d. Delete a node before specified position.
10. To study and implement following operations on the circular linked list.
    a. Insert a node at the end of the linked list.
    b. Insert a node before specified position.
    c. Delete a first node of the linked list.
    d. Delete a node after specified position.
11. Understand the stack structure and execute the push, pop operation on it.
12. Understand the Queue structure and execute the insertion, deletion operation on it.
13. Formulate and demonstrate Transforming Infix Expressions to Postfix Expression using Stack.
14. Formulate and demonstrate the Evaluation of Postfix Expression using Stack.
15. To study and execute Quick sort method.
16. Understand the Tree structure and implement the Pre-order, In-order, post-order traversing operations on it.
17. Understand the concept of Recursion and write a program to calculate factorial of a number using Recursion.
18. Understand the Heap sort and implement it on given data.
19. Understand the Insertion sort and implement it on given data.
20. Understand the Selection sort and implement it on given data.
21. To study and execute Merge sort method.
22. To study and execute Radix sort method.
23. Write a Program to implement the concept of BFS algorithm.
24. Write a Program to implement the concept of DFS algorithm.

To study and execute Josephus problem.

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3CS207EM / 3KE207EM / 3DS207EM / 3AD207EM

ENTREPRENEURSHIP DEVELOPMENT

Course Pre-requisites:

- Basic understanding of engineering problem-solving
- Interest in innovation or business development

Course Objectives:

The course aims to:

- Introduce engineering students to the fundamentals of entrepreneurship.
- Develop the ability to identify and evaluate entrepreneurial opportunities.
- Encourage creativity and innovation as key entrepreneurial traits.
- Equip students with knowledge of business planning, models, and funding.
- Emphasize the role of marketing, intellectual property, and ethical practices.

Course Outcomes:

At the end of the course, students will be able to:

1. Understand and explain key entrepreneurial concepts and the startup ecosystem.
2. Identify, assess, and evaluate business opportunities using feasibility analysis.
3. Develop a basic business plan including financial, marketing, and legal elements.
4. Recognize the importance of innovation, funding sources, and IP rights in startups.
5. Apply entrepreneurial thinking to engineering problems and real-world challenges.

Syllabus:

Unit I: Introduction to Entrepreneurship & Opportunity Identification (8 Hours)

Evolution and Importance of Entrepreneurship in the Engineering Context, Myths about Entrepreneurs, Role of Engineers as Entrepreneurs, Types of Startups, Entrepreneurial Traits, Ideation Techniques, Innovation vs. Invention, Identifying Opportunities and Gaps in the Market, Tools for Idea Generation (Brainstorming, SCAMPER, TRIZ).

Unit II: Feasibility Analysis, Business Models & Planning (7 Hours)

Feasibility Analysis: Product/Service, Market, Organizational & Financial, Business Model Canvas – Key Components, Elements of a Business Plan, Introduction to Financial Planning – Break-even, Basic Forecasting, Industry Analysis and Competitor Mapping, Value Proposition Design.

Unit III: Funding, Marketing & Intellectual Property (7 Hours)

Sources of Funding: Angel Investors, VCs, Bootstrapping, Government Schemes, Role of Incubators and Accelerators, Marketing for Startups – 4Ps, Digital Marketing Basics, Importance of IP: Patents, Copyrights, Trademarks, Trade Secrets, Ethics in Entrepreneurship, Role of Entrepreneurship in Sustainable Development.

Textbook:

Bruce R. Barringer & R. Duane Ireland, *Entrepreneurship: Successfully Launching New Ventures*, Pearson Education, 3rd Edition

Reference Books:

1. Poornima M.C., *Entrepreneurship Development – Small Business Enterprises*, Pearson
2. Ram Chandran, *Entrepreneurial Development*, Tata McGraw Hill
3. Arya Kumar, *Entrepreneurship*, Pearson
4. Khanka, S. S., *Entrepreneurial Development*, S. Chand & Co.
5. Kanishka Bedi, *Management and Entrepreneurship*, Oxford University Press
6. Badhai, B., *Entrepreneurship for Engineers*, Dhanpat Rai & Co.

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SEM IV

4CS205PC/4DS205PC/4AD205PC/4KE205PC

DATA COMMUNICATION AND NETWORKING

Course Pre-requisite:
Computer and Data Communication Requirements

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of Data Communication and Networking by being able to do each of the following:

- Study the basic taxonomy and terminology of the digital communication system & computer networking and enumerate the layers of OSI model and TCP/IP model.
- Acquire knowledge of Application layer paradigms and protocols.
- Study Transport layer design issues, Transport layer services, and protocols.
- Gain core knowledge of Network layer routing protocols and IP addressing.
- Study data link layer concepts, design issues, and protocols.

Course Outcomes (CO's):
On completion of the course, the students will be able to:

1. Describe the functions of each layer in OSI and TCP/IP model.
2. Describe the Transport layer and Transport layer services.
3. Classify the routing protocols and analyze how to assign the IP addresses for the given network.
4. Explain the functions of Application layer and Presentation layer paradigms and Protocols.
5. Describe the functions of data link layer and explain the protocols.
6. Explain the types of transmission media with real time applications.

Syllabus:

Unit I: Introduction to Network Models (Hours: 07)
Data Communication Components: Basic network types, switching mechanisms, Internet standards. **Layered Architecture**: Overview of the OSI and TCP/IP models, focusing on key functions of each layer.

Unit II: (Hours: 07)
Transmission Media: Guided vs. Unguided media, key characteristics, and real-time application examples. **Switching Techniques**: Circuit, Packet, and Virtual Circuit Switching.

Unit III: Application Layer Protocols - (Hours: 07)
Application Layer Overview: Client-server model, APIs, P2P networking. **Key Protocols**: HTTP, FTP, SMTP, DNS, focusing on their importance in internet communication.

Unit IV: Transport Layer Fundamentals - (Hours: 07)
Transport Layer Overview: Principles of connectionless and connection-oriented services. **Key Protocols**: UDP, TCP – Concepts of reliability, congestion control, flow control. **Multiplexing and Demultiplexing**: Basic mechanisms and their relevance in data transmission.

Unit V: Network Layer Protocols and IP Addressing - (Hours: 07)
Network Layer Overview: Services provided by the network layer, datagram vs. virtual circuit approaches. **IP Addressing**: IPv4, IPv6, NAT, DHCP, and ICMP functionalities. **Routing**: Introduction to routing algorithms (Distance Vector and Link-State), basic concept of forwarding.

Unit VI: Data Link Layer and MAC Protocols - (Hours: 07)
Data Link Layer Services: Framing, error detection (CRC, Checksum), and correction techniques. **MAC Layer**: Concepts of LAN addressing, ARP, CSMA/CD, and PPP. **Link Layer Protocols**: HDLC and Point-to-Point Protocol.

Text Books:
1. Behrouz A. Forouzan: Data Communication and Networking, (5/e) (TMH)
2. James F. Kurose & K W Ross: Computer Networking, Pearson Education (LPE)

Reference Books:
1. William Stallings: Data & Computer Communications, 6/e, Pearson Education
2. William L. Schweber: Data Communication, McGraw Hill
3. Douglas E. Comer: Computer Network & Internet, Addison Wesley.
4. Andrew S. Tanenbaum: Computer Networks, PHI (5E)
5. Leon Garcia & Widjaja: Communication Networks, TMH

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4CS206PC/4DS206PC/4AD206PC/4KE206PC

OPERATING SYSTEM

Course Pre-requisite:
Discrete Structures, Data Structure, Any programming Language

Course Objectives:
1. To make students aware of the kernel and shell structure of the operating systems.
2. To make students aware of the purpose, structure and functions of operating systems
3. To equip students with understanding of the various scheduling algorithms in OS.
4. To make students aware of understanding of memory management in different OS.

Course Outcomes: (Expected Outcome):
On completion of the course, the students will be able to:

- Explain memory management issues like external fragmentation, internal fragmentation.
- Illustrate multithreading and its significance.
- List various protection and security mechanisms of OS.
- Analyze and solve the scheduling algorithms.
- Analyze the deadlock situation and resolve it.
- Compare various types of operating systems

Syllabus:

Unit I: Introduction to OS (Hours: 07)
Introduction: Operating System definition, OS Evolution, Components and Services, Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Interprocess Communication, Threads Overview, Multithreading Models, Threading Issues, Java Threads

Unit II: Process Scheduling (Hours: 07)
Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR, Priority, Multilevel Queue, Multilevel Feedback Queue Scheduling

Unit III: Process Synchronization (Hours: 07)
Process Synchronization Basics: The Critical-Section Problem, Synchronization Hardware, Semaphores, Monitors, Deadlocks: Definition & Characterization, Deadlocks Prevention, Avoidance, Detection and Recovery from Deadlock

Unit IV: Memory Management (Hours: 07)
Memory Management Background, Swapping, Contiguous Memory Allocation Schemes, Paging, Segmentation, Virtual Memory Management: Background, Demand paging scheme, Process Creation, Page Replacement Policies, Allocation of Frames, Thrashing

Unit V: File System (Hours: 07)
File-System Interface; Directory Structure, File-System Mounting, File Sharing &Protection, File- System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free- Space Management.

Unit VI: I/O System (Hours:07)
I/O Systems: Overview, I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O to Hardware Operations , Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

Text Book :
Avi Silberschatz, P.B.Galvin, G.Gagne: “Operating System Concepts” (9/e) John-Wiley & Sons.

Reference Books:

1. A.S.Tanenbaum “Modern Operating Systems” Pearson Education.
2. William Stallings “Operating Systems” Prentice-Hall.
3. D. M. Dhamdhere “Operating Systems” Tata McGraw-Hill.
4. P. Balkrishna Prasad: “Operating Systems” Scitech Publications (I) Pvt. Ltd.

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4CS207PC/4KE207PC

THEORY OF COMPUTATION

Course Pre-requisites

- Discrete Mathematics
- Data Structures

Course Objectives:

- To understand automata theory and its operation.
- To understand mathematical expressions for formal languages.
- To learn implementing the state machines for solving real life problems.
- To study computing machines and comparing different types of computational models.
- To understand the fundamentals of problem decidability and Un-Decidability.

Course Outcomes: (Expected Outcome):

On completion of the course, the students will be able to:

1. To construct finite state machines to solve problems in computing.
2. To write regular expressions for the formal languages.
3. To construct and apply well defined rules for parsing techniques in compiler.
4. To construct and analyze Push Down, Turing Machine for formal languages
5. To express the understanding of the Chomsky Hierarchy.
6. To express the understanding of the decidability and un-decidability problems.

Syllabus:

Unit I: Finite State Machines: (Hours: 07)

Alphabet, String, Formal and Natural Language, Operations, Definition and Design DFA (Deterministic Finite Automata), NFA (Non-Deterministic Finite Automata), Equivalence of NFA and DFA: Conversion of NFA into DFA, Conversion of NFA with epsilon moves to NFA, Minimization Of DFA, Definition and Construction of Moore and Mealy Machines, Inter conversion between Moore and Mealy Machines. Minimization of Finite Automata. (Construction of Minimum Automaton).

Unit II: Regular Expression and Regular Grammar: (Hours: 07)

Definition and Identities of Regular Expressions, Construction of Regular Expression of the given Language, Construction of Language from the RE, Conversion of FA to RE using Arden’s Theorem, Inter-conversion RE to FA, Pumping Lemma for RL, Closure properties of RLs (proofs not required), Regular grammar, Equivalence of RG (RLG and LLG) and FA.

Unit III: Context Free Grammar and Languages: (Hours: 07)
Introduction, Formal Definition of Grammar, Notations, Derivation Process: Leftmost Derivation, Rightmost Derivation, Derivation Trees, Construction of Context-Free Grammars and Languages, Pumping Lemma for CFL, Simplification of CFG, Normal Forms (CNF and GNF), Chomsky Hierarchy.

Unit IV: Pushdown Automata: (Hours: 07)
Introduction and Definition of PDA, Construction of PDA, Acceptance of CFL, Equivalence of CFL and PDA: Inter-conversion, Introduction of DCFL and DPDA, Enumeration of properties of CFL, Context Sensitive Language, Linear Bounded Automata.

Unit V: Turing Machines: (Hours: 07)
Formal definition of a Turing Machine, Design of TM, Computable Functions, Church's hypothesis, Counter machine, Variants of Turing Machines: Multi-tape Turing machines, Universal Turing Machine.

Unit VI: Decidability and Un-Decidability: (Hours: 07)
Decidability of Problems, Halting Problem of TM, Un-Decidability: Recursive enumerable language, Properties of recursive & non-recursive enumerable languages, Post Correspondence Problem, Introduction to Recursive Function Theory.

Text Book

1. Hopcraft H.E. & Ullman J: Introduction to Automata Theory, Languages and Computation
2. Peter Linz: An Introduction to Formal Languages and Automata

Reference Book

1. Rajesh K. Shukla: Theory of Computation, CENGAGE Learning, 2009.
2. K V N Sunitha and N Kalyani: Formal Languages and Automata Theory, McGraw Hill,2010
3. Lewis H.P. and Papadimition C.H.: Elements of Theory of Computation
4. Mishra &Chandrashekharan: Theory of Computation
5. C. K. Nagpal: Formal Languages and Automata Theory, Oxford University Press, 2011.
6. Vivek Kulkarni : Theory of Computation, OUP India, 2013

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4DS207PC/4AD207PC

PROBABILITY AND STATISTICS FOR DATA SCIENCE

Course Objective:

- Understand and apply probability concept.
- Learn foundational concepts and applications of probability theory and common probability distributions.

- Understand and apply measures of central tendency, dispersion, correlation, and regression analysis in statistical analysis.
- Compute and interpret the correlation coefficient.
- Understand the computational details behind certain numerical methods.
- Gain proficiency in interpolation methods and numerical techniques for solving first-order differential equations.

Course Outcomes: (Expected Outcome):

On completion of the course, the students will be able to:

1. Understand about the collection of the data, condensation, and summarization into a compact form.
2. Apply probability axioms, analyze distributions, calculate conditional probabilities, and understand the central limit theorem.
3. Understand and compute measures of central tendency, dispersion, correlation, and regression for data analysis.
4. Apply numerical methods for curve fitting using least squares, including fitting straight lines and higher-degree curves.
5. Utilize numerical methods such as Newton-Raphson, false position, Gauss elimination, Gauss-Jordan, Gauss-Seidel, and matrix operations for solving equations and eigenvalue computations.
6. Apply interpolation techniques and numerical methods to solve differential equations accurately and efficiently.

Syllabus:

Unit: I (Hours: 07)

Meaning of experiment, random experiment, deterministic and non-deterministic models. Definition of the term: Outcome, sample space (finite and infinite), discrete sample space, Elementary event, Compound event, Complementary event, Favorable event, Equality-likely events, Sure event, Impossible event. Concept of Occurrence of an event, Union, and Intersection of two or more events, Exhaustive events, mutually exclusive events, Representation of sample space and events by Venn diagram, Occurrence of (i) at least one of the given events (ii) all of the events (iii) none of the given events, Example and problem.

Unit: II (Hours: 07)

Axioms of Probability, centre limit theorem, conditional probability, Bayes' rule, Bernoulli trials, probability mass function, continuous random variable, probability density function, probability distributions: Binomial distribution, Poisson distribution, normal distribution.

Unit: III (Hours: 07)

Measure of central tendency: Moments, Expectation, dispersion, skewness, kurtosis, expected value of two-dimensional random variable, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression, Line of Regression.

Unit: IV (Hours: 07)
Curve fitting by the numerical method: Curve fitting by of method of least squares, fitting of straight lines, second degree parabola and more general curves.

Unit: V (Hours: 07)
Newton Raphson method, false position method, Gauss elimination, Gauss Jordan, Gauss Seidel, Matrix Inversion by Gauss Jordan method, Eigen value of a matrix by power method.

Unit: VI (Hours: 07)
Interpolation: Forward Difference, Backward Difference, Newton's Forward Difference Interpolation, Newton's Backward Difference Interpolation, Lagrange's Interpolation. Numerical Solution of First order differential equation: Picard's method, Taylor series, Euler's Method, Modified Euler's Method, Runge-Kutta Method of fourth order.

Textbook:

1. Agarwal, B. I. (2047). Programmed Statistics, Third Edition, New Age International Publisher, New Delhi.
2. S. S. Shastri. Introductory Methods of Numerical Methods, PHI, Vol 2.

Reference Book:

1. Gupta S. C. and Kapoor V. K. (2019) Fundamental of Mathematical Statistics.
2. Numerical Methods for Scientifi c and Engineering Computation' by M. K. Jain, S. R. K. Iyengar, R. K. Jain
3. Myer,P. I. (1970): Introductory Probability and Statistical Application, Oxford & IBH Publishing, New Delhi.

== XX ==

4CS208PC/4DS208PC/4AD208PC/4KE208PC

DATA COMMUNICATION & NETWORKING LAB

Course Pre-requisite:
Computer and Data Communication Requirements

Course Objectives:
- To understand the working principle of various communication protocols
- To understand and analyze the signal flow in a digital communication system.
- To analyze error performance of a digital communication system in presence of noise and other interferences.
- To evaluate the errors using various error detection & correction techniques.
- To understand network based protocols in data communication and networking.

Course Outcomes :
On completion of the course, the students will be able to
1. Analyze performance of various communication protocols
2. Implement Configure various network protocols.
3. Compare IP Address classes of networks

List of Experiments:
This is a sample list of Experiments; **minimum 12 experiments** are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

1. To study various LAN topologies and their creation using network devices, cables and computers.
2. To connect the computers in Local Area Network.
3. Familiarization with Networking Components and devices: LAN Adapters, Hubs, Switches, Routers etc.
4. Write a program of bit stuffing used by Data Link Layer
5. Write a program to implement CRC(Cyclic Redundancy Check)
6. Write a program to implement Checksum
7. Write a program to implement Sliding window
8. Configure Internet connection and use IP-Config, PING / Tracer and Net stat utilities to debug the network issues.
9. Configuration of TCP/IP Protocols in Windows and Linux.
10. Transfer files between systems in LAN using FTP Configuration, install Print server in a LA and share the printer in a network.
11. Write a C Program to determine if the IP Address is in Class A, B, C, D, or E
12. Write a C Program to translate Dotted Decimal IP Address into 32 Bit Address.
13. Configure Host IP, Subnet Mask and Default Gateway in a System in LAN(TCP/IP Configuration)

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4CS209PC/4DS209PC/4AD209PC/4KE209PC

OPERATING SYSTEM LAB

Course Pre-requisite:
Basic computer programming

Course Objectives:
- To make students aware of the kernel and shell structure of the operating systems.
- To make students aware of the purpose, structure and functions of operating systems
- To equip students with understanding of the various scheduling algorithms in OS.
- To make students aware of understanding of memory management in different OS.

Course Outcomes:
On completion of the course, the students will be able to
1. Explain memory management issues like external fragmentation, internal fragmentation.
2. Illustrate multithreading and its significance.
3. List various protection and security mechanisms of OS.
4. Analyze and solve the scheduling algorithms.
5. Analyze the deadlock situation and resolve it.
6. Compare various types of operating systems

List of Experiments:
This is a sample list of Experiments; **minimum 12 experiments** are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

1. To study Linux Operating System along with its installation.

2. To Study and Execute basic file commands and process related open source Ubuntu commands
    a. Commands to view all executing, block and suspended process.
    b. Command to check and change the priority of process CPU utilization for executing processes.
    c. Commands to check for child process, sub-processes, process tree, abort & end process and all other basics commands related to processes
3. Write a program for multithreading using C.
4. To simulate First Come First Serve & Shortest Job First process scheduling algorithm
5. To simulate Shortest Job First process scheduling algorithm
6. To simulate Pre-emptive Shortest Job First process scheduling algorithm
7. To implement Round Robin Process scheduling Algorithm
8. To implement Priority Based Process scheduling Algorithm
9. To implement and analyze multi-level queue scheduling algorithm
10. To implement the following file allocation strategies.
11. To simulate paging technique of memory management.
12. To implement the FIFO page replacement policy
13. To implement the LRU page replacement policy
14. To implement the optimal page replacement policy
15. To simulate producer-consumer problem using semaphores.
16. To implement Dining-Philosophers problem to deal with concurrency control mechanism.
17. To implement contiguous memory allocation strategies to detect fragmentation using: First Fit, Best Fit and Worst Fit.
18. To implement FCFS Disk Scheduling algorithm
19. To implement SCAN Disk Scheduling algorithm
20. To implement C-SCAN Disk Scheduling algorithm
21. To simulate Banker's algorithm for deadlock avoidance
22. To implement following memory management techniques
23. Implement MVT and MFT where memory block size is 100 for 5 processes. Enter no. of blocks for each process and calculate internal fragmentation.
24. To simulate LFU page replacement algorithms
25. To simulate the Single level directory file organization techniques.
26. To Simulate bankers algorithm for Dead Lock Avoidance (Banker's Algorithm)

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4CS306VS/4DS306VS/4AD306VS/4KE306VS

Computing Skill #1 LAB (VSEC-III)

(Based on technology like -Python/Django etc. to be decided by Individual Dept. of respective College)

Course Prerequisite:
Basic knowledge of any Programming Language

Course Objectives:

- To be able to program design with functions using Python.
- To understand data and information processing techniques.
- To understand to Design a program to solve the problems.
- To be able to access database using python programming.
- To be able to design web applications using python programming.

Course Outcomes :

On completion of the course, the students will be able to

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python
2. Interpret different Decision Making statements, Functions, Object oriented programming in Python
3. Summarize different File handling operations
4. Explain how to design GUI Applications in Python and evaluate different database operations
5. Develop applications using Django framework or Flask

List of Experiments:

This is a sample list of Experiments, **minimum 12 experiments** are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

1. Write python program to store data in list and then try to print them.
2. Write python program to print list of numbers using range and for loop
3. Write python program to store strings in list and then print them.
4. Write python program in which an function is defined and calling that function prints Hello World.
5. Write a python script to print the current date in the following format “Sun May 29 02:26:23 IST
6. 2017”
7. Write a program to create, append, and remove lists in python.
8. Write a program to create, concatenate and print a string and accessing sub-string from a given string.
9. Write a program to demonstrate working with tuples in python.
10. Write a program to demonstrate working with dictionaries in python.
11. Write a python program to find largest of three numbers.
12. Write python program in which an function(with single string parameter) is defined and calling that function prints the string parameters given to function.
13. Write python program in which an class is define, then create object of that class and call simple print function define in class.
14. Write a Python script that prints prime numbers less than 20.
15. Write a python program to find factorial of a number using Recursion.
16. Write a python program to define a module to find Fibonacci Numbers and import the module to another program.
17. Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.
18. Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.
19. Write a Python class to convert an integer to a roman numeral.
20. Write a Python class to implement pow(x, n)
21. Write a Python class to reverse a string word by word.
22. Accessing and working with databases using Python.
23. Create data frame from .csv files and operations on it.
24. Plotting various graphs using Python.
25. Developing basic GUI using Python.
26. Developing web applications using Django framework or Flask

Reference Books :

1. “Core Python Programming”, R. NageswaraRao, dreamtech press.

2. “Python Programming A Modular Approach With Graphics, Database, Mobile and WebApplications”, SheetalTaneja, Naveen Kumar, Pearson.
3. Python Web Development with Django By Jeff Forcier, Paul Bissex, Wesley J Chun, Addison-Wesley Professional.
4. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning
5. Allen B. Downey , “ Think Python: How to Think Like a Computer Scientist”, Second Edition,
6. Shroff/O’Reilly Publishers
7. John V Guttag. “Introduction to Computation and Programming Using Python”, Prentice Hall of India
8. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structures and Algorithms in Python”, Wiley
9. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher, Revised and Expanded version (Referred by MIT)

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4CS217EM / 4KE217EM / 4DS217EM /4AD217EM

SOCIAL SCIENCES & ENGINEERING ECONOMICS

Course Objectives:

By the end of the course, students will:

- Understand the importance of social sciences and economics in engineering.
- Gain knowledge of the Indian Constitution, governance, and policy-making.
- Learn about economic principles, market trends, and financial institutions.
- Examine the impact of science, technology, and economic transformations on society.
- Understand professional ethics and responsibilities with socioeconomic considerations.

Course Outcomes (COs):

On completion of the course, students will be able to:

1. Understand the significance of social sciences and economic principles in engineering.
2. Analyze the role of governance, laws, and policies in shaping society and business environments.
3. Apply economic and market principles to assess financial systems and business trends.

Syllabus:

Unit I: Social Sciences and Governance (7 Hours) [CO1]

Importance of Social Sciences in Engineering, Indian Constitution: Salient features, Fundamental Rights and Duties, Directive Principles of State Policy, Governance in India: Structure of Indian Parliament, Role and Powers of the President, Prime Minister, and Council of Ministers.

Unit II: Society, Science, and Technology (7 Hours) [CO2]

Impact of Science and Technology on Culture and Civilization, Human Society: Structure, community groups, social institutions, Marriage and Family Systems: Types, functions, and modern challenges, Production & Business Organizations: Factors of production, laws of return, types of business entities.

Unit III: Economics and Market Trends (8 Hours) [CO3]

Nature and Scope of Economics: Special significance to engineers, Economic Development: Characteristics of underdevelopment, obstacles to economic growth, vicious circle of poverty. Banking & Financial Systems: Functions of Central and Commercial Banks, GST overview, Market Structures: Perfect & imperfect competition, monopoly, pricing mechanisms.

Textbook:

1. Pylee M. V. : Constitutional Govt. in India, S. Chand and Co.
2. C N Shankar Rao: Sociology, S. Chand and Co.

Reference Books:

1. Dewett and Varma J.D. : Elementary Economic Theory, S. Chand and Co.
2. A. N. Agrawal : Indian Economy, Problem of Development and Planning (Wiley Eastern Ltd), New Delhi.
3. S. K. Mishra : Indian Economy, Its Development Experience. Himalaya Pub. House, Bombay.
4. E. Kuper : Economics of W.R. Development, McGraw Hill Co.,
5. Brij Kishore Sharma. : The Constitution of India, PHI.
6. Mahajan : The Constitution of India, S. Chand, New Delhi.
7. Maclaver and Page : Principle of Sociology.
8. Davis K. : Human Society
9. Datt R.K. : Indian Economy, S. Chand and Comp. New Delhi P. M. Sundharam
10. Dhingra I.C. : Indian Economy

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Computer Science and Engineering

Multidisciplinary Minor

Note: These MDMs may be opted by students from any engineering discipline, except for those enrolled in Computer Science and Engineering, Computer Engineering, Computer Science and Engineering (Data Science), Artificial Intelligence and Data Science (AIDS), or allied discipline.

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3CS205MD / 3KE205MD / 3DS205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4CS214MD	Data Structures and Problem Solving	Theory	2
MDM#3	V	5CS227MD	Database Management Systems	Theory	2
MDM#4	V	5CS228MD	Web Technologies & Development	Theory	2
MDM#5	V	5CS229ML	Web Technologies Lab	Practical	1
MDM#6	VI	6CS239MD	Cloud Computing & Virtualization	Theory	2
MDM#7	VII	7CS307MD	Computational Thinking & Algorithmic Problem Solving	Theory	2
MDM#8	VII	7CS308ML	Interdisciplinary Computing Project Lab	Practical	1

Subject wise Syllabus

SEM III

Subject Code: 3CS205MD / 3KE205MD / 3DS205MD / 3AD205MD
Subject Title: Foundations of Computing & Programming
Type: Theory | **Credits:** 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic familiarity with mathematics and logical reasoning.

Course Objectives:

- To introduce fundamental concepts of computing and its relevance across engineering domains.
- To develop problem-solving skills using algorithmic approaches.
- To provide exposure to basic programming constructs using a high-level language (Python).
- To build foundational understanding required for advanced computational courses.

Course Outcomes (COs):

1. **CO1:** Understand computing systems and problem-solving logic. (Unit 1)
2. **CO2:** Apply algorithmic thinking to solve simple problems. (Unit 2)
3. **CO3:** Implement basic programs using control structures and I/O operations. (Unit 3)

Unit-wise Syllabus:

Unit 1: Basics of Computing & Programming (7 hrs)
Introduction to Computers and Programming Languages, Components of a Computer System and Software Types, Number Systems (Binary, Decimal, Hexadecimal) and Conversions, Basics of Algorithms and Flowcharts, Introduction to Python: Syntax, Variables, Data Types.

Unit 2: Control Structures and Functions (8 hrs)
Conditional Statements: if, if-else, nested if, Looping Constructs: for, while, Introduction to Functions and Modular Programming, Basic Math Operations and Built-in Functions in Python.

Unit 3: Input-Output and Basic Problem Solving (7 hrs)
Input from User and Output Formatting, Lists and String Handling, Simple Problem-Solving , Examples using Loops and Conditions, Writing and Executing Python Scripts.

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				1
CO2	2	3	2			2
CO3		3	2	3	2	3

Textbook(s):

Reema Thareja, "Python Programming: Using Problem Solving Approach," Oxford University Press, 2017.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist," O'Reilly Media, 2nd Edition, 2015.
2. Zelle, John M., "Python Programming: An Introduction to Computer Science," Franklin, Beedle & Associates, 2017.
3. Anita Goel, "Computer Fundamentals," Pearson Education, 2010.
4. Charles Severance, "Python for Everybody: Exploring Data Using Python 3," CreateSpace, 2016.
5. Yashavant Kanetkar, "Let Us Python," BPB Publications, 2020.

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SEM IV

Subject Code: 4CS214MD
Subject Title: Data Structures and Problem Solving
Type: Theory | **Credits**: 2
Total Contact Hours: 22–23 hours

Prerequisite: Basic understanding of programming (preferably in C or Python).

Course Objectives:

- To introduce fundamental data structures and their applications.
- To develop problem-solving skills through efficient use of data structures.
- To improve algorithmic thinking for common computational tasks.
- To expose students to practical scenarios where data structures are applied in engineering contexts.

Course Outcomes (COs):

1. **CO1**: Understand and differentiate various data structures and their use cases. (Unit 1)
2. **CO2**: Apply linear and non-linear data structures in solving engineering problems. (Unit 2)
3. **CO3**: Analyze algorithm performance and implement solutions using appropriate structures. (Unit 3)

Unit-wise Syllabus:

Unit 1: Introduction to Data Structures (7 hrs)
Concept and Classification of Data Structures, Abstract Data Types (ADT), Arrays, Strings, and Linked Lists, Applications: Polynomial Representation, Sparse Matrices.

Unit 2: Linear and Non-linear Structures (8 hrs)
Stacks and Queues: Operations and Applications (Infix to Postfix, Recursion, Job Scheduling) Trees: Binary Trees, Tree Traversals, Binary Search Trees, Applications in Expression Trees, Directory Structures.

Unit 3: Searching, Sorting & Hashing (7 hrs)
Searching Techniques: Linear and Binary Search, Sorting Algorithms: Bubble, Selection, Insertion, Merge Sort, Hashing and Collision Resolution Techniques, Time and Space Complexity Basics.

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO12
CO1	3	2				
CO2	2	3	3	2	2	2
CO3	2	3	3	3	3	2

Textbook(s):

1. Seymour Lipschutz, "Data Structures", Schaum's Outline Series, McGraw Hill Education.
2. Reema Thareja, "Data Structures Using C", Oxford University Press, 2nd Edition, 2014.

Reference Books:

1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", Universities Press, 2008.
2. Jean-Paul Tremblay & Paul G. Sorenson, "An Introduction to Data Structures with Applications", Tata McGraw-Hill.
3. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy", CareerMonk Publications.
4. Robert Lafore, "Data Structures and Algorithms in C++", Pearson Education.
5. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education.
6. Thomas H. Cormen et al., "Introduction to Algorithms", MIT Press (for higher interest).

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Computer Engineering

Multidisciplinary Minor

Note: These MDMs may be opted by students from any engineering discipline, except for those enrolled in Computer Science and Engineering, Computer Engineering, Computer Science and Engineering (Data Science), Artificial Intelligence and Data Science (AIDS), or allied discipline.

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3KE205MD / 3CS205MD / 3DS205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4KE214MD	Operating Systems Fundamentals	Theory	2
MDM#3	V	5KE227MD	Software Engineering Principles	Theory	2
MDM#4	V	5KE228MD	Mobile Application Development	Theory	2
MDM#5	V	5KE229ML	Mobile App Development Lab (Android/Kotlin)	Practical	1
MDM#6	VI	6KE239MD	DevOps and Software Deployment Practices	Theory	2
MDM#7	VII	7KE307MD	Full Stack Web Development	Theory	2
MDM#8	VII	7KE308ML	Software Project Lab	Practical	1

Subject wise Syllabus

SEM III

Subject Code: 3KE205MD / 3CS205MD / 3DS205MD / 3AD205MD
Subject Title: Foundations of Computing & Programming
Type: Theory | **Credits:** 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic familiarity with mathematics and logical reasoning.

Course Objectives:

- To introduce fundamental concepts of computing and its relevance across engineering domains.
- To develop problem-solving skills using algorithmic approaches.
- To provide exposure to basic programming constructs using a high-level language (Python).
- To build foundational understanding required for advanced computational courses.

Course Outcomes (COs):

1. **CO1:** Understand computing systems and problem-solving logic. (Unit 1)
2. **CO2:** Apply algorithmic thinking to solve simple problems. (Unit 2)
3. **CO3:** Implement basic programs using control structures and I/O operations. (Unit 3)

Unit-wise Syllabus:

Unit 1: Basics of Computing & Programming (7 hrs)
Introduction to Computers and Programming Languages, Components of a Computer System and Software Types, Number Systems (Binary, Decimal, Hexadecimal) and Conversions, Basics of Algorithms and Flowcharts, Introduction to Python: Syntax, Variables, Data Types.

Unit 2: Control Structures and Functions (8 hrs)
Conditional Statements: if, if-else, nested if, Looping Constructs: for, while, Introduction to Functions and Modular Programming, Basic Math Operations and Built-in Functions in Python.

Unit 3: Input-Output and Basic Problem Solving (7 hrs)
Input from User and Output Formatting, Lists and String Handling, Simple Problem-Solving , Examples using Loops and Conditions, Writing and Executing Python Scripts.

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				1
CO2	2	3	2			2
CO3		3	2	3	2	3

Textbook(s):

Reema Thareja, "Python Programming: Using Problem Solving Approach," Oxford University Press, 2017.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist," O'Reilly Media, 2nd Edition, 2015.
2. Zelle, John M., "Python Programming: An Introduction to Computer Science," Franklin, Beedle & Associates, 2017.
3. Anita Goel, "Computer Fundamentals," Pearson Education, 2010.
4. Charles Severance, "Python for Everybody: Exploring Data Using Python 3," CreateSpace, 2016.
5. Yashavant Kanetkar, "Let Us Python," BPB Publications, 2020.

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SEM IV

Subject Code: 4CE205MD
Subject Title: Operating Systems Fundamentals
Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 hours

Prerequisite: Familiarity with computer hardware basics and programming fundamentals.

Course Objectives:

- To introduce students to the fundamentals of operating systems and their role in computing.
- To explain the key functions of an OS including process, memory, and file management.
- To describe the basic concepts of multitasking, scheduling, and resource allocation.
- To provide a foundation for understanding system-level operations and future system software courses.

Course Outcomes (COs):

1. **CO1:** Understand the basic components and functions of an operating system. (Unit 1)
2. **CO2:** Explain concepts of process management and CPU scheduling. (Unit 2)
3. **CO3:** Demonstrate an understanding of memory and file system management. (Unit 3)

Unit-wise Syllabus:

Unit 1: Overview of Operating Systems (7 hrs)
Definition and Functions of Operating System, Types of Operating Systems: Batch, Multitasking, Time-Sharing, Real-Time, Mobile OS; Components of OS – Kernel, Shell, System Calls; System Boot Process; Examples of OS (Windows, Linux, Android).

Unit 2: Process Management and Scheduling (8 hrs)
Concept of Process, Process States and PCB; Threads and Multithreading; CPU Scheduling: FCFS, SJF, Round Robin (RR); Introduction to Deadlocks – Necessary Conditions, Deadlock Prevention and Recovery (Basic Concepts).

Unit 3: Memory & File Management (7 hrs)
Memory Hierarchy and Management Techniques: Paging, Segmentation (Conceptual Overview); Introduction to Virtual Memory; File Systems and Operations: Creation, Reading, Writing, Deletion; Directory Structures and File Allocation (Concept Only); Introduction to Disk Scheduling (FCFS, SSTF).

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				1
CO2	2	3	2			2
CO3		3	3	2	2	3

Textbook(s):

Silberschatz, Galvin, and Gagne, *Operating System Concepts*, 9th Edition, Wiley, 2013.

Reference Books:

1. Andrew S. Tanenbaum, Modern Operating Systems, Pearson, 4th Edition, 2014.
2. William Stallings, Operating Systems: Internals and Design Principles, Pearson, 8th Edition, 2018.
3. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 4th Edition, 2017.
4. D.M. Dhamdhere, Operating Systems: A Concept-Based Approach, McGraw Hill, 2012.
5. Milan Milenkovic, Operating Systems: Concepts and Design, McGraw Hill, 2001.
6. G. Nutt, Operating Systems: A Modern Perspective, Pearson, 2nd Edition, 2003.

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Computer Science and Engineering (Data Science)

Multidisciplinary Minor

Note: These MDMs may be opted by students from any engineering discipline, except for those enrolled in Computer Science and Engineering, Computer Engineering, Computer Science and Engineering (Data Science), Artificial Intelligence and Data Science (AIDS), or allied discipline.

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3DS205MD / 3CS205MD / 3KE205MD / 3AD205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4DS214MD	Foundations of Data Science & Statistics	Theory	2
MDM#3	V	5DS227MD	Data Wrangling & Preprocessing Techniques	Theory	2
MDM#4	V	5DS228MD	Data Visualization Techniques	Theory	2
MDM#5	V	5DS229ML	Data Analytics Lab	Practical	1
MDM#6	VI	6DS239MD	Applied Machine Learning for Engineers	Theory	2
MDM#7	VII	7DS307MD	Predictive Analytics & Decision Support	Theory	2
MDM#8	VII	7DS308ML	Data Science Project Lab	Practical	1

Subject wise Syllabus

SEM III

Subject Code: 3DS205MD / 3CS205MD / 3KE205MD / 3AD205MD
Subject Title: Foundations of Computing & Programming
Type: Theory | **Credits:** 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic familiarity with mathematics and logical reasoning.

Course Objectives:

- To introduce fundamental concepts of computing and its relevance across engineering domains.
- To develop problem-solving skills using algorithmic approaches.
- To provide exposure to basic programming constructs using a high-level language (Python).
- To build foundational understanding required for advanced computational courses.

Course Outcomes (COs):

1. **CO1:** Understand computing systems and problem-solving logic. (Unit 1)
2. **CO2:** Apply algorithmic thinking to solve simple problems. (Unit 2)
3. **CO3:** Implement basic programs using control structures and I/O operations. (Unit 3)

Unit-wise Syllabus:

Unit 1: Basics of Computing & Programming (7 hrs)
Introduction to Computers and Programming Languages, Components of a Computer System and Software Types, Number Systems (Binary, Decimal, Hexadecimal) and Conversions, Basics of Algorithms and Flowcharts, Introduction to Python: Syntax, Variables, Data Types.

Unit 2: Control Structures and Functions (8 hrs)
Conditional Statements: if, if-else, nested if, Looping Constructs: for, while, Introduction to Functions and Modular Programming, Basic Math Operations and Built-in Functions in Python.

Unit 3: Input-Output and Basic Problem Solving (7 hrs)
Input from User and Output Formatting, Lists and String Handling, Simple Problem-Solving , Examples using Loops and Conditions, Writing and Executing Python Scripts.

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				1
CO2	2	3	2			2
CO3		3	2	3	2	3

Textbook(s):

Reema Thareja, "Python Programming: Using Problem Solving Approach," Oxford University Press, 2017.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist," O'Reilly Media, 2nd Edition, 2015.
2. Zelle, John M., "Python Programming: An Introduction to Computer Science," Franklin, Beedle & Associates, 2017.
3. Anita Goel, "Computer Fundamentals," Pearson Education, 2010.
4. Charles Severance, "Python for Everybody: Exploring Data Using Python 3," CreateSpace, 2016.
5. Yashavant Kanetkar, "Let Us Python," BPB Publications, 2020.

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SEM IV

Subject Code: 4DS214MD
Subject Title: Foundations of Data Science & Statistics
Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic knowledge of mathematics, statistics, and computer operations.

Course Objectives:

- To introduce the fundamental concepts and workflow of Data Science.
- To build understanding of essential descriptive statistics and probability theory.
- To equip students with data interpretation and visualization skills using simple tools.
- To develop a statistical foundation required for data-driven engineering applications.

Course Outcomes (COs):

1. **CO1:** Understand the concepts, tools, and processes of the data science lifecycle. (Unit 1)
2. **CO2:** Apply descriptive statistics and probability for data summarization and inference. (Unit 2)
3. **CO3:** Perform data analysis and visualization using basic tools. (Unit 3)

Unit-wise Syllabus

Unit 1: Introduction to Data Science (7 hrs)
What is Data Science? Components and Lifecycle; Role of a Data Scientist; Types of Data (Structured, Unstructured, Semi-structured); Real-world Applications of Data Science; Overview of Data Collection and Preparation; Introduction to Python or Excel as data analysis tools.

Unit 2: Statistics and Probability for Data Science (8 hrs)
Descriptive Statistics: Measures of Central Tendency (Mean, Median, Mode), Dispersion (Range, Variance, Standard Deviation); Introduction to Probability: Basic Rules, Conditional Probability, Bayes' Theorem; Overview of Probability Distributions: Normal, Binomial, Poisson (Conceptual only).

Unit 3: Data Analysis & Visualization (7 hrs)
Exploratory Data Analysis (EDA): Identifying Trends and Outliers; Introduction to Data Cleaning (Missing Values, Duplicates); Data Visualization using Charts (Bar, Histogram, Pie, Boxplots); Introduction to Tools like Matplotlib/Excel/Power BI; Case Studies from Healthcare, Retail, or Education.

CO-PO Mapping Table

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				2
CO2	2	3	2			2
CO3		3	3	3	2	3

Textbook(s):

Joel Grus, *Data Science from Scratch*, O'Reilly Media, 2nd Edition, 2019.

Reference Books:

1. Cathy O'Neil and Rachel Schutt, Doing Data Science, O'Reilly Media, 2014.
2. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2nd Edition, 2017.
3. David Spiegelhalter, The Art of Statistics: Learning from Data, Penguin, 2019.
4. Allen B. Downey, Think Stats: Probability and Statistics for Programmers, O'Reilly Media, 2014.
5. Charles Wheelan, Naked Statistics: Stripping the Dread from the Data, W. W. Norton, 2013.
6. G. Jay Kerns, Introduction to Probability and Statistics Using R, Free Online Book, 2010.

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Artificial Intelligence and Data Science

Multidisciplinary Minor

Note: These MDMs may be opted by students from any engineering discipline, except for those enrolled in Computer Science and Engineering, Computer Engineering, Computer Science and Engineering (Data Science), Artificial Intelligence and Data Science (AIDS), or allied discipline.

Reference	Sem	Subject Code	Subject Title	Type	Credits
MDM#1	III	3AD205MD / 3CS205MD / 3KE205MD / 3DS205MD	Foundations of Computing & Programming	Theory	2
MDM#2	IV	4AD214MD	Essentials of Artificial Intelligence	Theory	2
MDM#3	V	5AD227MD	Introduction to Machine Learning	Theory	2
MDM#4	V	5AD228MD	AI for Engineering Applications	Theory	2
MDM#5	V	5AD229ML	Machine Learning Lab	Practical	1
MDM#6	VI	6AD239MD	Deep Learning Foundations	Theory	2
MDM#7	VII	7AD307MD	AI in Robotics, Healthcare, and Smart Systems	Theory	2
MDM#8	VII	7AD308ML	AI Tools and Frameworks Lab	Practical	1

Subject wise Syllabus

SEM III

Subject Code: 3AD205MD / 3CS205MD / 3KE205MD / 3DS205MD
Subject Title: Foundations of Computing & Programming
Type: Theory | **Credits:** 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic familiarity with mathematics and logical reasoning.

Course Objectives:

- To introduce fundamental concepts of computing and its relevance across engineering domains.
- To develop problem-solving skills using algorithmic approaches.
- To provide exposure to basic programming constructs using a high-level language (Python).
- To build foundational understanding required for advanced computational courses.

Course Outcomes (COs):

1. **CO1:** Understand computing systems and problem-solving logic. (Unit 1)
2. **CO2:** Apply algorithmic thinking to solve simple problems. (Unit 2)
3. **CO3:** Implement basic programs using control structures and I/O operations. (Unit 3)

Unit-wise Syllabus:

Unit 1: Basics of Computing & Programming (7 hrs)
Introduction to Computers and Programming Languages, Components of a Computer System and Software Types, Number Systems (Binary, Decimal, Hexadecimal) and Conversions, Basics of Algorithms and Flowcharts, Introduction to Python: Syntax, Variables, Data Types.

Unit 2: Control Structures and Functions (8 hrs)
Conditional Statements: if, if-else, nested if, Looping Constructs: for, while, Introduction to Functions and Modular Programming, Basic Math Operations and Built-in Functions in Python.

Unit 3: Input-Output and Basic Problem Solving (7 hrs)
Input from User and Output Formatting, Lists and String Handling, Simple Problem-Solving , Examples using Loops and Conditions, Writing and Executing Python Scripts.

CO-PO Mapping Table:

CO \ PO	PO1	PO2	PO4	PO5	PO10	PO12
CO1	3	2				1
CO2	2	3	2			2
CO3		3	2	3	2	3

Textbook(s):

Reema Thareja, "Python Programming: Using Problem Solving Approach," Oxford University Press, 2017.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist," O'Reilly Media, 2nd Edition, 2015.
2. Zelle, John M., "Python Programming: An Introduction to Computer Science," Franklin, Beedle & Associates, 2017.
3. Anita Goel, "Computer Fundamentals," Pearson Education, 2010.
4. Charles Severance, "Python for Everybody: Exploring Data Using Python 3," CreateSpace, 2016.
5. Yashavant Kanetkar, "Let Us Python," BPB Publications, 2020.

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SEM IV

Subject Code: 4AD214MD
Subject Title: Essentials of Artificial Intelligence
Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 hours

Prerequisite: Basic understanding of mathematics, logic, and programming fundamentals.

Course Objectives:

- To introduce fundamental concepts and domains of Artificial Intelligence (AI).
- To explore classical AI techniques for problem-solving and search.
- To familiarize students with basic applications of AI in various fields.
- To build foundational awareness required for more advanced AI and ML topics.

Course Outcomes (COs):

1. **CO1:** Understand the history, goals, and scope of Artificial Intelligence. (Unit 1)
2. **CO2:** Apply search strategies and reasoning techniques to solve basic problems. (Unit 2)
3. **CO3:** Explore real-world applications and ethical considerations of AI. (Unit 3)

Unit-wise Syllabus

Unit 1: Introduction to Artificial Intelligence (7 hrs)
Definition and Evolution of AI, Goals and Components of AI, Branches and Subfields (ML, NLP, Vision, Robotics), Applications in Engineering, Healthcare, and Finance; Intelligent Agents: Types and Environments, Task Environments, PEAS Framework.

Unit 2: Problem Solving and Knowledge Representation (8 hrs)
Concept of State Space and Search Strategies, Uninformed Search: BFS, DFS, Iterative Deepening; Introduction to Heuristics and A* Search; Basics of Knowledge Representation: Propositional Logic, Rule-Based Systems; Use Cases in Diagnostics and Planning.

Unit 3: Applications and Ethics in AI (7 hrs)
AI in the Real World: Use Cases in Chatbots, Autonomous Vehicles, Personal Assistants, Smart Cities; Overview of Machine Learning vs AI; Bias and Fairness in AI; Ethical and Societal Considerations; Career Opportunities in AI for Non-CS Backgrounds.

CO-PO Mapping Table

CO \ PO	PO1	PO2	PO4	PO5	PO6	PO8	PO12
CO1	3				2		2
CO2	2	3	2				2
CO3		2		2	2	3	3

Textbook(s):

Stuart Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 4th Edition, 2020.

Reference Books:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, McGraw-Hill Education, 3rd Edition, 2008.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson, 2005.
3. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 3rd Edition, 2014.
4. John Haugeland, Artificial Intelligence: The Very Idea, MIT Press, 1985.
5. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009.
6. Toby Walsh, Machines Behaving Badly: The Morality of AI, Basic Books, 2022.

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Double Minor Syllabus

Note: The syllabi provided herein for each subject are indicative and intended solely for reference purposes. As these courses are to be delivered through online platforms such as MOOC/NPTEL or other approved content providers, the exact alignment of content with the prescribed syllabus may not always be feasible. Therefore, the contents should be considered as a notional framework only.
The concerned Head of the Department, along with the duly constituted committee responsible for the curation and approval of online courses opted by students, shall exercise due diligence in reviewing and approving the selected courses, ensuring that the learning outcomes are in reasonable conformity with the reference syllabus provided.

Computer Science and Engineering

Track: Cyber Security (Honours / Double Minor)

SEM III	3CS245DH1	Fundamentals of Cyber Security	4	Theory
SEM IV	4CS246DH1	Network & Web Application Security	4	Theory

Syllabus

Subject Code: 3CS245DH1

Subject Title: Fundamentals of Cyber Security

Course Pre-requisite: Basic Computer Fundamentals, Networking Concepts

Course Objectives: Throughout the course, students will be expected to demonstrate their understanding of cyber security by being able to do each of the following: • Understand the core concepts of cybersecurity and its importance. • Identify different types of cyber threats and vulnerabilities. • Learn basic cryptographic techniques and security protocols. • Understand access control, authentication, and security mechanisms. • Explore real-world use cases of cybersecurity in systems and applications.

Course Outcomes (Expected Outcome): On completion of the course, the students will be able to:

1. Define and explain key cybersecurity principles and terminology.
2. Identify common cyber threats, attacks, and vulnerabilities.
3. Describe various cryptographic algorithms and their applications.
4. Understand security policies, controls, and user authentication.
5. Recognize secure software and system design practices.
6. Apply cybersecurity principles to protect information systems.

Syllabus:

Unit I: Introduction to Cyber Security (Hours: 07) Definition and goals, security principles (CIA), threat landscape, cybersecurity domains.

Unit II: Cyber Threats and Vulnerabilities (Hours: 07) Malware types, phishing, ransomware, social engineering, vulnerability types and lifecycle.

Unit III: Cryptography Basics (Hours: 07) Symmetric and asymmetric encryption, hashing, digital signatures, key exchange methods.

Unit IV: Network Security (Hours: 07) Firewalls, IDS/IPS, VPN, common network attacks and mitigation strategies.

Unit V: Authentication and Access Control (Hours: 07) User authentication techniques (password, biometric, multifactor), access control models (DAC, MAC, RBAC).

Unit VI: Cyber Security in Practice (Hours: 07) Secure software development, incident response basics, cyber law overview, introduction to ethical hacking.

Text Books:

1. William Stallings, "Network Security Essentials," Pearson.
2. Nina Godbole and Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives," Wiley.

Reference Books:

1. Michael T. Goodrich, Roberto Tamassia, "Introduction to Computer Security," Pearson.
2. Chuck Easttom, "Computer Security Fundamentals," Pearson.
3. Eric Maiwald, "Fundamentals of Network Security," McGraw-Hill.
4. Behrouz A. Forouzan, "Cryptography and Network Security," McGraw-Hill.
5. Official NIST Cybersecurity Framework Documentation

Subject Code: 4CS246DH1

Subject Title: Network & Web Application Security

Course Pre-requisite: Fundamentals of Cyber Security, Basic Networking Concepts

Course Objectives: Throughout the course, students will be expected to demonstrate their understanding of network and web application security by being able to do each of the following: • Learn about the threats and countermeasures in computer networks. • Understand the protocols and tools used in securing networks. • Explore web application vulnerabilities and mitigation techniques. • Understand secure web development practices. • Implement security testing tools and frameworks.

Course Outcomes (Expected Outcome): On completion of the course, the students will be able to:

1. Understand the nature of network-based threats and attacks.
2. Apply security mechanisms for securing network infrastructure.
3. Identify web application security issues.
4. Implement secure coding practices in web applications.

5. Use tools for web and network security testing.
6. Assess and mitigate risks in network and web environments.

Syllabus:

Unit I: Network Security Fundamentals (Hours: 07) Network vulnerabilities and threats, OSI & TCP/IP security layers, network security controls.

Unit II: Protocol Security (Hours: 07) IPSec, SSL/TLS, HTTPS, DNSSEC, Email security protocols (SPF, DKIM).

Unit III: Firewalls and Intrusion Detection Systems (Hours: 07) Types of firewalls, IDS/IPS architecture, anomaly vs signature-based detection, SIEM.

Unit IV: Web Application Threats and OWASP Top 10 (Hours: 07) Injection, XSS, CSRF, insecure deserialization, broken authentication and access control.

Unit V: Secure Web Development (Hours: 07) Input validation, session management, secure cookies, error handling, secure APIs.

Unit VI: Web Security Testing Tools and Frameworks (Hours: 07) Burp Suite, OWASP ZAP, Nikto, SQLMap, static and dynamic analysis tools.

Text Books:

1. William Stallings, "Network Security Essentials: Applications and Standards," Pearson.
2. Dafydd Stuttard & Marcus Pinto, "The Web Application Hacker's Handbook," Wiley.

Reference Books:

1. Neil Rowe, "Introduction to Cybersecurity: Networking and Security," Springer.
2. Joseph Migga Kizza, "Computer Network Security," Springer.
3. OWASP Testing Guide and OWASP Top 10 Documentation.
4. Mike Shema, "Web Application Security," Syngress.
5. Nina Godbole, "Information Systems Security," Wiley.

Track: Data Science (Honours / Double Minor)

SEM III	3CS245DH2	Introduction to Data Science	4	Theory
SEM IV	4CS246DH2	Statistical Methods for Data Analysis	4	Theory

Syllabus

Subject Code: 3CS245DH2

Subject Title: Introduction to Data Science

Course Pre-requisite: Computer Programming, Mathematics for Computing

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of data science concepts by being able to do each of the following:
• Understand the data science process and its applications.
• Learn data preprocessing and data visualization.
• Understand data types and sources.
• Explore real-world datasets and extract insights.
• Use Python for data analysis.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Understand the role and scope of data science.
2. Perform data preprocessing and exploratory analysis.
3. Work with structured and unstructured data.
4. Apply visualization techniques for insight generation.
5. Use Python libraries for data science (Pandas, NumPy, Matplotlib).
6. Understand real-life applications of data science.

Syllabus:

Unit I: Data Science Overview (Hours: 07)
Definition, lifecycle, applications, roles in data science.

Unit II: Data Types and Sources (Hours: 07)
Structured vs unstructured data, Datasets, APIs, Web scraping basics.

Unit III: Data Preprocessing (Hours: 07)
Data cleaning, transformation, handling missing data, normalization.

Unit IV: Exploratory Data Analysis (Hours: 07)
Descriptive statistics, visualization techniques, outlier detection.

Unit V: Introduction to Python for Data Science (Hours: 07)
Pandas, NumPy, Matplotlib, DataFrames, basic plots.

Unit VI: Mini Project and Case Studies (Hours: 07)
Mini project on real-world data, case studies from health, finance, e-commerce.

Text Books:

1. Cathy O'Neil and Rachel Schutt, “Doing Data Science”, O’Reilly Media.
2. Joel Grus, “Data Science from Scratch”, O’Reilly.

Reference Books:

1. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O'Reilly.
2. Vasant Dhar, “Data Science and Prediction”, Communications of the ACM.

3. Hadley Wickham, “R for Data Science”, O’Reilly.
4. Wes McKinney, “Python for Data Analysis”, O’Reilly.
5. IBM Data Science Course (MOOC).

Subject Code: 4CS246DH2

Subject Title: Statistical Methods for Data Analysis

Course Pre-requisite: Introduction to Data Science, Mathematics for Computing

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of statistical techniques in data analysis by being able to do each of the following:
• Understand fundamental concepts of statistics.
• Apply descriptive and inferential statistical techniques.
• Perform hypothesis testing and correlation analysis.
• Use regression models for prediction.
• Analyze and interpret statistical results using tools.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Understand and apply basic descriptive statistics.
2. Perform probability analysis and hypothesis testing.
3. Apply regression and correlation analysis techniques.
4. Evaluate statistical significance and draw conclusions.
5. Use Python/R for performing statistical computations.
6. Interpret results and communicate statistical findings.

Syllabus:

Unit I: Descriptive Statistics (Hours: 07)
Mean, median, mode, variance, standard deviation, graphical methods.

Unit II: Probability Theory (Hours: 07)
Random variables, distributions, Bayes theorem, discrete and continuous distributions.

Unit III: Statistical Inference (Hours: 07)
Sampling, Central Limit Theorem, Estimation, Confidence Intervals.

Unit IV: Hypothesis Testing (Hours: 07)
T-tests, Chi-square tests, ANOVA.

Unit V: Correlation and Regression (Hours: 07)
Pearson and Spearman correlation, Linear and logistic regression models.

Unit VI: Statistical Tools & Applications (Hours: 07)
Hands-on with Python/R, interpretation, case studies from scientific and business domains.

Text Books:

1. S. C. Gupta & V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand.
2. Allen B. Downey, "Think Stats: Probability and Statistics for Programmers", O'Reilly.

Reference Books:

1. Larry J. Stephens, "Essential Statistics", Cengage.
2. Andy Field, "Discovering Statistics Using R", Sage.
3. Peter Bruce & Andrew Bruce, "Practical Statistics for Data Scientists", O'Reilly.
4. John Verzani, "Using R for Introductory Statistics", CRC Press.
5. NPTEL Course Materials on Statistics for Data Science.

Computer Science and Engineering (Data Science)

Track: Artificial Intelligence (AI) (Honours / Double Minor)

SEM III	3DS245DH1	Fundamentals of Artificial Intelligence	4	Theory
SEM IV	4DS246DH1	Intelligent Systems and Applications	4	Theory

Syllabus

Subject Code: 3DS245DH1

Subject Title: Fundamentals of Artificial Intelligence
Credits: 4
Type: Theory

Course Pre-requisite:

- Basic Programming Concepts
- Discrete Mathematics and Logic
- Problem Solving Techniques

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of foundational concepts in Artificial Intelligence (AI) by being able to do each of the following:
• Understand the fundamental principles of AI and its historical evolution.
• Explore core techniques such as search strategies, logic-based reasoning, and knowledge representation.
• Introduce basic machine learning concepts.
• Understand applications of AI in various domains.
• Learn the ethical and societal impacts of AI technologies.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Define AI, its goals, and applications across sectors.
2. Solve problems using uninformed and informed search techniques.
3. Apply logical reasoning using propositional and predicate logic.
4. Understand basic concepts of machine learning and expert systems.
5. Represent knowledge using various representation techniques.
6. Discuss ethical considerations and future trends in AI.

Syllabus:
Unit I: Introduction to Artificial Intelligence (Hours: 07)
History and evolution of AI, Definitions and scope, Turing Test, Applications of AI (Robotics, NLP, Healthcare, Games, etc.), Intelligent agents and environments.
Unit II: Problem Solving and Search Techniques (Hours: 07)
Problem formulation, State space, Uninformed search (BFS, DFS, UCS), Informed search (Greedy, A*), Constraint satisfaction problems.
Unit III: Knowledge Representation and Reasoning (Hours: 07)
Propositional logic, Predicate logic, Resolution, Forward and backward chaining, Rule-based systems, Semantic networks and frames.
Unit IV: Introduction to Machine Learning (Hours: 07)
Supervised vs Unsupervised learning, Regression, Classification basics, Clustering overview, Decision Trees, Naive Bayes, k-NN.
Unit V: Expert Systems and Planning (Hours: 07)
Architecture of expert systems, Inference engines, Case-based reasoning, Classical planning, Planning graphs, STRIPS.
Unit VI: AI Ethics and Societal Implications (Hours: 07)
Ethical issues in AI, Bias in data and algorithms, Explainable AI, AI safety, Job displacement, Future of AI.

Text Books:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, “Artificial Intelligence”, McGraw Hill.
2. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson.

Reference Books:

1. Nils J. Nilsson, “Principles of Artificial Intelligence”, Morgan Kaufmann.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press.
3. Dan W. Patterson, “Introduction to AI and Expert Systems”, Pearson.
4. Peter Flach, “Machine Learning: The Art and Science of Algorithms”, Cambridge.
5. IBM AI Foundations Courseware (MOOC).

Subject Code: 4DS246DH2
Subject Title: Intelligent Systems and Applications

Credits: 4
Type: Theory

Course Pre-requisite:

- Fundamentals of Artificial Intelligence
- Programming Knowledge in Python
- Basic Concepts of Logic and Algorithms

Course Objectives:

Throughout the course, students will be expected to demonstrate their understanding of intelligent systems by being able to do each of the following:

• Understand the architecture and functioning of intelligent systems.
• Explore components such as sensors, actuators, agents, and environments.
• Learn design and development approaches for intelligent systems.
• Study real-life intelligent systems applications.
• Familiarize with AI-driven decision-making processes and adaptive systems.

Course Outcomes (Expected Outcome):

On completion of the course, the students will be able to:

1. Define intelligent systems and describe their core components.
2. Design agent-based models for intelligent decision-making.
3. Implement logic-based and rule-based intelligent systems.
4. Analyze adaptive systems using reinforcement and fuzzy logic.
5. Apply intelligent system techniques in robotics, IoT, and automation.
6. Evaluate real-world intelligent applications in various domains.

Syllabus:

Unit I: Introduction to Intelligent Systems (Hours: 07)
Definition and characteristics, Comparison with traditional systems, Types of intelligent systems, Intelligent agents and environments.

Unit II: Agent-Based Systems (Hours: 07)
Agent types (reflex, goal-based, utility-based), Multi-agent systems, Architecture of agent-based systems, Communication among agents.

Unit III: Rule-Based and Expert Systems (Hours: 07)
Rule representation, Inference mechanisms, Production systems, Knowledge-based expert systems, Forward and backward chaining.

Unit IV: Fuzzy Logic and Adaptive Systems (Hours: 07)
Fuzzy sets and operations, Fuzzy inference system, Applications of fuzzy logic, Basics of reinforcement learning, Feedback and learning loops.

Unit V: Intelligent System Applications in Robotics & IoT (Hours: 07)
Robotic perception and planning, Embedded intelligence, Sensor integration, Edge intelligence in IoT environments, Smart automation.

Unit VI: Case Studies and Emerging Applications (Hours: 07)
Intelligent healthcare systems, Smart transportation, E-commerce recommendation engines, Industrial automation, Smart cities.

Text Books:

1. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press.
2. Rajendra Akerkar, “Intelligence Systems”, PHI Learning.

Reference Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson.
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, McGraw Hill.

3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley.
4. Nils J. Nilsson, “Artificial Intelligence: A New Synthesis”, Morgan Kaufmann.
5. IEEE/ACM Case Studies on Intelligent Systems (Open Access Resources).

Track: Data Science (Honours / Double Minor)

SEM III	3DS245DH2	Data Science Foundations and Tools	4	Theory
SEM IV	4DS246DH2	Statistical Data Modelling and Inference	4	Theory

Syllabus

Subject Code: 3DS245DH2
Subject Title: Data Science Foundations and Tools
Credits: 4
Type: Theory

Course Pre-requisite:

- Computer Programming
- Basic Mathematics for Data Analysis

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of foundational concepts and tools in data science by being able to do each of the following:
• Understand the fundamental concepts and lifecycle of data science.
• Learn data wrangling, preprocessing, and cleaning techniques.
• Develop foundational Python skills for data analysis.
• Explore common data science libraries and tools.
• Work on real-world datasets using Jupyter Notebooks.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Define the scope, lifecycle, and goals of data science.
2. Perform basic data collection, exploration, and cleaning.
3. Use Python and its libraries for data manipulation and analysis.
4. Apply data visualization techniques using tools like Matplotlib and Seaborn.
5. Understand the role of data science in decision-making.
6. Build simple data-driven applications using open-source toolkits.

Syllabus:
Unit I: Introduction to Data Science (Hours: 07)
What is Data Science? Data science lifecycle, Roles (Data Analyst, Data Engineer, Data Scientist), Applications in different domains, Skills required for a data scientist.
Unit II: Python for Data Science (Hours: 07)
Python basics – variables, loops, conditionals, functions; Python libraries – NumPy, Pandas; DataFrames and Series; Reading and writing CSV/Excel/JSON files.
Unit III: Data Wrangling and Preprocessing (Hours: 07)
Handling missing data, Outliers, Encoding categorical variables, Feature scaling and transformation, String operations, Date-time handling.
Unit IV: Data Visualization (Hours: 07)

Introduction to Matplotlib and Seaborn, Histograms, Box plots, Pair plots, Heatmaps, Correlation matrices, Plot styling and labeling.

Unit V: Introduction to Databases and SQL (Hours: 07)

Relational database concepts, SQL queries (SELECT, JOIN, GROUP BY), Connecting Python with SQLite and MySQL using libraries.

Unit VI: Case Studies and Mini Project (Hours: 07)

Mini-project based on real-world dataset: health, social media, e-commerce, finance; Case studies demonstrating end-to-end data science workflows.

Text Books:

1. Joel Grus, "Data Science from Scratch", O'Reilly Media.
2. Wes McKinney, "Python for Data Analysis", O'Reilly Media.

Reference Books:

1. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly Media.
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow", O'Reilly.
3. Hadley Wickham, "R for Data Science", O'Reilly.
4. IBM Data Science Handbook (MOOC Resources).
5. Microsoft Learn and Kaggle Datasets for practice.

Subject Code: 4DS246DH2

Subject Title: Statistical Data Modelling and Inference

Credits: 4

Type: Theory

Course Pre-requisite:

- Data Science Foundations and Tools
- Applied Mathematics
- Probability and Basic Statistics

Course Objectives:

Throughout the course, students will be expected to demonstrate their understanding of statistical modeling and inference by being able to do each of the following:

• Understand the role of statistics in data-driven problem solving.
• Learn probability theory, distributions, and hypothesis testing.
• Develop skills for statistical inference and regression modeling.
• Apply linear and logistic regression for real-world data analysis.
• Interpret and communicate statistical findings effectively.

Course Outcomes (Expected Outcome):

On completion of the course, the students will be able to:

1. Understand core concepts of probability and statistical reasoning.
2. Apply descriptive and inferential statistics to analyze data.
3. Formulate and test hypotheses using appropriate statistical methods.
4. Build and evaluate linear and logistic regression models.
5. Work with real-world data using statistical software tools.
6. Interpret statistical results and communicate insights effectively.

Syllabus:

Unit I: Probability and Random Variables (Hours: 07)
Basic probability theory, Conditional probability, Bayes' theorem, Random variables (discrete & continuous), Expectation and variance.
Unit II: Probability Distributions (Hours: 07)
Common distributions: Binomial, Poisson, Normal, Exponential; Central Limit Theorem; Applications in modeling real-world events.
Unit III: Statistical Inference (Hours: 07)
Sampling, Point and interval estimation, Confidence intervals, Properties of estimators, Law of large numbers.

Unit IV: Hypothesis Testing (Hours: 07)
Null and alternative hypotheses, Type I and II errors, p-values, z-test, t-test, Chi-square test, ANOVA; Application scenarios.
Unit V: Regression Modelling (Hours: 07)
Simple and multiple linear regression, Model assumptions, Goodness-of-fit (R^2, Adjusted R^2), Multicollinearity, Residual analysis.
Unit VI: Logistic Regression and Applications (Hours: 07)
Binary classification, Odds and log-odds, Maximum likelihood estimation, ROC curve and AUC, Real-life applications and case studies.

Text Books:
1. Douglas C. Montgomery & George C. Runger, "Applied Statistics and Probability for Engineers", Wiley.
2. Larry Wasserman, "All of Statistics: A Concise Course in Statistical Inference", Springer.

Reference Books:
1. Allen B. Downey, "Think Stats: Probability and Statistics for Programmers", O'Reilly.
2. Freedman, Pisani, Purves, "Statistics", Norton.
3. Joseph Schmuller, "Statistical Analysis with Excel for Dummies", Wiley.
4. William Mendenhall et al., "Introduction to Probability and Statistics", Cengage.
5. JASP and R (Software Tools for Statistical Analysis – Open Source)

Artificial Intelligence & Data Science

Track: Blockchain Technologies (Honours / Double Minor)

SEM III	3AD245DH1	Foundations of Blockchain	4	Theory
SEM IV	4AD246DH1	Smart Contracts and DApps	4	Theory

Syllabus

Subject Code: 3AD245DH1
Subject Title: Foundations of Blockchain
Credits: 4
Type: Theory

Course Pre-requisite:
- Basics of Computer Networks

- Cryptography fundamentals
- Programming logic and data structures

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of blockchain fundamentals by being able to do each of the following:
• Understand the principles and architecture of blockchain technology.
• Explore key cryptographic and consensus mechanisms that support blockchain.
• Examine the structure and functionality of distributed ledgers.
• Analyze the role of blockchain in ensuring transparency, immutability, and security.
• Study real-world use cases and limitations of blockchain systems.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Describe the foundational components of blockchain architecture.
2. Explain the significance of cryptographic tools in securing blockchain transactions.
3. Differentiate between public, private, and permissioned blockchains.
4. Evaluate consensus mechanisms such as PoW, PoS, and alternatives.
5. Identify use cases and application areas of blockchain across industries.
6. Critically analyze the challenges and future potential of blockchain technologies.

Syllabus:

Unit I: Introduction to Blockchain (Hours: 07)
Definition, origin, and history of blockchain; Evolution of decentralized systems; Characteristics – transparency, decentralization, immutability; Blockchain vs traditional databases.

Unit II: Cryptographic Foundations (Hours: 07)
Public key cryptography, Hash functions (SHA-256), Digital signatures, Merkle trees; Importance of cryptography in blockchain security.

Unit III: Distributed Ledgers and Blockchain Architecture (Hours: 07)
Ledger structures, Blocks and chains, P2P network architecture, Nodes and mining, Blockchain forks, Block propagation and validation.

Unit IV: Consensus Mechanisms (Hours: 07)
Proof of Work (PoW), Proof of Stake (PoS), Delegated PoS, Practical Byzantine Fault Tolerance (PBFT), and emerging consensus models.

Unit V: Blockchain Types and Platforms (Hours: 07)
Public vs Private vs Consortium blockchain; Overview of Ethereum, Hyperledger Fabric, Corda, and Solana.

Unit VI: Blockchain Use Cases and Challenges (Hours: 07)
Applications in finance, supply chain, healthcare, identity management; Scalability, security, energy consumption, legal and ethical issues; Future directions in blockchain.

Text Books:

1. Arvind Narayanan et al., “Bitcoin and Cryptocurrency Technologies”, Princeton University Press.
2. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O'Reilly Media.

Reference Books:

1. Imran Bashir, “Mastering Blockchain”, Packt Publishing.
2. Josh Thompsons, “Blockchain Basics: A Non-Technical Introduction”, CreateSpace.
3. Andreas M. Antonopoulos, “Mastering Bitcoin”, O’Reilly Media.
4. Don Tapscott & Alex Tapscott, “Blockchain Revolution”, Portfolio Penguin.
5. Hyperledger Fabric & Ethereum Official Documentation.

Subject Code: 4AD246DH1
Subject Title: Smart Contracts and DApps
Credits: 4
Type: Theory

Course Pre-requisite:

- Foundations of Blockchain
- Basic knowledge of programming (preferably Python or JavaScript)
- Introduction to Ethereum and decentralized architecture

Course Objectives:

Throughout the course, students will be expected to demonstrate their understanding of smart contracts and decentralized applications (DApps) by being able to do each of the following:

• Understand the principles and lifecycle of smart contracts.
• Develop smart contracts using Solidity on the Ethereum blockchain.
• Design and deploy decentralized applications using blockchain platforms.
• Explore the interaction between front-end applications and blockchain back-end.
• Evaluate DApps from security, scalability, and usability perspectives.

Course Outcomes (Expected Outcome):

On completion of the course, the students will be able to:

1. Understand the architecture and lifecycle of smart contracts.
2. Develop, test, and deploy smart contracts using Solidity and related tools.
3. Create functional DApps using front-end and blockchain integrations.
4. Utilize Ethereum-based tools like Truffle, Ganache, and MetaMask.
5. Analyze the potential vulnerabilities and challenges in smart contract design.
6. Apply blockchain-based applications to real-world use cases.

Syllabus:

Unit I: Introduction to Smart Contracts (Hours: 07)
What are smart contracts? Key characteristics and benefits; Use cases; Limitations and legal implications; Smart contract platforms.
Unit II: Ethereum Ecosystem and Solidity Basics (Hours: 07)
Ethereum Virtual Machine (EVM), Gas mechanism; Introduction to Solidity syntax, data types, functions, contracts, and events.
Unit III: Smart Contract Development and Testing (Hours: 07)
Structs, modifiers, inheritance, libraries, mappings; Contract deployment using Remix IDE; Unit testing with Mocha/Chai and Truffle framework.
Unit IV: Decentralized Applications (DApps) (Hours: 07)
Architecture of DApps – front-end, smart contract, and blockchain layers; Web3.js and Ethers.js; Wallets and interactions using MetaMask.
Unit V: Advanced Concepts and Use Cases (Hours: 07)
Oracles and Chainlink, Inter-contract communication, Upgradable contracts, DAO (Decentralized Autonomous Organization), Token standards (ERC-20, ERC-721).
Unit VI: Security and Best Practices (Hours: 07)
Common vulnerabilities (reentrancy, overflows, denial of service); Security tools and audits; Best practices for smart contract development and deployment.

Text Books:

1. Andreas M. Antonopoulos and Gavin Wood, “Mastering Ethereum”, O’Reilly Media.

2. Narayan Prusty, “Building Blockchain Projects”, Packt Publishing.

Reference Books:

1. Ritesh Modi, “Solidity Programming Essentials”, Packt.
2. Kevin Solorio, Randall Kanna, David Hoover, “Hands-On Smart Contract Development with Solidity and Ethereum”, O'Reilly.
3. Ethereum and Solidity Official Documentation.
4. Truffle Suite Documentation.
5. OpenZeppelin Smart Contract Security Guidelines.

Track: Generative AI (Honours / Double Minor)

SEM III	3AD245DH2	Introduction to Generative AI	4	Theory
SEM IV	4AD246DH2	Foundation Models and Transfer Learning	4	Theory

Syllabus

Subject Title: Introduction to Generative AI
Subject Code: 3AD245DH2
Semester: III

Credits: 4
Type: Theory

Course Pre-requisite:

- Fundamentals of Artificial Intelligence
- Python Programming
- Basic Linear Algebra and Probability

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of generative models by being able to do each of the following:
• Understand the fundamentals and types of generative models.
• Explore mathematical foundations behind generative AI techniques.
• Study architectures such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs).
• Analyze the applications of generative AI in creative industries, healthcare, and NLP.
• Introduce tools and platforms commonly used in building generative models.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Define and differentiate between discriminative and generative models.
2. Explain the architecture and training process of VAEs and GANs.
3. Apply generative models for image, audio, and text generation.
4. Understand loss functions and optimization techniques for generative models.
5. Describe real-world use cases of generative AI in various sectors.
6. Get hands-on experience with libraries like TensorFlow, PyTorch, and HuggingFace.

Syllabus:

Unit I: Fundamentals of Generative Models (Hours: 07)
Introduction to Generative AI; Discriminative vs. Generative Models; Overview of unsupervised learning; Introduction to latent space representation.
Unit II: Mathematical Foundations (Hours: 07)
Probability theory, KL divergence, Bayesian inference, Maximum likelihood estimation; Optimization methods: SGD, Adam.
Unit III: Variational Autoencoders (VAEs) (Hours: 07)
Architecture of VAEs; Encoder-Decoder Framework; Reparameterization trick; Loss functions; Applications in image reconstruction.
Unit IV: Generative Adversarial Networks (GANs) (Hours: 07)
GAN architecture; Generator and Discriminator; Training dynamics; Common issues (mode collapse, convergence); DCGAN and conditional GANs.
Unit V: Applications of Generative AI (Hours: 07)
Image synthesis, Text generation, Music & art generation, DeepFakes, Data augmentation, Medical imaging applications.
Unit VI: Tools, Libraries and Trends (Hours: 07)
TensorFlow, PyTorch, HuggingFace, OpenAI APIs; Google Colab for experimentation; Ethical considerations and safety in generative AI.

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press.
2. David Foster, *Generative Deep Learning*, O'Reilly Media.

Reference Books:

1. Francois Chollet, *Deep Learning with Python*, Manning.
2. Sebastian Raschka, *Machine Learning with PyTorch and Scikit-Learn*, Packt.
3. Carl Doersch, *Tutorial on Variational Autoencoders*.
4. Papers from arXiv.org on GANs and VAEs.
5. HuggingFace and TensorFlow official documentation.

Subject Title: Foundation Models and Transfer Learning
Subject Code: 4AD246DH2
Semester: IV
Credits: 4
Type: Theory

Course Pre-requisite:

- Introduction to Generative AI
- Deep Learning Fundamentals
- Knowledge of Python and ML libraries (PyTorch/TensorFlow)

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of foundation models and transfer learning by being able to:
• Understand the concept and architecture of foundation models.
• Explore techniques in transfer learning, fine-tuning, and domain adaptation.
• Study the impact of large-scale pretraining in NLP and vision.
• Analyze transformer-based architectures and their applications.
• Work with APIs and platforms offering pre-trained models.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Explain what foundation models are and their role in modern AI systems.
2. Understand transformer architecture and pretraining techniques.
3. Apply transfer learning approaches like feature extraction and fine-tuning.
4. Use pretrained models for NLP, vision, and multimodal tasks.
5. Identify the trade-offs and challenges in deploying foundation models.
6. Experiment with models like BERT, GPT, and CLIP using open-source tools.

Syllabus:

Unit I: Introduction to Foundation Models (Hours: 07)
Definition, characteristics, and emergence; Pretraining and generalization; Examples: BERT, GPT, DALL·E, T5.

Unit II: Transformer Architecture (Hours: 07)
Attention mechanisms, self-attention, multi-head attention; Position encoding; Encoder-decoder models.

Unit III: Transfer Learning Techniques (Hours: 07)
Feature-based vs. fine-tuning approaches; Domain adaptation; Few-shot and zero-shot learning.

Unit IV: NLP Applications using Foundation Models (Hours: 07)
Text summarization, question answering, translation, sentiment analysis; HuggingFace Transformers; GPT-2/3 use cases.

Unit V: Vision and Multimodal Models (Hours: 07)
Vision Transformers (ViT), CLIP, DALL·E, BLIP; Pretrained models for image classification and captioning.

Unit VI: Tools, APIs and Deployment (Hours: 07)
HuggingFace, OpenAI, Google's T5 and PaLM APIs; Model evaluation, prompt engineering basics; Model cards and ethical considerations.

Text Books:

1. Thomas Wolf et al., *Transformers for Natural Language Processing*, O'Reilly.
2. Kevin Murphy, *Probabilistic Machine Learning: Advanced Topics*, MIT Press.

Reference Books:

1. Vaswani et al., *Attention is All You Need*, NeurIPS 2017.
2. Sebastian Ruder, *Transfer Learning Tutorial Series*.
3. Papers with Code: https://paperswithcode.com
4. HuggingFace Documentation and Model Hub
5. OpenAI API Docs and Research Papers

Computer Engineering

Track: Internet of Things (IoT) (Honours / Double Minor)

SEM III	3KE245DH1	Fundamentals of IoT and Smart Devices	4	Theory
SEM IV	4KE246DH1	IoT Architectures and Communication Protocols	4	Theory

Syllabus

Subject Code: 3KE245DH1

Subject Title: Fundamentals of IoT and Smart Devices
Semester: III
Credits: 4
Type: Theory

Course Pre-requisite:
Basic knowledge of electronics, computer fundamentals, and programming (C/Python preferred).

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of IoT and smart device fundamentals by being able to:
• Understand the scope, applications, and components of the Internet of Things (IoT).
• Study the architecture of IoT systems including sensors, actuators, and microcontrollers.
• Learn basic interfacing of hardware with software platforms.
• Develop foundational skills in device communication and control.
• Explore examples of smart devices in real-world IoT ecosystems.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:
1. Describe the structure and applications of IoT in different domains.
2. Identify the basic components of IoT systems (hardware and software).
3. Understand the functioning of sensors, actuators, and microcontrollers.
4. Interface simple sensors and output devices with a controller.
5. Build and simulate simple IoT projects using open-source platforms.
6. Analyze data collection and basic decision logic in smart devices.

Syllabus:
Unit I: Introduction to IoT (Hours: 07)
Definition, history and evolution, characteristics, trends, and applications of IoT in smart homes, agriculture, healthcare, and industry.
Unit II: IoT Building Blocks (Hours: 07)
Core elements: Things, Gateways, Network, Cloud, Data Analytics; Sensors and actuators, Edge devices, Microcontrollers (Arduino, NodeMCU).
Unit III: Microcontrollers and Embedded Systems (Hours: 07)
Architecture of microcontrollers, Introduction to Arduino/Raspberry Pi/ESP32, GPIO programming, working with development boards.
Unit IV: Sensor Interfacing and Data Acquisition (Hours: 07)
Types of sensors (temperature, light, proximity, humidity), analog/digital signal basics, ADC, sensor calibration, I/O programming.
Unit V: Actuators and Device Control (Hours: 07)
DC motors, servo motors, buzzers, relays, and display devices. Basic interfacing for real-time output.
Unit VI: Smart Devices and Project Demonstrations (Hours: 07)
Designing simple smart devices (e.g., smart light, smart fan), logic implementation, data flow from sensor to actuator, simulation using platforms like Tinkercad or Proteus.

Text Books:
1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press.
2. Raj Kamal, *Internet of Things: Architecture and Design*, McGraw Hill.

Reference Books:
1. Jan Holler et al., *From Machine-to-Machine to the Internet of Things*, Elsevier.

2. Pethuru Raj & Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press.
3. Marco Schwartz, *Internet of Things with the Arduino Yun*, Packt.
4. Michael Margolis, *Arduino Cookbook*, O'Reilly.
5. Tutorials and datasheets from Arduino.cc and Espressif.com.

Subject Code: 4KE246DH1
Subject Title: IoT Architectures and Communication Protocols
Semester: IV
Credits: 4
Type: Theory
Course Pre-requisite:
Fundamentals of IoT and Smart Devices, Basic Networking Concepts.

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of IoT system architectures and communication protocols by being able to:
• Understand layered architectures and functional models in IoT.
• Explore key wireless and wired communication protocols used in IoT.
• Study device-to-device and device-to-cloud communication patterns.
• Analyze protocol stacks such as MQTT, CoAP, HTTP, LoRaWAN.
• Investigate standards, interoperability, and protocol selection for use-case-driven IoT systems.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:
1. Explain the different layers and models used in IoT architectures.
2. Differentiate between various IoT communication protocols.
3. Design basic communication flows for device-to-device/cloud interaction.
4. Use lightweight protocols (MQTT/CoAP) in real-time data applications.
5. Understand the challenges in protocol selection for scalable IoT systems.
6. Apply interoperable protocol stacks in constrained networks.

Syllabus:
Unit I: IoT System Architectures (Hours: 07)
IoT reference architecture (three-layer, five-layer, and service-oriented), Functional view, Application view, Deployment view, Fog and edge layers.
Unit II: Networking Basics for IoT (Hours: 07)
OSI & TCP/IP models, MAC addressing, IPv4 vs IPv6, Routing in IoT, Network topologies and QoS issues.
Unit III: Wireless Communication Protocols (Hours: 07)
Wi-Fi, Bluetooth/BLE, Zigbee, LoRa, NB-IoT, RFID/NFC – working, pros/cons, and use-case suitability.
Unit IV: Device Communication Protocols (Hours: 07)
Serial communication (UART, I2C, SPI), Device-to-device, Sensor-actuator messaging, data bus communication.
Unit V: Application Layer Protocols (Hours: 07)
HTTP, MQTT, CoAP – features, comparison, RESTful APIs, protocol stacks for low-power networks.
Unit VI: Security and Interoperability in Protocols (Hours: 07)
Protocol vulnerabilities, Transport Layer Security (TLS), Interoperability challenges in heterogeneous IoT, protocol standardization efforts (IETF, IEEE, W3C).

Text Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things: Key Applications and Protocols*, Wiley.
2. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press.

Reference Books:

1. Raj Kamal, *Internet of Things: Architecture and Design*, McGraw Hill.
2. Pethuru Raj, Anupama Raman, *The Internet of Things: Enabling Technologies*, CRC Press.
3. Jan Holler et al., *From Machine-to-Machine to the Internet of Things*, Elsevier.
4. MQTT.org and CoAP documentation (IETF RFCs).
5. Cisco IoT Whitepapers & Protocol Stack Guidelines.

Track: Edge Computing (Honours / Double Minor)

SEM III	3KE245DH2	Introduction to Edge and Fog Computing	4	Theory
SEM IV	4KE246DH2	Edge Devices and Embedded Systems	4	Theory

Syllabus

Subject Code: 3KE245DH2
Subject Title: Introduction to Edge and Fog Computing

Semester: III
Credits: 4
Type: Theory

Course Pre-requisite:
Computer Fundamentals, Basics of Networking and Cloud Computing

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of edge and fog computing by being able to do each of the following:
• Understand the need for edge and fog computing as an extension of cloud computing.
• Explore architectures, key technologies, and components involved.
• Compare edge, fog, and cloud paradigms for latency-sensitive applications.
• Identify challenges, trends, and research directions.
• Analyze various use cases where edge/fog computing is applicable.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Explain the evolution from cloud to edge and fog computing.
2. Understand the architecture and components of edge and fog systems.
3. Evaluate the performance and trade-offs of edge/fog vs cloud computing.
4. Identify key technologies supporting edge and fog computing.
5. Apply edge/fog paradigms to real-world applications.
6. Analyze challenges and future directions in edge computing.

Syllabus:
Unit I: Fundamentals of Edge and Fog Computing (Hours: 07)
Introduction to distributed computing paradigms, Edge vs Cloud, Fog vs Edge, Importance of low-latency processing, Real-time analytics.

Unit II: Edge and Fog Architectures (Hours: 07)
Architectural models – layered and hierarchical, Cisco Fog computing model, OpenFog Consortium Reference Architecture, Edge gateways and micro data centers.
Unit III: Key Technologies and Platforms (Hours: 07)
IoT devices and sensors, Edge AI and ML, Virtualization (VMs, containers), Edge orchestration platforms (KubeEdge, EdgeX Foundry, Azure IoT Edge).
Unit IV: Communication Protocols and Standards (Hours: 07)
MQTT, CoAP, HTTP/HTTPS, BLE, Zigbee, 5G for edge, SDN/NFV in edge networks, Interoperability.
Unit V: Use Cases and Applications (Hours: 07)
Smart cities, Industrial IoT, Healthcare, Autonomous vehicles, Video surveillance, Retail and edge analytics.
Unit VI: Challenges and Research Trends (Hours: 07)
Security and privacy at the edge, Data management, Scalability, Energy efficiency, Standardization efforts, Emerging trends (serverless edge, federated learning).

Text Books:
1. Flavio Bonomi et al., *Fog Computing: A Platform for Internet of Things and Analytics*, Wiley.
2. Rajkumar Buyya, Satish Narayana Srirama, *Fog and Edge Computing: Principles and Paradigms*, Wiley.

Reference Books:
1. Tom Laszewski et al., *Cloud and Edge Computing*, Packt.
2. Perry Lea, *Internet of Things for Architects*, Packt.
3. Weisong Shi, Schahram Dustdar, *Edge Computing in the Internet of Things*, Springer.
4. Tutorials on EdgeX Foundry, Azure IoT Edge, KubeEdge (official docs).
5. IEEE papers and OpenFog Consortium whitepapers.

Subject Code: 4KE246DH2
Subject Title: Edge Devices and Embedded Systems

Semester: IV
Credits: 4
Type: Theory

Course Pre-requisite:
Fundamentals of IoT, Introduction to Edge and Fog Computing, Basics of Digital Electronics

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of edge devices and embedded systems by being able to do each of the following:
• Understand the architecture and functioning of edge devices and embedded systems.
• Interface sensors and actuators with microcontrollers.
• Learn real-time data acquisition, processing, and transmission at the edge.
• Explore development environments and platforms for embedded applications.
• Build foundational skills for developing embedded and edge-enabled smart systems.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:
1. Explain the role and structure of embedded systems in edge computing.
2. Interface hardware components and implement real-time edge solutions.
3. Develop software for microcontrollers and edge devices.

4. Utilize development platforms like Arduino, Raspberry Pi, ESP32.
5. Analyze performance constraints in embedded edge environments.
6. Design basic edge applications integrating embedded hardware and software.

Syllabus:

Unit I: Introduction to Embedded Systems and Edge Devices (Hours: 07)
Definition and characteristics of embedded systems, Real-time systems, Role in edge computing, Classification of edge devices (Arduino, Raspberry Pi, ESP8266, Jetson Nano).

Unit II: Microcontroller and Processor Architecture (Hours: 07)
Microcontrollers vs microprocessors, ARM architecture, GPIOs, Timers, ADC, Interrupts, Memory hierarchy in edge devices.

Unit III: Sensor and Actuator Interfaces (Hours: 07)
Analog and digital sensors, Interfacing methods (I2C, SPI, UART), Actuator control (motors, relays), Real-world sensing for edge analytics.

Unit IV: Embedded Programming and OS (Hours: 07)
Embedded C and Python basics, Programming microcontrollers (Arduino IDE, MicroPython), Lightweight OS for edge (RIOT, FreeRTOS, TinyOS).

Unit V: Communication and Connectivity (Hours: 07)
Wired and wireless interfaces, Bluetooth, Wi-Fi, LoRa, Zigbee, Integration with cloud/edge platforms (Node-RED, MQTT brokers, Firebase).

Unit VI: Applications and Case Studies (Hours: 07)
Use cases: Smart home, Smart grid, Industrial automation, Wearables, Hands-on project ideas using embedded systems and edge communication.

Text Books:

1. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, McGraw Hill.
2. John Catsoulis, *Designing Embedded Hardware*, O'Reilly.

Reference Books:

1. Muhammad Ali Mazidi, *AVR Microcontroller and Embedded Systems*, Pearson.
2. Lyla B. Das, *Embedded Systems – An Integrated Approach*, Pearson.
3. Jonathan Valvano, *Embedded Systems: Real-Time Interfacing*, CreateSpace.
4. Arduino & Raspberry Pi Official Guides and Community Documentation.
5. IEEE articles on IoT/Embedded & Edge Integration.

Open Electives I , II and III

- **Computer Science and Engineering**
- **Computer Engineering**
- **Computer Science and Engineering (Data Science)**
- **Artificial Intelligence and Data Science**

Open Elective I: 3CS206OE1/2 | 3KE206OE1/2 | 3DS206OE1/2 | 3AD206OE1/2

i. Basics of Computing for Engineers ii. E-Commerce

Open Elective II: 4CS216OE1/2 | 4KE216OE1/2 | 4DS216OE1/2 | 4AD216OE1/2

i. Intellectual Property Rights ii. Information Systems for Engineers

Open Elective III: 5CS230OE1/2 | 5KE230OE1/2 | 5DS230OE1/2 | 5AD230OE1/2

i. Cyber Laws and Ethics ii. Introduction to Data Analytics

Subject Title: Basics of Computing for Engineers
Subject Code: 3CS206OE1 / 3KS206OE1 / 3DS206OE1 / 3AD206OE1
Semester: III | **Type**: Theory | **Credits**: 3
Total Contact Hours: 45 Hours

Pre-requisites:

- Basic understanding of mathematical logic and problem-solving.
- Familiarity with basic operations on a computer (keyboard, file handling, browsing).
- General curiosity towards technology and engineering applications.

Course Objectives:

- To introduce the fundamentals of computing and its applications across engineering domains.
- To familiarize students with core computing concepts such as data, logic, programming, and storage.
- To provide hands-on understanding of basic programming logic and computational thinking.
- To help students develop problem-solving skills using algorithms and flowcharts.
- To relate computing applications with real-life engineering challenges and tools.

Course Outcomes (COs):

After completing this course, students will be able to:

1. Understand the role of computing in modern engineering practices.
2. Apply basic logical reasoning and computational thinking to solve simple engineering problems.
3. Interpret data and operations using flowcharts, pseudo-code, and basic algorithms.
4. Recognize various computing tools used in engineering industries.
5. Appreciate ethical and societal implications of computing.

Syllabus:

Unit 1: Introduction to Computers & Computing (8 Hours)

Evolution and Applications of Computers in Engineering, Components of a Computer System: Hardware & Software, Operating Systems Basics (Windows/Linux), Introduction to Data, Binary Systems, and Memory Hierarchy, Role of Computers in Engineering Domains (CAD, CAM, Simulation, etc.).

Unit 2: Fundamentals of Programming & Logic Building (8 Hours)
Understanding Algorithms and Flowcharts, Variables, Constants, Data Types, Input/Output, Arithmetic and Logical Operators, Control Structures: if-else, loops (for, while), Problem Solving with Simple Pseudocode Examples.

Unit 3: Introduction to Computational Thinking (8 Hours)
What is Computational Thinking?, Abstraction, Decomposition, Pattern Recognition, Algorithm Design, Case Studies of Computational Thinking in Civil, Mechanical, and Electrical Engineering Real-World Examples using Block-Based Programming (e.g., Scratch or Blockly),

Unit 4: Data & File Management in Engineering (7 Hours)
Understanding Structured vs Unstructured Data, File Handling Basics (Creating, Reading, Writing Files), Data Representation (Tables, Graphs, Charts), Applications: Excel, Google Sheets, Data Logging in Labs.

Unit 5: Overview of Programming Tools & Environments (7 Hours)
Common Engineering Programming Tools (Python, MATLAB, Excel Macros), Introduction to Online IDEs, Simulators, and AutoCAD Programming, Cloud-Based Tools for Engineers (e.g., Google Colab, Replit), Software Tools in Design and Simulation.

Unit 6: Ethical and Professional Aspects of Computing (7 Hours)
Digital Citizenship and Responsible Use of Technology, Data Privacy, Cyber Ethics and Safety Open Source Software and Licensing, Introduction to Engineering Software Lifecycle & Automation, Relevance of Computing in Sustainable Engineering Practices.

CO-PO Mapping Table:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	3					2		2
CO2	2	3		2	3			2
CO3	2	3		3	3		2	
CO4		2			3		2	2
CO5						3	2	2

Textbook(s):

1. **"Computing Fundamentals and Programming in C"** – E. Balagurusamy, McGraw Hill Education, 2018
2. **"Let Us Compute"** – P. K. Sinha, BPB Publications, 2020

Reference Books:

1. **"Computational Thinking for the Modern Problem Solver"**, David D. Riley and Kenny A. Hunt, CRC Press, 2014
2. **"Python Programming for the Absolute Beginner"**, Michael Dawson, Cengage Learning, 2010
3. **"Introduction to Computation and Programming Using Python"**, John Guttag, MIT Press, 2016
4. **"Digital Fundamentals"**, Thomas L. Floyd, Pearson Education, 11th Edition
5. **"Introduction to Computers"**, Peter Norton, McGraw Hill Education, 7th Edition
6. **"Computational Thinking: A Beginner's Guide to Problem Solving and Programming"**, Karl Beecher, BCS Learning, 2017

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Subject Title: E-Commerce
Subject Code: 3CS206OE2 / 3KS206OE2 / 3DS206OE2 / 3AD206OE2
Semester: III | **Type**: Theory | **Credits**: 3
Total Contact Hours: 45 Hours
Pre-requisites:

- Basic knowledge of the Internet and Computers.
- General awareness of business and commerce.

Course Objectives:

- To introduce students to E-Commerce and its applications in modern business.
- To help students understand different types of online businesses and digital transactions.
- To familiarize students with online payment systems and digital security.
- To explore how technology supports E-Commerce, including mobile commerce and digital marketing.
- To discuss ethical, legal, and security aspects of E-Commerce.
- To provide an overview of future trends and career opportunities in the E-Commerce industry.

Course Outcomes (COs):
After completing this course, students will be able to:

1. Explain the basic concepts of E-Commerce and its significance.
2. Identify different types of online business models and their applications.
3. Understand digital payment methods and their security aspects.
4. Analyze the impact of digital marketing and online customer engagement.
5. Recognize legal, ethical, and cybersecurity challenges in E-Commerce.
6. Explore career opportunities and emerging trends in E-Commerce.

Syllabus:

UNIT 1: Introduction to E-Commerce (7 Hours)
Definition and Scope of E-Commerce, Advantages and Challenges of E-Commerce, Traditional vs. Digital Business, Popular E-Commerce Platforms (Amazon, Flipkart, Alibaba, etc.), Impact of E-Commerce on Society and Business

UNIT 2: E-Commerce Business Models & Online Marketplaces (8 Hours)
Types of E-Commerce Businesses (B2B, B2C, C2C, D2C, etc.), How Online Marketplaces Work (Amazon, eBay, Meesho, etc.), Selling Products and Services Online, Role of Small Businesses & Startups in E-Commerce, E-Commerce in Different Sectors (Retail, Education, Healthcare, etc.)

UNIT 3: Digital Payments and Security (7 Hours)
Overview of Online Payment Methods (UPI, Debit/Credit Cards, Digital Wallets), How Payment Gateways Work (Google Pay, PayPal, Razorpay, etc.), Security Concerns in Online Transactions, Best Practices for Safe Online Shopping, Case Study: Digital Payment Success in India (UPI, RuPay, etc.)

UNIT 4: Digital Marketing & Customer Engagement (7 Hours)
What is Digital Marketing?, Role of Social Media in E-Commerce (Facebook, Instagram, LinkedIn, etc.), Basics of Search Engine Optimization (SEO) & Online Advertising, How Businesses Use Email & Influencer Marketing, Customer Feedback & Personalization in E-Commerce

UNIT 5: Legal, Ethical & Cybersecurity Issues in E-Commerce (8 Hours)
Consumer Rights in Online Shopping, E-Commerce Laws & Regulations (IT Act, Consumer Protection Laws, etc.), Cybersecurity Threats (Hacking, Phishing, Data Privacy Issues), Ethical

Concerns in Online Business (Fake Reviews, Data Privacy), How to Protect Yourself While Shopping Online

UNIT 6: Emerging Trends & Career Opportunities in E-Commerce (8 Hours)
Growth of Mobile Commerce (M-Commerce), The Future of E-Commerce (AI, Augmented Reality, Metaverse), E-Commerce and Logistics (Online Delivery & Warehousing), Starting Your Own Online Business (Basic Steps & Challenges), Career Paths in E-Commerce (Marketing, Business, Technology Roles)

Textbooks:

"E-Commerce: Fundamentals and Applications", *Henry Chan and Raymond Lee*, **John Wiley & Sons**, 2001

Reference Books:

1. **"E-Commerce and Digital Business" ,** *D. G. Harkut, K. N. Kasat,* **Notion Press, 2025.**
2. **"E-Commerce Essentials"**, *Kenneth C. Laudon, Carol Guercio Traver*, **Pearson Education**, 2014
3. **"Electronic Commerce 2018: A Managerial and Social Networks Perspective"**, *Efraim Turban, Jon Outland, David King, Jae Lee, Ting-Peng Liang*, **Springer**, 2018
4. **"Digital Marketing for Dummies"**, *Ryan Deiss, Russ Henneberry*, **John Wiley & Sons**, 2020
5. **"Click Millionaires: Work Less, Live More with an Internet Business You Love"**, *Scott Fox*, **AMACOM**, 2012
6. **"Cybersecurity and Cyberlaw"**, *Pavan Duggal*, **Universal Law Publishing**, 2019
7. **"The E-Commerce Book: About a Channel that Became an Industry"**, *Alexander Graf, Holger Schneider*, **Independently published**, 2021

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Subject Title: Intellectual Property Rights
Subject Code: 4CS216OE1 / 4KE216OE1 / 4DS216OE1 / 4AD216OE1
Semester IV | Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 Hours

Course Prerequisite:
Basic understanding of communication skills, general ethics, and awareness of creative work (projects, research, design, coding, etc.)

Course Objectives:
- To provide students with foundational knowledge of Intellectual Property Rights (IPR) and their significance in innovation and research.
- To introduce different forms of intellectual properties such as patents, copyrights, trademarks, and designs.
- To create awareness about the legal and ethical aspects of protecting intellectual creations and innovations in engineering and beyond.

Course Outcomes:
On successful completion of the course, students will be able to:
1. Explain the significance of intellectual property in research, development, and innovation.
2. Identify various types of intellectual property and understand their application in different domains.

3. Demonstrate basic knowledge of procedures involved in protecting intellectual property and the roles of regulatory bodies.
4. Relate IPR knowledge to their project work, industrial applications, and entrepreneurship.

Syllabus:

Unit I: Introduction to Intellectual Property Rights (8 Hours)
Creativity, Innovation, and their Role in Development, What is Intellectual Property?, Types of Intellectual Property: Patents, Copyrights, Trademarks, Trade Secrets, Industrial Designs, and Geographical Indications, Importance of IPR in Engineering, Research, Startups, and Academia, Examples and Case Studies from various engineering disciplines.

Unit II: Patent, Copyright, and Design Protection (7 Hours)
Patent: What can be patented? Basic criteria (novelty, utility, non-obviousness), Simple steps of Patent Filing in India, Use of patents in project work or research, **Copyright**: For literature, music, software codes, and digital content, **Industrial Design**: Protection of new designs and their aesthetic value, Ownership, Licensing, and Rights of Creators.

Unit III: Trademarks, Geographical Indications & IPR in the Digital Era (7 Hours)
Trademarks: Brand names, logos, slogans – importance in business and marketing, **Geographical Indications**: Indian examples (e.g., Darjeeling Tea, Nagpur Orange), Role of IPR in Startups and Product Commercialization, Government Initiatives: National IPR Policy 2016, Startup India, Atmanirbhar Bharat, Career Opportunities in IPR, Case Studies and Recent Trends.

Text Books:
1. K. V. Nithyananda (2019), "Intellectual Property Rights: Protection and Management", Cengage Learning India.
2. P. Neeraj and D. Khusdeep (2014), "Intellectual Property Rights", PHI Learning.

Reference Books:
1. Deborah E. Bouchoux, "Intellectual Property for Paralegals", 4th Edition, Cengage Learning, 2012.
2. M. M. S. Karki, "Intellectual Property Rights: Basic Concepts", Atlantic Publishers, 2009.
3. V. K. Ahuja, "Law relating to Intellectual Property Rights", Lexis Nexis, 2017.
4. Prabuddha Ganguli, "Intellectual Property Rights – Unleashing the Knowledge Economy", Tata McGraw Hill, 2001.

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Subject Title: Information Systems for Engineers
Subject Code: 4CS216OE2 / 4KE216OE2 / 4DS216OE2 / 4AD216OE2
Semester IV | Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 Hours

Prerequisites:
- Basic understanding of engineering processes and workplace practices.
- Familiarity with computer usage and basic productivity tools (Word, Excel, etc.).

Course Objectives:
1. To introduce the fundamental concepts of Information Systems (IS) and their relevance in engineering and business domains.
2. To explore how engineers can use IS for decision-making, automation, and efficiency.

3. To familiarize students with various types of information systems including MIS, ERP, and industrial systems.
4. To understand the challenges, risks, and future trends associated with the implementation of MIS.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

1. Understand the basic structure and components of Information Systems used in engineering.
2. Identify and evaluate applications of Information Systems across different engineering disciplines.
3. Demonstrate understanding of ERP, MIS, and database systems and their integration with engineering workflows.

Unit-wise Syllabus:

Unit 1: Basics of Information Systems in Engineering (7–8 Hours)

Introduction to Information Systems: Definition, Need, and Importance, Components of IS: Hardware, Software, Data, People, Processes, Types of IS: Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS), Role of IS in different Engineering Domains (Manufacturing, Civil, Electrical, etc.).

Unit 2: Enterprise Systems and Engineering Applications (7–8 Hours)

Overview of Enterprise Resource Planning (ERP) Systems, Functional Modules in ERP: Finance, Production, Inventory, HR, Industrial Automation Systems & SCADA, Role of IS in Supply Chain, Maintenance, Quality, and Smart Manufacturing (Industry 4.0).

Unit 3: Emerging Trends and Case Studies in IS (7–8 Hours)

Cloud-Based Information Systems, Role of IoT and Data Analytics in Engineering IS, Engineering Workflow Automation with IS Tools (Examples: AutoCAD Vault, PLM, BIM), Case Studies: Use of IS in Smart Cities, Energy Management, Water Resource Planning, Challenges in IS Implementation: Data Security, Change Management, Cost.

CO–PO Mapping Table:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO12
CO1	3	2			2			2
CO2	2	3	2		2		2	2
CO3		2	3	2	3	2		3

Textbooks:

1. Laudon & Laudon, *Management Information Systems: Managing the Digital Firm*, Pearson Education, 2021
2. James A. O'Brien, *Introduction to Information Systems*, McGraw-Hill, 2020

Reference Books:

1. Rainer & Prince, *Introduction to Information Systems*, Wiley India, 2019
2. Turban et al., *Information Technology for Management*, Wiley, 2021
3. Monk & Wagner, *Concepts in Enterprise Resource Planning*, Cengage Learning, 2016
4. Mahadeo Jaiswal & M. Mital, *Management Information Systems*, Oxford University Press, 2015
5. Rajesh Ray, *Enterprise Resource Planning*, Tata McGraw Hill, 2011
6. Ghosh, *Management Information Systems*, PHI Learning, 2014

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Subject Title: Cyber Laws and Ethics
Subject Code: 5CS230OE1 / 5KE230OE1 / 5DS230OE1 / 5AD230OE1
Semster: V | Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 Hours

Pre-requisites:
- Basic understanding of internet and computing
- Familiarity with digital communication and information sharing

Course Objectives:
By the end of the course, students will:
- To introduce the foundations of cyberspace and the nature of cybercrimes.
- To understand the national and international legal frameworks related to cyber laws.
- To develop ethical awareness and responsible behaviour in the digital environment.

Course Outcomes:
At the end of the course, students will be able to:
1. Understand the nature, types, and evolution of cybercrimes and ethical issues.
2. Describe legal provisions under Indian cyber laws and global cyber regulations.
3. Apply ethical principles and legal knowledge to real-world digital issues.

Syllabus:

Unit I: Introduction to Cyber Space and Cyber Crimes (8 Hours)
Evolution of the digital world and rise of cybercrimes, Types and categories: hacking, phishing, identity theft, cyberbullying, Impact on individuals and organizations, Case Study: The 202X Data Breach in India

Unit II: Legal Framework Governing Cyber Space (7 Hours)
Regulation of cyberspace and need for cyber laws , Overview of Indian IT Act 2000 and key amendments, Global treaties and conventions (e.g., Budapest Convention), Case Study: Indian Cyber Law implementation under IT Act.

Unit III: Cyber Ethics and Responsible Digital Citizenship (7 Hours)
Understanding cyber ethics, digital behavior, and online responsibilities, Concepts of privacy, consent, intellectual property, and digital rights, Ethical hacking, AI ethics, and future challenges in digital society, Case Study: Ethics and Cyberbullying / Ethical Hacking in Corporates

Textbook:
"Ethical Bytes: Navigating the Digital World with Integrity" *D. G.Harkut & K.N. Kasat*, Notion Press, 2023

Reference Books:

1. Nina Godbole & Sunit Belapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India.
2. Vakul Sharma, *Information Technology Law and Practice*, Universal Law Publishing.
3. Pavan Duggal, *Cyber Law: The Indian Perspective*, Saakshar Law Publications.
4. Rodney Ryder, *Guide to Cyber Laws*, Wadhwa Publications.

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Subject Title: Introduction to Data Analytics
Subject Code: 5CS230OE2 / 5KE230OE2 / 5DS230OE2 / 5AD230OE2
Semster: V | Type: Theory | **Credits**: 2
Total Contact Hours: 22–25 Hours

Prerequisites:
- Basic understanding of mathematics and statistics at high school level.
- Familiarity with spreadsheets or tools like Excel.

Course Objectives:
1. To introduce the fundamental concepts and applications of data analytics in engineering and business.
2. To enable students to understand different types of data, data processing, and analysis techniques.
3. To equip students with practical knowledge of tools used in data visualization and basic modeling.
4. To develop the ability to interpret data and make informed decisions based on analytical findings.

Course Outcomes (COs):
After successful completion of the course, students will be able to:
Understand the basics of data types, sources, and the analytical process.
1. Apply basic data analysis techniques for real-world datasets.
2. Visualize data using appropriate tools and interpret results for decision-making.

Syllabus:

Unit 1: Fundamentals of Data Analytics (7–8 Hours)
Introduction to Data Analytics: Importance, Scope, and Applications, Types of Data: Structured, Semi-structured, and Unstructured, Data Lifecycle: Collection, Cleaning, Processing, Analysis, and Reporting, Introduction to Tools: Excel, Python, R (only basic overview), Role of Data Analytics in Engineering, Manufacturing, Business, and Public Policy.

Unit 2: Data Processing and Exploratory Analysis (7–8 Hours)
Data Preprocessing: Cleaning, Handling Missing Values, Filtering, Descriptive Statistics: Mean, Median, Mode, Standard Deviation, Introduction to Correlation and Covariance, Basics of Sampling, Data Grouping, Sorting, Hands-on Demonstration using Excel or Google Sheets.

Unit 3: Data Visualization and Decision Making (7–8 Hours)
Principles of Data Visualization: Importance and Types, Tools for Visualization: Excel Charts, Google Sheets, Tableau Public (overview), Creating Bar Charts, Line Charts, Histograms, Pie Charts, Dashboards and Storytelling with Data, Use Cases: Analytics in Retail, Healthcare, Engineering Systems, Ethical Considerations in Data Use: Bias, Privacy, and Transparency.

CO–PO Mapping Table:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	3	2			2			2
CO2	2	3	2		3		2	2
CO3		2	2	2	3	2	3	3

Textbooks:

1. **"Data Analytics Made Accessible"** by Anil Maheshwari, Amazon Publishing, 2017
2. **"Data Science for Business"** by Foster Provost and Tom Fawcett, O'Reilly Media, 2013

Reference Books:

1. **"Fundamentals of Data Analytics"** by Bharti Motwani, Wiley India, 2019
2. **"Data Analytics Using Excel"** by Seema Acharya, McGraw Hill Education, 2021
3. **"Naked Statistics"** by Charles Wheelan, W. W. Norton & Company, 2014
4. **"Storytelling with Data"** by Cole Nussbaumer Knaflic, Wiley, 2015
5. **"Python for Data Analysis"** by Wes McKinney, O'Reilly Media, 2018
6. **"Business Analytics – Data Analysis & Decision Making"** by S. Christian Albright and Wayne Winston, Cengage Learning, 2016

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