NATIONAL INSTITUTE OF TECHNOLOGY MEGHALAYA

Department of Computer Science & Engineering

Under Graduate

Curriculum & Syllabus

Regulation - 2018

B.Tech in Computer Science & Engineering

CONTENTS

Vision and Mission

Vision

Attaining global recognition in Computer Science & Engineering education, research and training to meet the growing needs of the industry and society.

Mission

- Imparting quality education through well-designed curriculum in tune with the challenging software needs of the industry.
- Providing state-of-art research facilities to generate knowledge and develop technologies in the thrust areas of Computer Science and Engineering.
- Developing linkages with world class organizations to strengthen industry-academia relationships for mutual benefit.

Program Educational Objectives (PEOs)

PEO1: Apply computer science theory blended with mathematics and engineering to model computing systems.

PEO2: Design, implement, test and maintain software systems based on requirement specifications.

PEO3: Communicate effectively with team members, engage in applying technologies and lead teams in industry.

PEO4: Assess the computing systems from the view point of quality, security, privacy, cost, utility, etiquette and ethics.

PEO5: Engage in lifelong learning, career enhancement and adapt to changing professional and societal needs.

Program Outcomes (POs)

- **PSO 1:** The ability to understand, analyse and develop solution strategy towards problems in the areas related to algorithms, system software, machine learning, and Artificial Intelligence, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.
- **PSO 2:** The ability to understand the evolutionary changes in computing, apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success, real world problems and meet the challenges of the future.
- PSO 3: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, lifelong learning and a zest for higher studies and also to act as a good citizen by inculcating in them moral values & ethics.

Structure of Curriculum

SEMESTER - 1							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
MA 101	Differential Calculus and Linear Algebra	Sc/HS	3	1	0	4	None
ME 101	Engineering Mechanics	BE	3	0	0	3	None
CY101/ PH101	Chemistry/Physics	Sc/HS	2/3	1	0	3/4	None
CE 101	Engineering Drawing	BE	1	0	4	3	None
EE101/ EC101	Basic Electrical Engineering /Basic Electronics Engineering	BE	2	0	0	2	None
HS 101	English Language Skills	Sc/HS	2	0	0	2	None
HS 151	English Language Skills Lab	L	0	0	2	1	None
CY151/ PH151	Chemistry Lab /Physics Lab	L	0	0	2	1	None
EE151/ EC151	Basic Electrical Lab /Basic Electronics Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			**13/ 14**	**2**	**10**	---	
Total Contact Hours			**25/26**			**20/21**	---

SEMESTER – 2							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
MA 102	Integral Calculus and Complex Variables	Sc/HS	3	1	0	4	None
EE101/ EC101	Basic Electrical Engineering /Basic Electronics Engineering	BE	2	0	0	2	None
PH101/ CY101	Chemistry/Physics	Sc/HS	2/3	1	0	3/4	None
CY 102	Environmental Science	Sc/HS	2	0	0	2	None
CS 102	Introduction to Computing	BE	2	1	0	3	None
ME 152	Workshop Practice	L	0	0	4	2	None
EE151/ EC151	Basic Electrical Lab/ Basic Electronics Lab	L	0	0	2	1	None
CY151/ PH151	Chemistry Lab /Physics Lab	L	0	0	2	1	None
CS 152	Computing Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			**11/ 12**	**3**	**10**	---	
Total Contact Hours			**24/25**			**19/20**	---

SEMESTER - 3							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
MA 201	Integral Transforms and PDEs	M	3	1	0	4	None
Professional Core Courses - 1, 2, 3							
CS 201	Data Structures	PC	3	0	0	3	None
CS 203	Digital Logic Design	PC	3	1	0	4	None
CS 205	Discrete Mathematical Structures	PC	3	1	0	4	None
Special Course – 1							
ME 291	Safety Engineering	S	2	0	0	2	None
Lab Courses - 1, 2, 3							
CS 251	Data Structures Lab	L	0	1	2	2	None
CS 253	Digital Logic Design Lab	L	0	1	2	2	None
CS 255	Internet Web Technology Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			**14**	**5**	**6**	---	
Total Contact Hours			**25**			**22**	---

SEMESTER – 4							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
Professional Core Courses - 4, 5, 6							
CS 202	Computer Organization	PC	3	1	0	4	CS 203
CS 204	Object Oriented Programming and Design	PC	3	1	0	4	CS 101
CS 206	Data Communication	PC	3	0	0	3	None
Professional Elective – 1							
CS 212	Analysis and Design of Algorithms	PE	3	0	0	3	None
CS 214	Computational Models for Real Time Systems	PE	3	0	0	3	None
CS 216	Cyber Physical Systems	PE	3	0	0	3	None
CS 218	Computer Arithmetic	PE	3	0	0	3	None
Professional Elective – 2							
CS 220	Principles of Programming Languages	PE	3	0	0	3	CS 101
CS 222	Programming in Java	PE	3	0	0	3	CS 101
CS 224	GUI Design and Programming	PE	3	0	0	3	CS 101
CS 226	Python Programming	PE	3	0	0	3	CS 101

Open Elective – 1							
CS 272	Object Oriented Programming	OE	2	0	0	2	CS 101
Lab Courses - 4, 5,6							
CS 252	Computer Organization Lab	L	0	0	2	1	CS 203
CS 254	Object Oriented Programming and Design Lab	L	0	1	2	2	CS 101
CS 256	Data Communication Lab	L	0	1	2	2	None
Total Contact Hours – Component wise			**17**	**4**	**6**	---	
Total Contact Hours			**27**			**24**	---

SEMESTER – 5							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
Professional Core Courses - 7, 8, 9							
CS 301	Operating Systems	PC	3	1	0	4	CS 204
CS 303	Database Management Systems	PC	3	1	0	4	CS 201
CS 305	Computer Networks	PC	3	0	0	3	None
Professional Elective – 3							
CS 311	Microprocessors and Interfacing	PE	3	1	0	4	None
CS 313	Embedded Systems	PE	3	1	0	4	None
CS 315	E-commerce and Cyber Laws	PE	3	1	0	4	None
CS 317	Machine Vision	PE	3	1	0	4	None
Professional Elective – 4							
CS 319	Automata and Formal Language	PE	3	0	0	3	None
CS 321	Formal Verification	PE	3	0	0	3	None
CS 323	Computational Geometry	PE	3	0	0	3	None
CS 325	Modern Digital Arithmetic	PE	3	0	0	3	None
Open Elective – 2							
CS 371	Database System Concepts	OE	2	0	0	2	None
Lab Courses - 7, 8, 9							
CS 351	Operating Systems Lab	L	0	1	2	2	CS 204
CS 353	Database Management Systems Lab	L	0	1	2	2	CS 201
CS 355	Computer Networks Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			**17**	**5**	**6**	---	
Total Contact Hours			**28**			**25**	---

SEMESTER – 6							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
Professional Core Courses – 10, 11							
CS 302	Software Engineering	PC	3	1	0	4	None
CS 304	Compiler Design	PC	3	1	0	4	None
Professional Elective – 5							
CS 312	Computer Graphics	PE	3	0	0	3	None
CS 314	Shell Programming	PE	3	0	0	3	None
CS 316	Augmented and Virtual Reality	PE	3	0	0	3	None
CS 318	Information Theory and Coding	PE	3	0	0	3	None
Professional Elective – 6							
CS 320	Machine Learning	PE	3	0	0	3	None
CS 322	Cryptography And Network Security	PE	3	0	0	3	None
CS 324	Data Analysis and Visualization	PE	3	0	0	3	None
CS 326	Multimedia	PE	3	0	0	3	None
CS 328	System Software	PE	3	0	0	3	None
Open Elective – 3							
CS 372	Introduction to Machine Learning	OE	2	0	0	2	None
Special HS Course – 2							
HS 392	Corporate Communication	S	2	0	0	2	None
Lab Courses – 10, 11							
CS 352	Software Engineering Lab	L	0	1	2	2	None
CS 354	Compiler Design Lab	L	0	1	2	2	None
CS 382	Term Paper	T	0	0	2	1	None
Total Contact Hours – Component wise			**16**	**4**	**6**	---	
Total Contact Hours			**26**			**23**	---

SEMESTER – 7							
Course Code	Course Title	Course Type	Contact Hours			Credit	Pre-requisites
			L	T	P	C	
CS 401	Project – I	P	0	0	10	5	None
Professional Elective –7							
CS 411	Soft Computing	PE	3	0	0	3	None

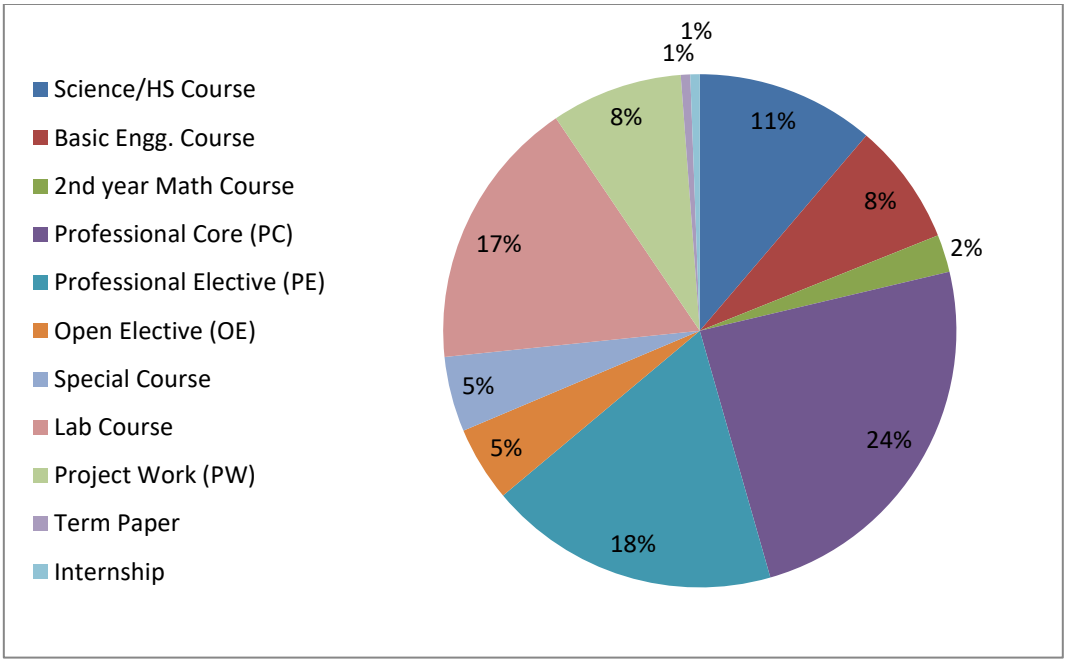
CS 413	Pattern Recognition	PE	3	0	0	3	None
CS 415	Complex Networks	PE	3	0	0	3	None
CS 417	Blockchain Technologies	PE	3	0	0	3	None
CS 419	High Performance Architecture	PE	3	0	0	3	None
Professional Elective –8							
CS 421	Image Processing	PE	3	0	0	3	None
CS 423	Artificial Intelligence	PE	3	0	0	3	None
CS 425	Advanced Web Technology	PE	3	0	0	3	None
CS 427	Software Defined Network	PE	3	0	0	3	None
CS 429	Robotics and Automation	PE	3	0	0	3	None
Open Elective –4							
CS 471	Data Analytics using Python	OE	2	0	0	2	None
Special Course – 3							
CE 491	Disaster Management	S	2	0	0	2	None
Lab Courses– 12							
CS 461	Computational Intelligence Lab	L	0	1	2	2	None
CS 481	Summer Internship	I	0	0	0	1	None
Total Contact Hours – Component wise			**10**	**1**	**12**	---	
Total Contact Hours			**23**			**18**	---

SEMESTER –8							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
CS 402	Project – II	P	0	0	18	9	None
Professional Elective –9							
CS 412	Mobile Computing	PE	3	0	0	3	None
CS 414	Cloud Computing	PE	3	0	0	3	None
CS 416	Wireless Sensor Network	PE	3	0	0	3	None
CS 418	Natural Language Processing	PE	3	0	0	3	None
CS 420	Cyber Forensics and Analysis	PE	3	0	0	3	None
Professional Elective –10							
CS 422	Data Mining	PE	3	0	0	3	None
CS 424	Distributed Computing	PE	3	0	0	3	None
CS 426	Bioinformatics	PE	3	0	0	3	None
CS 428	Internet of Things	PE	3	0	0	3	None

CS 430	Human Computer Interaction	PE	3	0	0	3	None
Special Course –4							
HS 492	Entrepreneurship	S	2	0	0	2	
Total Contact Hours – Component wise			**8**	**0**	**18**	---	
Total Contact Hours			**26**			**17**	---

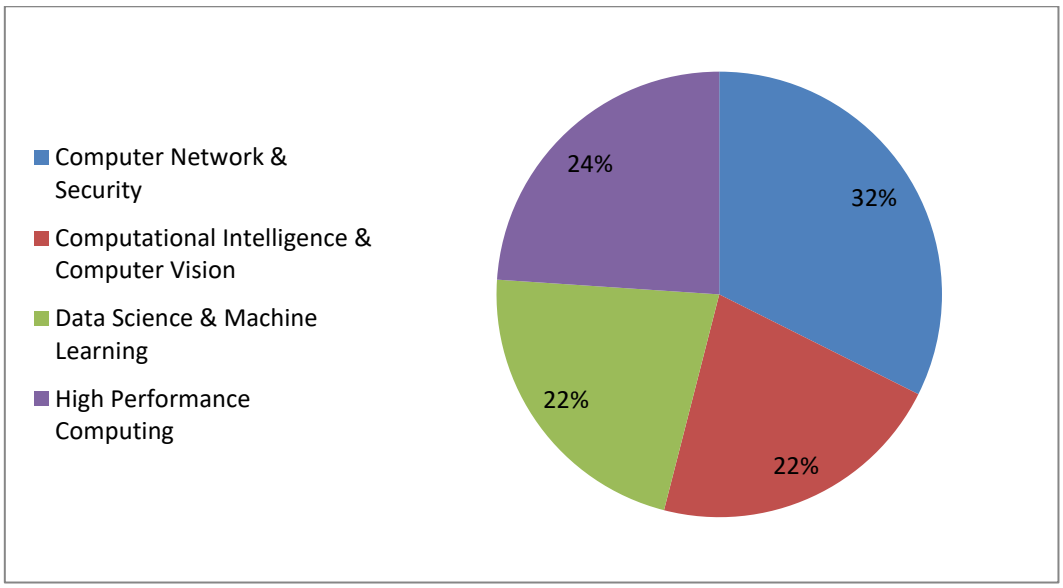
Credit Distribution (Course Components)

Category	Sem - 1	Sem - 2	Sem - 3	Sem - 4	Sem - 5	Sem - 6	Sem - 7	Sem - 8	Total
Science/HS Course	**9/10**	**9/10**	-	-	-	-	-	-	**19**
Basic Engg. Course	**8**	**5**	-	-	-	-	-	-	**13**
2nd year Math Course	-	-	**4**	-	-	-	-	-	**4**
Professional Core (PC)	-	-	**11**	**11**	**11**	**8**	-	-	**41**
Professional Elective (PE)	-	-	-	**6**	**7**	**6**	**6**	**6**	**31**
Open Elective (OE)	-	-	-	**2**	**2**	**2**	**2**	-	**8**
Special Course	-	-	**2**	-	-	**2**	**2**	**2**	**8**
Lab Course	**3**	**5**	**5**	**5**	**5**	**4**	**2**	-	**29**
Project Work (PW)	-	-	-	-	-	-	**5**	**9**	**14**
Term Paper	-	-	-	-	-	**1**	-	-	**1**
Internship	-	-	-	-	-	-	**1**	-	**1**
Total	**20/21**	**19/20**	**22**	**24**	**25**	**23**	**18**	**17**	**169**



Credit Distribution (Research Components)

Research Group	Sem – 1	Sem - 2	Sem - 3	Sem - 4	Sem - 5	Sem - 6	Sem - 7	Sem - 8	Total
Computer Network & Security	-	-	-	11	25	15	6	12	69
Computational Intelligence & Computer Vision	-	-	4	3	4	20	12	3	46
Data Science & Machine Learning	-	4	1	17	3	3	10	9	47
High Performance Computing	-	-	11	11	14	3	6	6	51
Total	--	4	16	42	46	41	34	30	213



List of Professional Core Courses

Sl.NO	Course Code	Course Name	Credits
1	CS 201	Data Structures	3
2	CS 203	Digital Logic Design	4
3	CS 205	Discrete Mathematical Structures	4
4	CS 202	Computer Organization	4
5	CS 204	Object Oriented Programming and Design	4
6	CS 206	Data Communication	3
7	CS 301	Operating Systems	4
8	CS 303	Database Management Systems	4
9	CS 305	Computer Networks	3
10	CS 302	Software Engineering	4
11	CS 304	Compiler Design	4

List of Professional Electives

Sl.NO	Course Code	Course Name	Credits
1	CS 212	Analysis and Design of Algorithms	3
2	CS 214	Computational Models for Real Time Systems	3
3	CS 216	Cyber Physical Systems	3
4	CS 218	Computer Arithmetic	3
5	CS 220	Principles of Programming Languages	3
6	CS 222	Programming in Java	3
7	CS 224	GUI Design and Programming	3
8	CS 226	Python Programming	3
9	CS 311	Microprocessors and Interfacing	4
10	CS 313	Embedded Systems	4
11	CS 315	E-commerce and Cyber Laws	4
12	CS 317	Machine Vision	4
13	CS 319	Automata and Formal Language	3
14	CS 321	Formal Verification	3
15	CS 323	Computational Geometry	3
16	CS 325	Modern Digital Arithmetic	3
17	CS 312	Computer Graphics	3
18	CS 314	Shell Programming	3
19	CS 316	Augmented and Virtual Reality	3
20	CS 318	Information Theory and Coding	3
21	CS 320	Machine Learning	3
22	CS 322	Cryptography and Network Security	3
23	CS 324	Data Analysis and Visualization	3
24	CS 326	Multimedia	3
25	CS 328	System Software	3
26	CS 411	Soft Computing	3
27	CS 413	Pattern Recognition	3
28	CS 415	Complex Networks	3
29	CS 417	Blockchain Technologies	3
30	CS 419	High Performance Architecture	3

31	CS 421	Image Processing	3
32	CS 423	Artificial Intelligence	3
33	CS 425	Advanced Web Technology	3
34	CS 427	Software Defined Network	3
35	CS 429	Robotics and Automation	3
36	CS 412	Mobile Computing	3
37	CS 414	Cloud Computing	3
38	CS 416	Wireless Sensor Network	3
39	CS 418	Natural Language Processing	3
40	CS 420	Cyber Forensics and Analysis	3
41	CS 422	Data Mining	3
42	CS 424	Distributed Computing	3
43	CS 426	Bioinformatics	3
44	CS 428	Internet of Things	3
45	CS 430	Human Computer Interaction	3

List of Open Electives

Sl.NO	Course Code	Course Name	Credits	Offered by
1	CS 272	Object Oriented Programming	2	
2	CS 371	Database System Concepts	2	
3	CS 372	Introduction to Machine Learning	2	
4	CS 471	Data Analytics using Python	2	

List of Special Courses

Sl.NO	Course Code	Course Name	Credits	Offered by
1	ME 291	Safety Engineering	2	
2	HS 392	Corporate Communication	2	
3	CE 491	Disaster Management	2	
4	HS 492	Entrepreneurship	2	

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2018**
Department	**Mathematics**	Semester	**I**

Course Code	Course Name	Pre-requisite	Credit Structure				Marks Distribution			
			L	T	P	C	INT	MID	END	Total
MA 101	**Differential Calculus and Linear Algebra**	**NIL**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the fundamental concepts of differential calculus, ordinary differential equations and linear algebra.	Course Outcomes	CO1	Able to understand the concept of limit, continuity and differentiation for functions of single and multivariables, and the consequences of different mean value theorems for differential functions
			CO2	Able to apply Taylor series to approximate differentiable functions of single and multivariables and estimate the error.
	To apply these concepts of in modeling and analyzing several engineering problems		CO3	Able to understand the idea of optimization and be able to solve extreme value problems, and relate such problems with real world problems
			CO4	Able to solve ordinary differential equations analytically and apply the ODEs to model real world problems
			CO5	Able to understand the basic concepts of vector spaces and matrix algebra
			CO6	Able to solve systems of linear equations

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
4	CO4	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
5	CO5	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
6	CO6	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	**Differential Calculus of Single Variable:** Limit; continuity; differentiation, Rolle's theorem, mean value theorems of Lagrange and Cauchy; Taylor's and Maclaurin's series, indeterminat forms, L' Hospital's rule	**11**	**CO1** **CO2**
II	**Differential Calculus of Multi-variable:** Real valued functions of two/three variables, limit, continuity, differentiability, partial differentiation; Euler's theorem for homogeneous functions; Taylor's and Maclaurin's series for function of two variables; Extreme values of functions of two variables; Lagrange's method of undetermined multipliers.	**16**	**CO1** **CO2** **CO3**
III	**Ordinary Differential Equations:** Linear differential equations with constant co-efficients, Euler- Cauchy forms; Method of variation of parameters	**10**	**CO4**
IV	**Linear Algebra:** Vector space over R, subspaces, bases and dimension; Echelon form, rank of a matrix, system of linear equations; eigen values and eigen vectors; Symmetric, skew-symmetric, Hermitian, skew-Hermitian, othogonal, unitary matrices.	**11**	**CO5** **CO6**
Total Hours		**48**	

Essential Readings

1. J. Stewart, "Calculus", Cengage Learning India Pvt. Limited, 7th edition, 2017.
2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition 2015

Supplementary Readings

1. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5th edition, 2016.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**B.Tech in Mechanical Engineering**	Academic Year of Regulation	**2019-20**
Department	**Mechanical Engineering**	Semester	**I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
ME 101	**Engineering Mechanics**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	This course describes the different laws of forces associated with different engineering elements.	Course Outcomes	CO1	Able to classify the different laws of forces associated with engineering systems. (Understanding)
	This course introduces the use of force and moments in various working conditions.		CO2	Able to i) Illustrate the use of force and moments in various working conditions (Understanding). ii) solving related problems. (Applying)
	This course illustrates the use of subject knowledge in the fields of engineering.		CO3	Able to identify the equilibrium conditions of engineering structures (truss, beams, frames) under various loads. (Applying)
	This course introduces the states of an engineering elements and structures under various loading conditions.		CO4	Able to solve the practical mechanics problems considering static friction. (Applying)
	This course explains how to solve the practical problems of mechanics to determine the static forces with their magnitudes and directions.		CO5	Able to understand the principle of virtual work and solve related problems. (Applying)

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
2	CO2	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
3	CO3	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**
4	CO4	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
5	CO5	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Introduction Classification, Basic terminologies, Laws of Mechanics, Units, Characteristics of forces, Vectors, Dimensional homogeneity, Assumptions in mechanics	**03**	**CO1**
II	Compositions of two force system, Resolution of forces, General method of composition of forces, Equilibrium of bodies, Free body diagra. Lami's theorem, Equilibrium of connected bodies	**03**	**CO1**
III	Moment of force, Varignon's theore, Couple, Resolution of a force into a force and couple, Resultant of non-concurrent force system, Equilibrium of non-concurrent system of forces	**04**	**CO2**
IV	Types of supports, Types of beam, Types of loadin, Finding reactions at support	**04**	**CO3**
V	Center of gravity, Centroid, Use of axis of symmetry, Centroid of a composite section, Center of gravity of a flat plate, Difference between center of gravity and centroid, Determination of centroid from first principle	**03**	**CO1** **CO2** **CO3**
VI	Moment of inertia, Radius of gyration, Polar moment of inertia, Moment of inertia from first principles, Theorems of moment of inertia, Moment of inertia of composite sections, Moment of inertia of standard sections	**03**	**CO3**
VII	Frames, Assumptions in analysis of frame, Nature of forces, Methods of analysis, Method of joints, Method of sections	**04**	**CO3**
VIII	Laws of friction, Angle of friction, angle of repose, cone of friction, Wedges, Problems involving non-concurrent force system Rope/belt friction	**02**	**CO1** **CO2** **CO4**
IX	Work, Work done by varying force, Energy, Power, Work energy equation for translation , Motion of connected bodies Work done by spring	**03**	**CO2** **CO5**
X	Simple harmonic motion, Simple harmonic motion as a sine wave, Simple pendulum	**03**	**CO2** **CO5**
Total Hours		**32**	

Essential Readings

1. F.P. Bear, E. R. Johnston, Vector Mechanics for Engineers, 9th ed.2009, Tata McGraw Hill.

Supplementary Readings

1. H. J. Shah, S. B. Junarkar, Applied Mechanics, 19th Ed.2015, Charotar Publication, Anand.
2. S. S. Bhavikatti, K. G. Rajashekarappa, Engineering Mechanics,1994, Wiley Eastern Ltd.
3. R. C. Hibbeler, Engineering Mechanics –Statics & Dynamics, 11th Ed., Macmillan Publication Co.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2019-20**
Department	**Physics**	Semester	**I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
PH 101	**Physics**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To handle the concepts of mechanics with help of vector calculus	Course Outcomes	CO1	Students able to articulate and describe fundamental law of Physics
	To understand the fundamentals of electromagnetism		CO2	Gain the concept of electromagnetism applied to Engineering concepts
	To introduce various concepts of optical phenomena in Physics and Engineering		CO3	Students able to gain information about Geometrical and Physical Optics
	To introduce students, the developments of Physics in the 20th century		CO4	Able to understand the concepts and theories of 20-th century Physics and its applications.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2	CO2	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	CO3	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	CO4	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Mechanics:** Vector Calculus, Revisiting Newton's laws of motion, Motion along a straight line, Motion in 2D and 3D, work and kinetic energy, Potential energy and energy conservation, momentum, impulse, and collisions, Rotation of rigid bodies	**13**	**CO1**
II	**Electromagnetism:** Gauss's law and its applications, Divergence and curl of electrostatic fields, Electrostatic potential. Lorentz force, Biot-Savart and Ampere's laws and their applications, Divergence and curl of magnetostatic fields, Force and torque on a magnetic dipole. Motional EMF, Faraday's law, Lenz's law, Maxwell's equations.	**13**	**CO2**
III	**Optics:** Interference - Coherence, Principle of Superposition, Young's double slit experiment, Newton's rings. Diffraction - Fresnel and Fraunhofer diffracting, Grating and its usages; Polarization- Introduction, Malus' law, Polarization by reflection and Brewster's law.	**13**	**CO3**
IV	**Modern Physics:** Old quantum theory, black body radiation, Planks law, photoelectric effect, Compton effect, de-Broglie's hypothesis, Heisenberg uncertainty principle, wave packet, group and phase velocities, postulates of quantum mechanics. Schrödinger's equation, application in 1-dimension: particle in a box.	**13**	**CO4**
	Total Hours	**52**	

Essential Readings

1. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers with Modern Physics", CENGAGE Learning Custom Publishing, 9th edition, 2012.
2. Hafez A. Radi, John O. Rasmussen, Principles of Physics for Scientists and Engineers, Springer, 2013

Supplementary Readings

1. J. C. Morrison, Modern Physics for Scientists and Engineers, Elsevier; 1st edition, 2011.
2. M. Mansfield and C. O'Sullivan, "Understanding Physics", Wiley-Blackwell; 2nd Edition, 2010.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2019-20**
Department	**Civil Engineering**	Semester	**I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CE 101	**Engineering Drawing**	**1**	**0**	**4**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To develop the student's ability to understand the role and importance of technical drawings in engineering drawing process, and application of BIS and ISO conventions.	Course Outcomes	CO1	Understand the lettering, lining and dimensioning process in engineering drawing
	To develop the student's ability to understand the proper representation and practice of Lines, Lettering, and dimensioning.		CO2	Understand the importance of various types of scales associated with engineering drawing
	To develop student's ability to understand the importance of types of scales.		CO3	Construct points, lines, curves, polygons, planes and solids.
	To develop the student's ability to construct plane geometry.		CO4	Create orthographic, isometric, multi-view drawing, and create sectional views of objects.
	To develop the student's ability to understand the concepts of projection and their application in technical drawing.		CO5	Illustrate the development process of surfaces of various objects.
	To develop the student's ability to apply projection technique to draw Multi-view, pictorial view (Isometric View) drawings.			
	To develop the student's ability to understand development process of surfaces of various objects.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**3**	**0**	**0**
2	CO2	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**3**	**0**	**0**
3	CO3	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**3**	**0**	**0**
4	CO4	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**3**	**0**	**0**
5	CO5	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**3**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Importance of Engineering Drawing, drawing Instruments and materials, B.I.S. and ISO conventions	**01**	**CO1**
	Lines, Lettering, and Dimensioning	**05**	**CO1**
II	**Plane Geometry** Geometrical Construction: line, arc, and angle, divisions of straight line and circumference, construction of polygon	**05**	**CO3**
III	**Scales** Construction of scales – plane scale, diagonal scale, Vernier scale, functional scale; concept of conversion scale and nomogram	**05**	**CO2**
IV	**Conic Sections and other Curves** Construction of Ellipse, Parabola, Hyperbola, Rectangular Hyperbola, Cycloidal Curves: Cycloid, Involute	**05**	**CO3**
V	**Projection** Principle of Projection and Orthographic Projection	**01**	**CO4**
	Projection of points and lines	**05**	**CO4**
	Projection of Planes	**05**	**CO4**
VI	**Solid Geometry** Types of Solids: polyhedral, prisms, pyramids, cylinder, cone, sphere, auxiliary projection method	**01**	**CO4**
	Orthographic projection of solids: one view, two view and three view drawings, Missing view, rules for selection of views	**05**	**CO4**
VII	Sectional view, section plane perpendicular to the HP & VP and other Various positions, true shape of sections	**05**	**CO4**
VIII	Classification, line of intersection, line/generator method and section plane method: intersection of two prisms, two cylinders, intersection of cone and cylinder	**05**	**CO4**
IX	Method of development, parallel line development, radial line development, developments of cylinder, cone, prism, pyramid, true length of edges – oblique surface.	**05**	**CO5**
X	Terminology, isometric scale, isometric view and isometric projection, isometric axes, and lines, missing view	**05**	**CO4**
Total Hours		**58**	

Essential Readings

1. N.D. Bhatt, Engineering Drawing, Chrotar Publishing House.
2. Dhananjay A Jolhe, Engineering drawing, TMH, 2008
3. M.B. Shah and B.C. Rana, Engineering Drawing, Pearson, 2009.

Supplementary Readings

1. T E French, C J Vierck and R J Foster, Graphic Science and Design, 4th edition, McGraw Hill, 1984
2. W J Luzadder and J M Duff, Fundamentals of Engineering Drawing, 11th edition, Prentice-Hall of India, 1995.
3. K Venugpoal, Engineering Drawing and Graphics, 3nd edition, New Age International, 1998.

4. Gary R. Bertoline, Eric N. Wiebe, Nathan W. Hartman, William A. Ross, Technical graphics Communication, 4th Edition, McGraw Hill Higher Education, 2009
5. Frederick E. Giesecke, Shawna Lockhart, Marla Goodman, Cindy M. Johnson Technical Drawing With Engineering Graphics, 15th Edition, Prentice Hall, 2016
6. SP 46: 2003, Engineering Drawing Practice for schools and colleges.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology**	Year of Regulation: **2019-20**
Department	**Electrical Engineering**	Semester: **I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EE 101	**Basic Electrical Engineering**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand basic circuit theorems and laws		CO1	Acquire knowledge of circuit theorems, understand and apply circuit theorems to DC circuits
			CO2	Understand the laws of electricity and magnetism and apply them in simple circuits
			CO3	Analyze single phase AC circuits for voltage and circuit and calculate complex power
	To develop the skills to analyze the basic DC/AC system		CO4	Understand polyphase systems and solve problems of simple polyphase system
			CO5	Acquire knowledge of different types of electric machines and measurement instruments

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**3**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
4	CO4	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
5	CO5	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	**Analysis of DC circuits** Mesh, node, branch, Ohm's law, series and parallel circuit, basic devices: resistors, capacitors, inductors, dependent and independent sources, Kirchhoff's Laws, Mesh and Node Analysis, Star-Delta conversion, Superposition theorem, Source conversion, Thevenin theorem, Norton theorem, Maximum power transfer theorem	**06**	**CO1**
II	**Electromagnetic Induction & Magnetic Circuit** Magnetic field, Right hand rule, Left hand rule, Electromechanical laws, relation between electricity and magnetism, production of emfs (ac & dc), Faraday's law of electromagnetic induction, direction of induced emf, Lenz law, dynamically and statically induced emfs, self-inductances, and mutual inductances, coefficient of coupling, Inductance in series and parallel, energy stored in a magnetic field.	**06**	**CO2**
III	**A.C Fundamentals and R.L.C circuits** Phasors, Complex quantities, Application of complex algebra to A.C circuit, series and parallel RL, RC, RLC circuit, concept of impedance triangle, complex power: active, reactive and apparent power, power triangle, admittance triangle, series-parallel circuit.	**05**	**CO3**
IV	**Polyphase Networks** Balanced two phase and three phase systems, Balanced Star-Delta connections, phase and line currents and voltages and their relations, Measurement of three phase power	**04**	**CO4**
V	**Measuring Instruments** MC, MI and DM type instruments, energy meter. **Elementary Overview of Electrical Machines:** Principle, Construction and Types of different rotating electrical machines, transformers.	**03**	**CO5**
	Total Hours	**24**	

Essential Readings

1.A. Hussain, Fundamental of Electrical Engineering, Dhanpat Rai & Co. Ltd., 3rd edition, 2007.

2. V.N Mittle, Basic Electrical Engineering, Tata McGraw Hill, 2nd edition 2017.

3 A. Chakroborty, S. Nath and C.K. Chanda, "Basic Electrical Engineering", McGraw Hill Education Pvt. Ltd., 1st Edition, 2009.

4. M.S. Sukhija and T.K. Nagsarkar, "Basic Electrical and Electronics Engineering", Oxford University Press, 1st Edition, 2014.

Supplementary Readings

1. H. Cotton, "Electrical Technology", Pitman Publication, 7th edition 2005.

2. Hughes, "Electrical Technology", Longman, 10th edition 2010.

3. John Bird, Electrical Circuit Theory and Technology, Routledge, Taylor & Francis Group, 4th edition 2010.

4. W.H. Hayt, J.E. Kemmerley, Engineering circuit analysis, Int. St. Ed. McGraw Hill, 8th edition 2013.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2018-2019**
Department	**Humanities and Social Sciences**	Semester	**I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
HS 101	**English Language Skills**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	This course introduces the basic concepts of communication	Course Outcomes	CO1	Able to define and explain the basic concepts of communication
	This course familiarizes speaking skill		CO2	Able to demonstrate fluency in speaking English
	This course familiarizes writing skill		CO3	Able to demonstrate good writing skill in English
	This course familiarizes listening and reading Skills		CO4	Able to understand and interpret ideas presented to them in English
	This course familiarizes presentation skills		CO5	Able to explain their ideas clearly in English
	This course familiarizes body language		CO6	Able to choose appropriate body language while communicating with others

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			
2	CO2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			
3	CO3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			
4	CO4	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			
5	CO5	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**2**			

SYLLABUS

No.	Content	Hours	COs
I	**Overview** English: An essential language; Objective and importance of the course; A discussion on the course content, course plan and books; Evaluation plan	01	All COs
II	**Vocabulary** Antonym; Synonym; Homonym; Word substitution; Foreign Words & Phrases; Idioms & Proverbs	02	CO2 CO3 CO4 CO5
III	**Grammar** Fundamentals of Grammar; Common Sentence Structures; Common Errors in English	04	CO2 CO3 CO4 CO5
IV	**Oral Communication** Speaking & Listening Skills – Some basic tips; Greetings, Introductions, Requests, Suggestions; Giving a description, Invitations, Telephonic Conversation; Extempore Speech, Declamation/Elocution, Group Discussion, Seminar; Pronunciation	07	CO2 CO4 CO5 CO6
V	**Reading** Unseen Comprehension; Precis, Writing summary, Paraphrase, Central idea; Reading materials from internet and talking and writing about them	03	CO4
VI	**Writing** Process of Writing, Writing an article/speech/essay/Notice writing, Report writing; Letter writing – Personal, Official, Business, Job application, e-correspondence	07	CO3 CO5
Total Hours		**24**	

Essential Readings

1. C. Muralikrishna & Sunita Mishra, “Communication Skills for Engineers,” Pearson, 2nd Edition, 2014.
2. Nitin Bhatnagar & Mamta Bhatnagar, “Communicative English for Engineers and Professionals,” Pearson, 2010.

Supplementary Readings

1. J. K. Gangal, “A Practical Course for Developing Writing Skills in English,” PHI, 2011.
2. John Seely, “Oxford Guide to Effective Writing and Speaking,” Oxford University Press, Indian Edition, 2019.
3. Sanjay Kumar & Pushp Lata, “Communication Skills,” Oxford University Press, 2012.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2018-19**
Department	**Humanities and Social Sciences**	Semester	**I**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution		
			L	T	P	C	Continuous Assessment		Total
HS 151	**English Language Skills Lab**	**Nil**	**0**	**0**	**2**	**1**	**01 Experiment**	**10**	**100**

Course Objectives	This course introduces the basic concepts of communication	Course Outcomes	CO1 Able to define and explain the basic concepts of communication
	This course familiarizes speaking skill		CO2 Able to demonstrate fluency in speaking English
	This course familiarizes writing skill		CO3 Able to demonstrate good writing skill in English
	This course familiarizes listening and reading Skills		CO4 Able to understand and interpret ideas presented to them in English
	This course familiarizes presentation skills		CO5 Able to explain their ideas clearly in English
	This course familiarizes body language		CO6 Able to choose appropriate body language while communicating with others

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	0	0	0	0	0	0	0	0	1	3	0	2			
2	CO2	0	0	0	0	0	0	0	0	1	3	0	2			
3	CO3	0	0	0	0	0	0	0	0	1	3	0	2			
4	CO4	0	0	0	0	0	0	0	0	1	3	0	2			
5	CO5	0	0	0	0	0	0	0	0	1	3	0	2			
6	CO6	0	0	0	0	0	0	0	0	1	3	0	2			

SYLLABUS

No.	Content	Hours	COs
1	Short Speeches or other audio files (Listening, Discussing with the teacher or other students)	02	All COs
2	Short Speeches or other audio files (Listening, Writing a summary, Speaking and recording of important points)	02	
3	Short Movies or other video files (Watching, Discussing with the teacher or other students)	02	
4	Short Movies or other video files (Watching, Writing a summary, Speaking and recording of important points)	02	
5	Internet materials (Reading materials from the internet, Discussing with the teacher or other students)	02	
6	Internet materials (Reading materials from the internet, Writing a Summary)	02	
7	Group Seminar Presentations on pre-assigned topics	04	
8	Pronunciation Skills Exercises	02	
9	Group Discussion	04	
10	Taking and Giving Interviews	02	
	Total Hours	**24**	

Essential Readings

1. C. Muralikrishna & Sunita Mishra, “Communication Skills for Engineers,” Pearson, 2nd Edition, 2014.
2. Nitin Bhatnagar & Mamta Bhatnagar, “Communicative English for Engineers and Professionals,” Pearson, 2010.

Supplementary Readings

1. J. K. Gangal, “A Practical Course for Developing Writing Skills in English,” PHI, 2011.
2. John Seely, “Oxford Guide to Effective Writing and Speaking,” Oxford University Press, Indian Edition, 2019.
3. Sanjay Kumar & Pushp Lata, “Communication Skills,” Oxford University Press, 2012.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2013-14**
Department	**Physics**	Semester	**I/II**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution		
			L	T	P	C	Continuous Assessment		Total
PH 151	**Engineering Physics Laboratory**	**NIL**	**0**	**0**	**2**	**1**	**01 Experiment**	**10**	**100**

Course Objectives	To understand the fundamentals of electromagnetism	Course Outcomes	CO1	Able to gain the concept of electromagnetism applied to Engineering
	To understand various concepts of optical phenomena in Physics and Engineering		CO2	Able to gain information about Geometrical and Physical Optics
	To understand the transition from classical to quantum mechanics		CO3	Able to understand the concepts of general Physics and its applications.
	To understand the fundamentals of general physics		CO4	Able to apply lasers in engineering

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2	CO2	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	CO3	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	CO4	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
1	To determine the wavelength of sodium light by measuring the diameters of Newton's rings.	**02**	**CO1** **CO2** **CO3** **CO4**
2	To find the refractive index of prism by measuring angle of prism and angle of minimum deviation.	**02**	
3	To verify inverse square law (using a point source of light).	**02**	
4	Determination of wavelength of monochromatic light (LASER) using Fresnel Biprism.	**02**	
5	To determine the wavelength of LASER using Diffraction grating.	**02**	
6	To verify Coulomb's Law of force between two magnetic poles.	**02**	
7	To find resonance frequency in series RLC circuit.	**02**	
8	To determine frequency of A.C. Mains using sonometer.	**02**	
9	To determine the Young's modulus of elasticity of the material of a sample beam by bending.	**02**	
10	To draw the V-1/λ characteristic for Light Emitting Diode (LED) and determine the value of Planck's constant.	**02**	
	Total Hours	**20**	

Essential Readings

1. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers with Modern Physics", CENGAGE Learning Custom Publishing.
2. D. J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India.
3. A. Ghatak, "Optics", Tata McGraw-Hill.

Supplementary Readings

1. D. Kleppner, and R. J. Kolenkow, "An Introduction to Mechanics", Tata McGraw
2. R. Eisberg, and R. Resnick, "Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", John

Essential Readings

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2019-20**
Department	**Electrical Engineering**	Semester	**I**

Course Code	Course Name	Credit Structure				Marks Distribution	
		L	T	P	C	Continuous evaluation	Total
EE 151	**Basic Electrical Lab**	**0**	**0**	**2**	**1**	**100**	**100**

Course Objectives	To understand basic circuit theorems and laws	Course Outcomes	CO1	Verify the application of circuit theorems
			CO2	Measure voltage, current, power, power factor etc of different circuits like fluroscent, RLC series, RLC parallel
			CO3	Calculate circuit parameters from measured values for a choke coil and transformer
	To develop the skills to analyze the basic DC/AC system		CO4	Measure power in three phase circuits, verify star delta connection

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**			
2	CO2	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**			
3	CO3	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**			
4	CO4	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**			
5	CO5	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	To study and verify the Kirchhoff's Voltage Law and Kirchhoff's Current Law applied to D.C. circuit.	02	CO1
II	To study and verify the Maximum Power Transfer Theorem.	02	CO1
III	To study and measure the inductance of choke coil.	02	CO3
IV	To study and obtain the *v-i* characteristics of a Fluorescent Lamp.	02	CO2
V	To study and perform amplitude, frequency and phase measurements using calibrated cathode ray oscilloscope.	02	CO2
VI	To study the R-L-C series circuit, it is connected to an AC supply and the voltage, current, power are consumed. The relations to be verified by drawing the phasor diagram.	02	CO2
VII	To study the R-L-C Parallel circuit,and the relations of currents and voltages in different branches .The relations to be verified by drawing the phasor diagram.	02	CO2
VIII	To determine equivalent circuit parameters, efficiency and regulation of a single phase transformer by conducting OC and SC tests.	02	CO3
IX	Verify the relation of phase and line value of voltage and current in 3 Phase Star and Delta balanced connection.	02	CO4
X	Measuremnt and verification of 3-ϕ power in star and delta connection.	02	CO4
	Total Hours	**20**	

Supplementary Readings

1. W.H. Hayt, J.E. Kemmerley, "Engineering circuit analysis", Int. St. Ed. McGraw Hill.
2. John Bird, "Electrical Circuit Theory and Technology", Routledge, Taylor & Francis Group.
3. V.N Mittle, "Basic Electrical Engineering", Tata McGraw Hill, 2nd edition 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2018**
Department	**Mathematics**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
MA 102	**Integral Calculus and Complex Variables**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the fundamental concepts and techniques of integral calculus of single and multi-variables, vector calculus and theory of complex variables	Course Outcomes	CO1	Able to apply definite integrals to evaluate length of plane curves; to determine volume and surface area of solids of rotation
			CO2	Able to understand the concepts of improper integrals and their convergence properties
			CO3	Able to apply the knowledge of multiple integrals to solve problems related to areas, volumes, etc
	To develop problem solving and critical thinking skills.		CO4	Able to apply Gauss' divergence theorem, Stokes' theorem and Green's theorem to evaluate double and triple integrals
			CO5	Able to understand complex numbers, the algebra and geometry of complex numbers, complex plane and analytic functions
			CO6	Able to evaluate contour integrals by using Cauchy's Integral Theorem, Cauchy Integral Formulae, Residual Theorem

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
4	CO4	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
5	CO5	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
6	CO6	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	**Integral Calculus:** Definite integral: length of a plane curve, surface area of revolution, volume of solids of revolution; Differentiation under sign of integral: Leibnitz rule; Improper integrals, convergence tests, beta and gamma functions; Multiple Integrals: double and triple integrals, volume and surface integrals.	**21**	**CO1** **CO2**
II	**Vector Calculus:** Gradient, divergence, curl; line and surface integrals; Green's theorem; Gauss' theorem; Stokes theorem.	**11**	**CO3** **CO4**
III	**Complex Variables:** Analytic functions, Cauchy-Riemann equations, harmonic functions; Line integrals, Cauchy's integral theorem, Cauchy's integral formula; Power series, Taylor and Laurent series; Poles and residues, Cauchy's residual theorem.	**16**	**CO5** **CO6**
Total Hours		**48**	

Essential Readings

1. J. Stewart, "Calculus", Cengage Learning India Pvt. Limited, 7th edition, 2017.
2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition 2015.

Supplementary Readings

1. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5th edition, 2016.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation **. 2018-19**
Department	**Electronics and Communication Engineering**	Semester **I/II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 101	**Basic Electronics**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To develop the student's ability to apply the basic principles ofelectronics in circuit analysis.		CO1	Verify the V-I characteristics of p-n junction diode, schottkydiode, zener diode (Voltage Regulation), LED and study ofrectifier and filtering Circuits.
	To develop the student's ability to design basic circuits based on diode,transistor and digital logic ICs.		CO2	Study the characteristics and switching action of BJT in CE, CB andCC mode.
	To provide the students with some knowledge and analysisskills associated with the principles of operation andapplications of the digitalsystems.		CO3	Interpret the truth tables of logic gates and De-morgan'stheoremsfor digital electronics circuits.
	To develop the student's ability to communicate effectively the knowledge of electronics and communication systems.		CO4	Understand about Radio Frequency Spectrum, modulation anditsapplication in transmitter and receivers.
			CO5	Explain the working of electronic instruments like Cathode RayOscilloscope & Digital Storage Oscilloscope, FunctionGenerator, Power Supply, Digital Multimeter.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**	**3**
2	CO2	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**
3	CO3	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**	**3**
4	CO4	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**	**3**
5	CO5	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Fundamentals concept of semiconductor (Energy Bandgap, Mobility, Conductivity & Resistivity) and Junction(Metal-Semiconductor and Semiconductor –Semiconductor (homo and hetero-junction). **Diode and it's circuits** Basic p-n junction Diode Theory, Zener Diode, Photodiode, Light Emitting Diode, Varactor Diode, and Schottky Diode. Half Wave Rectifier Circuit, Full Wave Rectifier Circuit and Bridge Rectifier Circuit, Filtering Circuits (C, L, L-C & πfilters), Voltage Multipliers.	**07**	**CO1**
II	**Diode and it's circuits** Transistor Theory, Transistor Action, Transistor Symbols, Common Collector, Common Emitter and Common Base Configurations, Different Biasing Techniques, Concept of Transistor Amplifier.	**04**	**CO2**
III	**Digital Electronics** Boolean Algebra, Logic Gates, Combinational Circuits.	**03**	**CO3**
IV	**Communication** Introduction to Radio Frequency Spectrum, Modulation, Need of Modulation, Different Types of Modulation, BasicCircuits of Modulation and Demodulation, Transmitters and Receivers, Application of Modulation.	**06**	**CO4**
V	**Instrumentation** Cathode Ray Oscilloscope & Digital Storage Oscilloscope: Theory and Applications, Function Generator, Power Supply, Digital Multimeter.	**04**	**CO5**
Total Hours		**24**	

Essential Readings

1. Basic Electronics, Chattopadhyay&Rakshit, New Age Publisher, 2009

Supplementary Readings

1. Electronics Principles, Albert P. Malvino, Publisher: Tata McGraw-Hill, 2010
2. Electronics Devices, Thomas L. Floyd, Publisher: Pearson Education, 2008

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology (All branches)**	Year of Regulation	**2019-20**
Department	**Chemistry**	Semester	**I or II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CY 101	**Chemistry**	**2**	**1**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To provide the students with some knowledge of coordination chemistry and properties and applications of co-ordinations compounds	Course Outcomes	CO1	Able to acquireknowledge about coordination chemistry, properties and identification of its application
	To provide fundamental understanding on electrochemistry, corrosion, reaction dynamics, polymer science and importance of green chemistry		CO2	Able to acquire knowledge about electrochemical analysis and identification of application to engineering problems (energy storage devices and corrosion)
	To develop the student's ability to apply knowledge of different instrumental methods for chemical analysis		CO3	Able to acquire knowledge about the basics chemical kinetics, theories of reaction rates and their applications in catalysis
			CO4	Able to acquireknowledge about various instrumental techniques and their applications in chemical analysis
	To introduce the students with the concept, classifications and industrial applications of different polymers		CO5	Able to acquire knowledge about different types (solid, liquid and gases) of fuels and its extraction process and their applications
			CO6	Able to acquire knowledge about the concepts of polymers, polymerization processes and their industrial applications

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
4	CO4	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
5	CO5	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
6	CO6	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	Double salts, coordination compounds, different types Werner's theory of coordination compounds, valance bond and crystal field theory of co-ordination compounds, optical and magnetic properties, isomerism in co-ordination compounds	**05**	**CO1**
II	Conductance of electrolytic solutions, effect of temperature and concentration, conductometric titrations Redox reactions, electrode potential, Nernst equation, factors affecting the emf of half cells, Latimer diagram, hydrogen half-cell, calomel half-cell, quinhydrone half-cell. Introduction to fuel cell.	**07**	**CO2**
III	Galvanic series, electrochemical theory, galvanic corrosion, crevice corrosion and pitting corrosion, control of corrosion.	**04**	**CO2**
IV	Theoretical and experimental pH-metry, potentiometry and colorimetry.	**04**	**CO4**
V	Principals and applications of green chemistry	**01**	**CO3**
VI	Various factors affecting the rate of reactions, integrated rate laws for zero, first and second order reactions, half-life periods Activation energy, theories of reaction rates, catalysis, kinetics of homogeneous, heterogeneous and enzyme catalysis	**06**	**CO3**
VII	Solid, liquid and gaseous fuels, coal analysis, classification of coal, anti-knocking agents, octane number and cetane number, aviation fuel and biodiesel.	**04**	**CO5**
VIII	Concepts, classification, structures, and molecular weights of polymers, mechanism and kinetics of various polymerization process, natural rubber and its properties, vulcanization of rubber, synthesis and applications of various industrial polymers.	**05**	**CO6**
	Total Hours	**36**	

Essential Readings

1. P. C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publication Co.
2. S. S. Dara, "A Text Book of Engineering Chemistry", S. Chand & Co. Ltd.

Supplementary Readings

1. M. G. Fontana, "Corrosion Engineering", McGraw-Hill Book Company.
2. R. Gopalan, "Engineering Chemistry", Vikas Publishing House Pvt. Ltd.
3. B. K. Sharma, "Engineering Chemistry", Krishna Prakashan Media (P) Ltd.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology (All branches)**	Year of Regulation	**2019-2020**
Department	**Chemistry**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CY 102	**Environmental Science**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To provide the basic knowledge about the environment and its related socio-economic problems by motivating various stakeholders to participate in environment protection and environment improvement programmes.	Course Outcomes	CO1	Able to develop the knowledge of various types of natural resources, their proper utilizations and conservations for maintaining ecological balance.
	The supply the knowledges of chemistry of elements and compounds in the atmosphere, water and soil, and to give special emphasis on the different processes that define the linkages between individual segments of environment.		CO2	Able to determine the features of renewable energy resources, their establishment and proper functioning at large scale, futher they may find ways for sustainable development.
	To give student the awareness of the fundamental chemical processes those are significant to environmental problems.		CO3	Able to understand the resources and impacts of various types of pollutions on environment, futher they will get the ideas of probable solutions based on current sciences and technologies methods
	To nurture the knowledge of protection for the natural resources based on sustainable development and uses for the living beings.		CO4	Able to distinguish the interrelation of multiple factors in environmental challenges

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**			
4	CO4	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**			
5	CO5	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
I	**Introduction and natural resources** Multidisciplinary nature of environmental studies, scope and importance, concept of sustainability and sustainable development. Land resources: Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, population growth and associated problems. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs and case studies.	**06**	**CO1 CO2**
II	**Ecology** Elements of ecology, definition of ecosystem, biotic and abiotic components. Ecological balance and consequence of change: Effect of abiotic factor on population, flow chart of different cycles with only elementary reaction (oxygen, nitrogen, phosphate, sulphur) and food chain.	**02**	
III	**Air pollution** Source and effect of pollutants, primary and secondary pollutants, control measures. Acid rain: Impacts on human communities and agriculture. Green-house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Depletion of ozone layer: CFC, destruction of ozone lair by CFC, impact of other greenhouse gases, effect of ozone modification.	**03**	**CO3 CO4**
IV	**Water pollution** Natural water; pollutants: their origin and effects: oxygen demanding wastes, pathogens, nutrients, salts, thermal application, heavy metals, pesticides, volatile organic compounds. River/ lake/ ground water pollution: River water – BOD, COD and TOC, oil, Grease, pH. Lake water: Eutrophication, Ground water: Aquifers, hydraulic gradient, and ground water flow.	**03**	**CO3 CO4**
V	**Land pollution** Lithosphere composition. Pollutants: Municipal, industrial, commercial, agricultural, hazardous solid wastes; recovery and conversion method waste and waste management land filling, incineration, composting.	**03**	**CO3 CO4**
VI	**Noise pollution** Definition of noise, effect of noise pollution, noise classification, transport noise, occupational noise, neighbourhood noise, definition of noise intensity, noise threshold limit value.	**03**	**CO3 CO4**
VII	**Human communities and the environment** Human health and welfare, resettlement and rehabilitation of affected persons, case studies, disaster management: flood, earthquake, cyclones and landslides. Environmental movements – Chipko, Silent valley and Bishnois of Rajasthan. Environmental ethics: Role of Indian and other nations and cultures in environmental conservations, public awareness. Environmental protection Acts.	**04**	**CO1 CO2**
Total Hours		**24**	

Essential Readings

1. A. Basak, "Environmental Studies", Pearson, 1st Edition, 2009.
2. D. Dave and S.S. Katewa, "Text Book of Environmental Studies", Cenage Learning, 2nd Edition, 2012.

Supplementary Readings

1. R. Daniels and J. Khrishnaswamy, “Environmental Studies”, Wiley, 1st Edition, 2009.
2. S. Somvanshi and R. Dhupper, “Fundamentals of Environmental Studies”, S. K. Kataria& Sons, 1st Edition 2011.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 102	**Introduction to Computing**	**2**	**1**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To introduce the basic architecture of a computer, the concept of algorithm, the basic concepts and terminology of programming in general and concept of functional hierarchical code organization.		CO1	**Able to explain the basic architecture of a computer, the concept of algorithm, and the basic concepts and terminology of programming in general.**
	To inculcate the ability to do algorithmic thinking to analyse real-world problems and develop algorithms to solve those.		CO2	**Able to develop the ability to do algorithmic thinking to analyse a problem and develop an algorithm to solve it.**
	To introduce programming using C language and writing programs in C on a computer, and edit, compile, debug, correct, recompile and run those.		CO3	**Able to use the C programming language to implement various algorithms.**
	To train the students in choosing right data representation formats based on a problem specification.		CO4	**Able to choose the right data representation formats based on the requirements of the problem.**
			CO5	**Able to write programs on a computer, edit, compile, debug, correct, recompile and run those.**
			CO6	**Able to understand the concept of functional hierarchical code organization.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	0	1	0	1	0	0	0	0	1	1	1	0	0	0
2	CO2	2	3	3	2	1	1	0	0	1	0	0	0	1	1	1
3	CO3	3	3	3	2	1	0	0	0	1	0	0	0	0	1	1
4	CO4	3	1	1	2	0	0	0	0	0	0	0	0	0	2	3
5	CO5	3	0	3	1	3	0	0	0	1	0	0	0	0	1	1
6	CO6	3	2	2	2	0	0	0	0	2	0	0	0	0	0	1

SYLLABUS

No.	Content	Hours	Cos
I	**Introduction** **• Organization of a Computer: Von Neumann architecture; CPU; Memory; RAM; ROM; Hardware; Software; Application Programs; System Programs; Operating Systems; Number Systems.** **• Concept of Programming and Programming Languages: Machine Language; Assembly Language; High-Level Programming language; Compiler; Assembler; Interpreter; Linker; Loader; Compiling a C program in command line and in an IDE** **• Concept of Algorithm, Flowchart, Pseudo code, Illustrative Problem Solving Examples.**	**07**	**CO1** **CO2**
II	**Introduction to C programming language** **• Features of a Programming Language: Character Set; Constants; Escape Sequences; Identifiers; Keywords; Data Types; Data Type Qualifiers; Variables; Declarations; enum; typedef; Operators & Expressions - Binary operators :- Arithmetic Operators, Logical Operators, Relational Operators, Bitwise Operators; Assignment Operator; Shorthand Assignment Operators; Unary Operators; Ternary Operators; Special Operators; sizeof(); Operator Precedence and Associativity in expressions; Data type conversion: coercion (implicit type conversion), type casting (explicit type conversion); Statements: Assignment statements, Input/ Output statements for standard input/ output devices.** **Flow Control - Conditionals and Branching :- Simple if Statement, if-else Statement, Nested if-else Statement, Ladder structure of if-else, switch-case statement, goto statement;** **Iteration - while Statement, do-while Statement, for Statement, break and continue.** **Functions; Function Types - standard library functions, user defined functions; syntax of functions; Arguments and Parameters; Call by Value; Call by Reference; parameterized main function; Storage Classes - auto, register, static, extern; Scope Rule: Variable scope - local, global; Recursion.** **Arrays - Single Dimensional Arrays, Multi-Dimensional Arrays, Introduction to strings :- Definition of a string, character arrays and strings, pointers and strings, standard library string functions, arrays of strings; Pointers - different types of pointers, pointer arithmetic, pointers and arrays.** **Structures - creating structures using struct, Arrays in Structures, Array of Structures, Difference between arrays and structures; Unions - creating structures using union, difference between structures and unions.** **Preprocessor directives and Files - Preprocessor directives :- File inclusion by macro, macros, macros and functions; Basic Input/ Output operations on Files :- Text files and binary files, file opening modes, opening, closing, reading, writing and appending to a file.** **(A programming language like C/ C++ shall be used as a basis language. The same language is to be used for the laboratory).**	**29**	**CO3** **CO4** **CO5** **CO6**
	Total Hours	**36**	

Essential Readings

1. E. Balagurusamy, “Programming in ANSI C”, McGraw-Hill Education, 6th edition, 2019.

2. V. Rajaraman, “Fundamentals of Computers”, PHI Learning, 6th revised edition, 2014.
3. Yashavant Kanetkar, “Let Us C”, BPB Publications, 16th edition, 2017.

Supplementary Readings

1. Byron S. Gottfried, “Programming with C”, McGraw-Hill Education, 4th edition, 2018.
2. Brian W. Kernighan, Dennis M. Ritchie, “The C Programming Language: ANSI C Version”, Pearson Education India, 2nd edition, 2015.
3. Darrel L. Graham, “C Programming Language”, Createspace Independent Publishing, 1st edition, 2016.

	National Institute of Technology Meghalaya An Institute of National Importance								CURRICULUM
Programme	**Bachelor of Technology in Mechanical Engineering**					Year of Regulation			**2020-21**
Department	**Mechanical Engineering**					Semester			**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
ME 152	**Workshop practice**	**0**	**0**	**4**	**2**	**100**	**0**	**0**	**100**

Course Objectives	Explain the tools, equipments and safety procedures of carpentry, fitting, welding and machine shops. (understanding).	Course Outcomes	CO1	Utilize the tools and equipments to perform specified jobs in fitting shop and compare with prescribed dimensions. (Applying).
			CO2	Utilize the tools and equipments to perform specified jobs in carpentry shop and compare with prescribed dimensions. (Applying).
	To explain the working of lathe machine and perform operations		CO3	Utilize the tools and equipments to perform specified jobs in welding shop and compare with prescribed dimensions. (Applying).
			CO4	Utilize the lathe to develop the prescribed job (Application)

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**3**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**0**
3	CO3	**3**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**0**
4	CO4	**3**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**0**

SYLLABUS

No.	Content	Hours	COs
I	To perform T-join with drilling in the centre in the fitting with the use of specific tools	**08**	**CO1**
II	To develop cross join, dovetail join and briddle join in carpentry shop with the use of specific tools	**08**	**CO2**
III	To develop L-join, Butt join in Metal arc welding and T-join Oxy-acetylene gas welding	**08**	**CO3**
IV	To make specific job using Lathe machine in machine	**08**	**CO4**
	Total Hours	**32**	

Essential Readings

1. S.K. Hajra Chaudhary, Elements of Workshop Technology Vol-I and II, Asia Publishing House

Supplementary Readings

1. Gupta K.N. & Kaushish J.P., Workshop Technology, New Delhi Heights Pub., New Delhi.
2. H.S. Bava, Workshop Technology, Tata McGraw Hill Publishing Co. Ltd.
3. W.A.J. Chapman, Workshop Technology, ELBS Low Price Text, Edward Donald Pub. Ltd.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**I/II**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	INT	END	Total
EC 151	Basic Electronics Engineering Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**

Course Objectives	To develop the student's ability to apply the basic principles ofelectronics in circuit designing.	Course Outcomes	CO1	Verify the V-I characteristics of p-n junction diode, schottky diode, zener diode (Voltage Regulation), LED and study of rectifier and filtering Circuits.
	To develop the student's ability to design circuits based on diode,transistor and digital logic ICs.		CO2	Study the characteristics and switching action of BJT in CE, CBand CC mode.
	To develop the student's ability to communicate effectively the knowledge of electronics and communication systems.		CO3	Interpret the truth tables of logic gates and Demorgan's theoremsfor digital electronics circuits.
			CO4	Work in teams to plan and execute the creation of complex Digitalsystems.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**3**	**0**	**3**	**3**
2	CO2	**3**	**1**	**1**	**0**	**1**	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**2**	**0**	**2**	**3**
3	CO3	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**2**	**3**	**2**	**3**
4	CO4	**1**	**1**	**1**	**1**	**0**	**3**	**3**	**1**	**1**	**3**	**0**	**0**	**2**	**3**	**2**	**3**

SYLLABUS

No.	List of Experiments	Hours	COs
	1. I-V characteristics of forward biased P-N junction Diode. 2. Reverse characteristics of Zener Diode 3. Zener Diode as a reference Diode. 4. Half-wave rectifier using diode 5. Full-wave rectifier using diode 6. Bridge rectifier. 7. Truth Table verification of Logic Gates. 8. Design of basic logic gates using NAND & NOR gates 9. Input & output characteristics of BJT in CB mode 10. Input & output characteristics of BJT in CE mode	12	CO1, CO2, CO3 & CO4
	Total Hours	**12**	

Essential Readings

1. Basic Electronics, Chattopadhyay & Rakshit, New Age Publisher, 2009

Supplementary Readings

1. Electronics Principles, Albert P. Malvino, Publisher: Tata McGraw-Hill, 2010
2. Electronics Devices, Thomas L. Floyd, Publisher: Pearson Education, 2008

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology (All Branches)**	Year of Regulation	**2019-2020**
Department	**Chemistry**	Semester	**I or II**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution		
			L	T	P	C	Continuous Assessment		Total
CY 151	**Chemistry Laboratory**	**NA**	**0**	**0**	**2**	**1**	**01 Experiment**	**10**	**100**

Course Objectives	To provide the students with knowledge on various techniques for chemical analysis	Course Outcomes	CO1	Able to acquireknowledge about various techniques for quantitative analysis and theirapplications for estimation of metal ions and anions
	To provide the students with knowledge on various techniques for chemical analysis		CO2	Able to acquireknowledgeabout spectrophotometryand its application in chemical analysis; kinetics of chemical reactions
	To develop the student's ability to use of different instrumental methods for chemical analysis		CO3	Able to understand the resources and impacts of various types of pollutions on environment, further to achieve the ideas of probable solutions based on current sciences and technologies methods

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
2	CO2	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
3	CO3	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			

SYLLABUS

No.	Content	Hours	COs
1	To determine the alkalinity of given water sample	**2**	**CO1**
2	Estimation of Fe(II) in Mohr's salt solution using standard $KMnO_4$ solution via Redox titration	**2**	**CO1**
3	Conductometric titration of an unknown acid solution using a standard base solution	**2**	**CO3**
4	pH-metric titration of an unknown acid solution using a standard base solution	**2**	**CO3**
5	Complexometric determination of hardness of water	**2**	**CO3**
6	Iodometric determination of copper in brass alloy	**2**	**CO1**
7	Spectrophotometry on copper sulphate solution	**2**	**CO2**
8	Determination of partition coefficient of acetic acid between *n*-butanol and water	**4**	**CO1**
9	Determination of percentage composition of sugar solution from viscosity	**4**	**CO1**
10	Estimation of Fe(II) in a solution using standard $K_2Cr_2O_7$ solution via potentiometric titration	**2**	**CO1**
	Total Hours	**24**	

References

1. J. Mendham, R. Denny, J. Barnes, M. Thomas, 'Vogel's Quantitative Chemical Analysis', Prentice Hall
2. V. D. Athawale, P. Mathur, 'Experimental Physical Chemistry', New Age International (P) Limited Publishers
3. Departmental laboratory manual

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Mechanical Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Quiz/ Viva	Total
CS 152	**Computing Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	To introduce programming using C language and to write programs in C on a computer, and to edit, compile, debug, correct, recompile and run those.	Course Outcomes	CO1	Able to explain the basic concepts and terminology of programming in general.
			CO2	Able to do algorithmic thinking to analyse a problem and develop an algorithm to solve it.
	To inculcate the ability to do algorithmic thinking to analyse real-world problems and develop algorithms to solve those.		CO3	Able to use the C programming language to implement various algorithms.
			CO4	Able to choose the right data representation formats based on the requirements of the problem.
	To train the students in choosing right data representation formats based on a problem specification.		CO5	Able to write programs on a computer, edit, compile, debug, correct, recompile and run those.
			CO6	Able to understand the concept of functional hierarchical code organization.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**
2	CO2	**2**	**3**	**3**	**2**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**0**
3	CO3	**3**	**3**	**3**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**3**	**0**
4	CO4	**3**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
5	CO5	**3**	**0**	**3**	**2**	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**
6	CO6	**3**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**

SYLLABUS

No.	Content	Hours	COs
I	C program to print the paragraph as shown below: " Hello World " % Hello World % \\ Hello World \\ C program to print the result of the following arithmetic expression where a=4, b= 5. $\frac{5a + ab^2}{a^2+9}$	**02**	**CO1** **CO2** **CO3** **CO4** **CO5** **CO6**
II	C program to check a given number is odd or even and positive or negative. C program to read three numbers and find the greatest one.	**02**	
III	C program to read five numbers and find the second smallest number. C program to find GCD and LCM of two numbers.	**02**	
IV	C program to store ten numbers in an array and find the largest and smallest. C program to store N numbers in an array and count the total positive, negative, odd and even numbers [0 < N < 11].	**02**	
V	C program to check whether a given number is prime or not. C program to print first N numbers of Fibonacci series.	**02**	
VI	C program to find a key from n numbers using sequential search (Linear search), and if found, show the position. Implementation of an algorithm to insert an element at any arbitrary position in an array of integer numbers and also the implementation of an algorithm to display the condition of the array before and after insertion.	**02**	
VII	Implementation of an algorithm to delete an element in an array of integer numbers and also the implementation of an algorithm to display the condition of the array before and after deletion. Implementation of an algorithm to reverse the elements of an array of integer numbers and also the implementation of an algorithm to display the condition of the array before and after reversal.	**02**	
VIII	C program to solve Tower of Hanoi problem for n disks. C program to generate n Fibonacci numbers using both recursive and non-recursive methods.	**02**	
IX	C program to implement a swap function to swap the values of two variables. C program to store the name, roll number, marks and grades of 5 students using array of structure.	**02**	
X	C program to create a file named "StudentDatabase" and storing the name, roll number, phone number and average marks of N students, where N is a natural number between 2 to 10.	**02**	
	Total Hours	**20**	

Essential Readings

1. E. Balagurusamy, "Programming in ANSI C", McGraw-Hill Education, 6th edition, 2019.
2. V. Rajaraman, "Fundamentals of Computers", PHI Learning, 6th revised edition, 2014.
3. Yashavant Kanetkar, "Let Us C", BPB Publications, 16th edition, 2017.

Supplementary Readings

1. Byron S. Gottfried, "Programming with C", McGraw-Hill Education, 4th edition, 2018.
2. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", Pearson Education India, 2nd edition, 2015.
3. Darrel L. Graham, "C Programming Language", Createspace Independent Publishing, 1st edition, 2016.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology**	Year of Regulation	**2018**
Department	**Mathematics**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
MA 201	**Integral Transforms and PDEs**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the fundamental concepts of Fourier series, Fourier transforms and Laplace transforms To introduce their applications to differential equations	Course Outcomes	CO1	Able to find Fourier series, Fourier cosine and sine series for a given periodic function
			CO2	Able to determine Fourier and inverse Fourier transform of a function and understand the fundamental properties
			CO3	Able to determine Laplace transform of a function and understand the fundamental properties
			CO4	Able to apply Fourier and Laplace transform in solving ODEs and PDEs
			CO5	Able to determine series solution for Legendre's and Bessel's equation
			CO6	Able to classify the second order PDEs and obtain the solution of heat, wave and Laplace equations by using Fourier series

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
2	CO2	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
3	CO3	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
4	CO4	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
5	CO5	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
6	CO6	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**

No.	Content	Hours	COs
I	**Fourier Series**: Periodic functions, trigonometric series, Fourier series of a function with arbitrary period with special emphasis on functions of period 2π, Fourier series of even and odd functions, half-range Fourier series.	**11**	**CO1**
II	**Integral Transforms:** Fourier Transform: Fourier integral theorem, Fourier sine and cosine integrals, complex form of Fourier integral, Fourier transform of derivative of a function, applications of Fourier transform in boundary value problems; Laplace Transform: Laplace transform of a function, existence theorem, Laplace transform of derivatives and integrals, inverse Laplace transform, convolution theorem, use of Laplace transform in solving differential equations**.**	**20**	**CO2** **CO3** **CO4**
III	**Series Solution to ODE:** Legendre's and Bessel's differential equations.	**6**	**CO5**
IV	**Partial Differential Equations** Introduction to partial differential equations, separation of variable	**11**	**s**
	Total Hours	**48**	

Essential Readings

1. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition 2015.
2. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5th edition, 2016.

Supplementary Readings

1. P. Dyke, "An Introduction to Laplace Transforms and Fourier Series", Springer Undergraduate Mathematics Series, 2005

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science and Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 201	**Data Structures**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To understand the fundamental concept of data structures and algorithms.		CO1	**Students shall be able to understand of basic concepts of dynamic memory management, data types, algorithms, asymptotic notation and basic data structures.**
To develop skill for choosing data structures for different applications.		CO2	**Students shall be able to design, analyze and implement searching and sorting algorithms using different data structures for various applications.**
To develop skill for solving problems using algorithm design techniques such as divide and conquer and writing programs for these solutions.		CO3	**Students shall be able to find the bugs in programs with data structures, formulate new solutions and improve in existing code using learned algorithms and data structures**
To develop skill for designing, analyzing, correctness and implementing algorithms using various data structures.		CO4	**Students shall be able design of algorithm for representing and implementing nonlinear data structure such as Tree, Graph in real world applications.**
To implement hashing, linear and nonlinear data structures for real word application as per requirements.		CO5	**Students shall be able to analysis of algorithms in terms of space and time complexities for different application using linear and nonlinear data structures.**
		CO6	**Students shall be able to realize the basic concepts of hashing schemes, collision concepts and implement hashing shames for applications.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**2**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**3**	**2**	**3**
2	CO2	**2**	**2**	**3**	**3**	**1**	**0**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**
3	CO3	**1**	**3**	**3**	**2**	**2**	**0**	**2**	**2**	**1**	**1**	**2**	**0**	**2**	**3**	**3**
4	CO4	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**3**
5	CO5	**2**	**2**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**3**
6	CO6	**2**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction & Overview:** Concept of data type, definition and brief description of various data structures, operations on data structures, algorithm complexity, Big Oh notation, recursion, some illustrative examples of recursive functions. **Review of Pointers and Dynamic Memory Management**: Understanding pointers, usage of pointers, memory management functions, debugging pointers. **Arrays:** Linear and multi-dimensional arrays and their representation, operations on arrays, sparse matrices and their storage.	**10**	**CO1** **CO2**
II	**Linked Lists:** Linear linked list, operations on linear linked list, doubly linked list, operations on doubly linked list, application of linked lists. **Stacks:** Sequential and linked representations, operations on stacks, multi stacks, application of stacks such as parenthesis checker, evaluation of postfix expressions, conversion from infix to postfix representation, implementing recursive functions. **Queues:** Sequential representation of queue, linear queue, circular queue, operations on linear and circular queue, linked representation of a queue and operations on it, priority queues, applications of queues.	**11**	**CO2** **CO3**
III	**Sorting & Searching:** Sorting arrays using bubble sort, selection sort, insertion sort, quick sort, merge sort, heap sort, shell sort, tree sort, radix sort, etc., searching an element using linear search and binary search techniques, concatenation of arrays and merging sorted arrays. **Heaps:** Representing a heap in memory, operations on heaps, application of heap in implementing priority queue and heapsort algorithm.	**05**	**CO3** **CO4**
IV	**Trees:** Basic terminology, array and linked representations of trees, traversing a binary tree using recursive and non-recursive procedures, inserting a new node, deleting a node, counting nodes, finding height, finding a mirror image of a binary tree, threaded binary trees, AVL trees and B-trees. **Graphs:** Basic terminology, representation of graphs (adjacency matrix, adjacency list), traversal of a graph (breadth first search and depth-first search), adding nodes, deleting nodes, applications of graphs in problems such as finding shortest paths, obtaining minimum cost spanning tree, etc.	**10**	**CO4** **CO5**
V	**Hashing:** Comparing direct address tables with hash tables, hash functions, concept of collision and its resolution using open addressing and separate chaining, double hashing, rehashing	**03**	**CO5** **CO6**
Total Hours		**39**	

Essential Readings

1. Dr. D.S. Kushwaha, Dr. Arun Kumar Mishra, "A Programming approach with C ", 2nd Edition, PHI India, 2014.
2. Seymour Lipschutz, "Data Structures", Revised 1st Edition, Tata McGraw hill Publication, 2013.

3. Mark Allen Weiss, “Data Structures And Algorithm Analysis In C”, 2nd Edition, Pearson Education, 2002.

Supplementary Readings

1. A.K. Sharma,” Data Structures using C”, Pearson, 2011.
2. Yedidyah Langsam, Aaron M. Tenenbaum, Moshe J. Augenstein, “Data Structures Using C and C++, 2nd Edition, PHI, 2011.
3. Kyle Loudon ,“Mastering Algorithms With C Useful Techniques From Sorting To Encryption”1st Edition, O'Reilly, 2009.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 203	**Digital Logic Design**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To introduce the concept of digital and binary systems, number representation and conversion between different representations in digital electronic circuits and to acquire the knowledge of digital logic levels and Boolean logic.		CO1	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
			CO2	To understand and examine the structure of various number systems and its application in digital design.
			CO3	The ability to understand, analyse and design various combinational circuits.
	To make student be able to design and analyse combinational logic circuits and design and analyse sequential logic circuits.		CO4	The ability to understand, analyse and design various sequential circuits.
			CO5	Develop a digital logic and apply it to solve real life problems.
	To understand concept of Programmable Devices, RAM, ROM, PLA, PAL.			

No.	Cos	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
2	CO2	**2**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
3	CO3	**3**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
4	CO4	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
5	CO5	**3**	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**2**

SYLLABUS

No.	Content	Hours	COs
I	Number systems and codes: Addition, Subtraction, Multiplication and Division using Different Number Systems; Representation of Binary Number in Sign-Magnitude, Sign 1's Complement and Sign 2's Complement Notation; Rules for Addition and Subtraction with Complement Representation; BCD, EBCDIC, ASCII, Extended ASCII, Gray and other Codes.	**05**	**CO1,CO2**
II	Boolean algebra and switching functions : Basic Logic Operation and Logic Gates, Truth Table, Basic Postulates and Fundamental Theorems of Boolean Algebra, Standard Representations of Logic Functions- SOP and POS Forms, Simplification of Switching Functions-K-Map and Quine-Mccluskey Tabular Methods, Synthesis of Combinational Logic Circuits.	**07**	**CO1, CO5**
III	Combinational logic circuits using msi integrated circuits: Binary Parallel Adder, BCD Adder, Encoder Priority Encoder, Decoder, Multiplexer and Demultiplexer Circuits, Implementation of Boolean Functions using Decoder and Multiplexer, Arithmetic and Logic Units, BCD-To-Segment Decoder, Common Anode and Common Cathode, 7-Segment Displays, Random Access Memory, Read Only Memory and Erasable Programmable ROMs, Programmable Logic Arrays(PLA) and Programmable Array Logic(PAL).	**13**	**CO1, CO3**
IV	Introduction to flip-flops: Basic Concepts of Sequential Circuits, Cross Coupled SR Flip-Flop Using NAND or NOR Gates, JK Flip-Flop Rise Conditions, Clocked Flip-flops, D-Types and Toggle Flip-flops, Truth Tables and Excitation Tables for Flip-flop. Master Slave Configuration, Edge Triggered and Level Triggered Flip-flop, Elimination of Switch Bounce using Flip-flop, Flip-flop with Preset and Clear.	**10**	**CO1,CO4**
V	Sequential logic circuit design : Introduction to State Machine, Mealy and Moore Model, State Machine Notation, State Diagram, State Table, Transition Table, Table Excitation, Table and Equation, Basic Concepts of Counters and Register, Binary Counters, BCD Counters, Up Down Counter, Johnson Counter, Module-N Counter, Design of Counter using State Diagrams and Tables, Sequence Generators, Shift Left and Right Register, Registers with Parallel Load, Serial -in-Parallel-Out(SIPO) and Parallel-In-Serial-Out(PISO), Register Using Different Types of Flip-flop.	**12**	**CO1, CO4**
VI	Digital logic families : Digital IC Terminology, Transistor-Transistor Logic(TTL), Integrated Injection Logic(I2L), Emitter Coupled Logic (ECL), Metal Oxide Semiconductor(MOS) Logic, Complementary Metal oxide semiconductor (CMOS) Logic.	**03**	**CO1, CO5**
	Total Hours	**50**	

Essential Readings:

1. L. Thomas Floyd and R.P. Jain, "Digital Fundamentals", 11th ed., 2015, Pearson Education.
2. Kime Charies R and Morris Mano, "Logic and Computer Design Fundamentals", 4th ed., 2014, Pearson Education.
3. Morris Mano, "Digital Logic and Computer Design", 1st ed., 2004, Pearson Education.

Supplementary Readings:

1. R.P. Jain and M.H.S. Anand, "Digital Electronics Practice using Integrated Circuits", 1st ed., 2004, Tata McGraw Hill.
2. Samuel C. Lee, "Digital Circuits and Logic Design", 2009 edition, PHI (Prentice-Hall of India).
3. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 2nd ed., 2017, Tata McGraw Hill.

National Institute of Technology Meghalaya

An Institute of National Importance

CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS205	**Discrete Mathematics**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	1. This course introduces the elementary structures such as sets, graphs, and trees used in computer algorithms and systems. Define and understand the properties of some of the discrete structures in Mathematics.		CO1	Able to acquire knowledge about different discrete structures of mathematics and identification of its application in computer science area
	2. This course illustrates elementary proofs, proofs by induction, deductive proofs in propositional and first order logic.		CO2	Able to acquire knowledge about different methods of proofs in propositional logic and first order predicate logic and identification of application in real world problems
	3. This course explains the principles of counting; understand recurrence relations and generating functions.		CO3	Able to work out on different problems on counting, recurrence relations and generating functions and solve these problems in real world scenarios
	4. This course illustrates the understand the basic concepts of graphs, group and ring theory		CO4	Students will be able to apply discrete structure such as graphs to solve problems of connectivity, scheduling, optimization etc.
	5. This course introduces the formulation of generating function and series evaluations		CO5	Students will be able to express recurrence relations and solve them, represent sequences and series using generating functions.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**
6	CO6	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Introduction History and Overview of discrete structure and general problems:Basic operations on sets, cartesian products, disjoint union, power sets, inverse of functions, composition of functions, relations, properties of binary relations, equivalence relations and partitions. Principle of inclusion and exclusion, pigeonhole principle	**08**	**CO1**
II	Propositional Logic: Syntax and semantics, proof systems, satisfiability, validity, soundness and completeness. Introduction to first order logic.	**08**	**CO1**
III	Introduction to recurrence relations and generating functions	**05**	**CO1 CO2**
IV	Posets, lattices, chains and anti-chains	**03**	**CO2 CO3 CO4**
V	Graphs and their basic properties – degree, path, cycle, subgraphs, isomorphism, Eulerian and Hamiltonian cycles, trees	**04**	**CO4 CO5**
VI	Groups and Rings: Groups, Subgroups, Cosets, Lagrange's theorem, Homomorphisms and Normal subgroups, Rings.	**08**	**CO2 CO4**
	Total Hours	**36**	

Essential Readings

1. Trembly, Manohar, "Discrete Mathematical Structures with Applications to Computer Science", McGraw Hill.
2. C. L. Liu, D. P. Mahapatra, "Elements of Discrete Mathematics", Tata McGraw Hill.
3. Harry Lewis and Rachel Zax, "Essential Discrete Mathematics for Computer Science", Princeton University Press, 2019

Supplementary Readings

1. Norman L. Biggs, "Discrete Mathematics", Oxford University Press.
2. Albert R. Meyer, Eric Lehman, and Frank Thomson Leighton, "Mathematics for Computer Science", Samurai Media Limited, 2010
3. V.K. Balakrishnan, "Introductory Discrete Mathematics", Dover Publications Inc., 2000

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Mechanical Engineering**	Year of Regulation	2019-20
Department	**Mechanical Engineering**	Semester	V

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
ME 291	**SAFETY ENGINEERING**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To explain the basic concept of safety, Philosophy of safety, accidents in industries and their prevention.	Course Outcomes	CO1	Students will be able to outline of safety, accidents in industry and the preventive measures.
	To explain the implication of safety engineering in industries, associated hazards, risk involved and the mitigation methods and to understand different types of machine guarding, manual and mechanical material handling.		CO2	Students will understand the necessity of safety engineering in by way of identifying the hazards, assessing the risk involved and the mitigation measures like machine guarding and safe material handling techniques etc to ensure safety at work.
	To explain the use of hand tools & portable power tools and to understand the electrical safety, fires, explosions and toxic releases in the industry.		CO3	Students will be able to Illustrate different safety tools to deal with electrical safety, fires, explosion and toxic release in industries.
	To explain the safety in construction industries and to understand the use of personal protective equipments.		CO4	Students will be able to describe the personal protective equipments and safety measures in construction sites.
	To explain the process of First Aid for the workers and safety management in the industries.		CO5	Students will be able to Illustrate the First Aid process.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
2	CO2	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
3	CO3	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
4	CO4	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
5	CO5	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	Cos
I	Concept of safety, Philosophy of safety, safety terminology, behaviour based safety, Accident - cause and prevention.	**3**	**CO1**
II	Safety engineering in industry, statutory provisions, Principles of Machine guarding, types and selection of guards, ergonomics of machine guarding, mechanical and manual material handling, hand tools and portable power tools.	**4**	**CO2**
III	Electrical safety, safety measures for electric work, fires and explosion, classification fires and fire extinguishers, toxic gas release and preventive measures thereof.	**4**	**CO3**
IV	Safety in construction industry, underground works, above ground works, underwater works, movement of men and materials, Personal protective equipment, selection and classification of PPE, statutory provisions to ensure safety at work.	**4**	**CO4**
V	Need of First Aid, Electrical injuries, artificial respiration, poisoning, first aid and antidotes, Industrial safety management, Safety Audit, Job safety analysis, Safety motivation.	**5**	**CO5**
	Total Hours	20	

Essential Readings

1. Dr. K.U. Mistry, 'Fundamentals of industrial safety and health, Siddharth Prakashan, 1st edition,2008.

Supplementary Readings

1. Charles D. Reese, Industrial Safety and Health for People-Oriented Services, CRC Press,
2. C. Ray Asfahl, David W. Rieske, Industrial Safety and Health Management, Pearson,

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS251	**Data Structure Lab**	**0**	**1**	**2**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To develop the student's ability to understand the basic concept of data structure.		CO1	**Able to understand and implement the basic data structure such as array using pointers.**
	To provide the students with various kinds of sorting and searching algorithm required in various applications.		CO2	**Able to implement and analyse the various types of sorting and searching and algorithms using different data structures for various applications.**
	To develop the student's ability to implement and analyse the various linear and non-linear data structure applicable to various applications		CO3	**Able to implement using data structure such linked list, stack, queue and analyse which particular data structure will be efficient according to the application.**
	To familiarize the student the various hashing schemes.		CO4	**Able to implement using nonlinear data structure such as Tree, Graph and analyse which particular data structure will be efficient according to the application.**
			CO5	**Able to understand and implement the various hashing schemes for applications.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
2	CO2	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**2**
3	CO3	**3**	**3**	**2**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**2**
4	CO4	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**3**	**2**	**2**
5	CO5	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**3**

Suggested List of Experiments

No.	Content	Hours	COs
I	Implement an algorithm to insert and delete an element at any arbitrary position in an array of integer numbers and also implement an algorithm to display the condition of the array before and after insertion.	**2**	**CO1**
II	Write a C program to implement sorting of n numbers using a. Bubble sort. b. Selection sort c. Insertion sort. d. Quick sort. e. Merge sort.	**6**	**CO2**
III	a. Write a program for addition of two polynomial using linked list. b. Write a program for multiplication of two polynomial using linked list c. Implement algorithms to insert an element in a stack(push), to delete an element from a stack(pop) and to display the elements of the stack.[Assume: initially, top= -1] d. Implement algorithms to insert an element in a queue, to delete an element from a queue and to display the elements of the queue.[Assume: initially, front= -1, rear= -1] e. Implement algorithms to insert an element in a circular queue, to delete an element from a circular queue and to display the elements of the circular queue.[Assume: initially, front= 0, rear= -1] 17.	**6**	**CO3**
IV	a. Write a C program to implement searching of a key from n numbers (given in Descending order) using Binary search. b. Write a C program to find a key from n numbers using sequential search (Linear search) & if found, show the position	**2**	**CO2**
V	a. Implement a binary tree using array. b. Implement a binary search tree using linked list and traverse in pre- order, in-order and post-order c. Create a binary search tree of N nodes with given N elements and search a given key element. d. Write a C program to implement sorting of n numbers using binary search tree e. Implement an AVL tree.	**4**	**CO4**
VI	a. Create a Hash table to store the account number and balance of the customers. Provide proper option to create, search and delete customer details. b. Write a c program to create a file, named "StudentDatabase" . Store the the name, roll number, phone number and average marks of N students, where N is a natural number between 2 to 10. Ex: Sl.No. Name roll number phone number average marks 1. xyz 1234567 9900221188 8.2 After creating database, modify the phone no. and marks of ith student, 1< i < =N	**4**	**CO5**
	Total Hours	**24**	

Essential Readings

1. Dr. D.S. Kushwaha, Dr. Arun Kumar Mishra, "A Programming approach with C ", 2nd Edition, PHI India, 2014.
2. Seymour Lipschutz, "Data Structures", Revised 1st Edition, Tata McGraw hill Publication, 2013.
3. Mark Allen Weiss, "Data Structures And Algorithm Analysis In C", 2nd Edition, Pearson Education, 2002.

Supplementary Readings

1. A.K. Sharma,"Data Structures using C", Pearson, 2011.
2. Yedidyah Langsam, Aaron M. Tenenbaum, Moshe J. Augenstein, "Data Structures Using C and C++, 2nd Edition, PHI, 2011.
3. Kyle Loudon ,"Mastering Algorithms With C Useful Techniques From Sorting To Encryption"1st Edition, O'Reilly, 2009.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C		Continuous evaluation	Quiz/Viva	Total
CS 253	**Digital Logic Design Lab**	**0**	**1**	**2**	**2**		**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To introduce the concept of digital and binary systems, number representation and conversion between different representations in digital electronic circuits and to acquire the knowledge of digital logic levels and Boolean logic.		CO1	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
			CO2	To understand and examine the structure of various number systems and its application in digital design.
			CO3	The ability to understand, analyse and design various combinational circuits.
	To make student be able to design and analyse combinational logic circuits and design and analyse sequential logic circuits.		CO4	The ability to understand, analyse and design various sequential circuits.
			CO5	Develop a digital logic and apply it to solve real life problems.
	To understand concept of Programmable Devices, RAM, ROM, PLA, PAL.			

No.	Cos	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
2	CO2	**2**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
3	CO3	**3**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
4	CO4	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
5	CO5	**3**	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**2**

SYLLABUS

No.	Content	Hours	COs
I	Logic Gates using Discrete Components.	**02**	**CO1,CO2**
II	Half-Adder/ Half-subtarctor Circuits using a serial Input.	**02**	**CO1, CO3**
III	Full-Adder/ Full-subtarctor Circuits using a serial Input.	**02**	**CO1, CO3**
IV	4-Bit Gray to Binary/ Binary to Gray Code convertor using Select input.	**02**	**CO1,CO3**
V	Implementing Logic Functions using MUX IC 74153.	**02**	**CO1, CO3**
VI	Flip-flops using NAND/ NOR Gate.	**02**	**CO1, CO4**
VII	Modulo-m Ripple Counter.	**02**	**CO1, CO4, CO5**
VIII	4-Bit Shift Left/Right Register	**02**	**CO1, CO4, CO5**
IX	Sequence Generator	**02**	**CO1, CO4, CO5**
X	Excess-3 BCD Adder/ Subtractor with Select Input.	**02**	**CO1, CO4, CO5**
XI	Quiz/Viva	**02**	**CO1-CO5**
Total Hours		**22**	

Essential Readings:

1. L. Thomas Floyd and R.P. Jain, "Digital Fundamentals", 11th ed., 2015, Pearson Education.
2. Kime Charies R and Morris Mano, "Logic and Computer Design Fundamentals", 4th ed., 2014, Pearson Education.
3. Morris Mano, "Digital Logic and Computer Design", 1st ed., 2004, Pearson Education.

Supplementary Readings:

1. R.P. Jain and M.H.S. Anand, "Digital Electronics Practice using Integrated Circuits", 1st ed., 2004, Tata McGraw Hill.
2. Samuel C. Lee, "Digital Circuits and Logic Design", 2009 edition, PHI (Prentice-Hall of India).
3. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 2nd ed., 2017, Tata McGraw Hill.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Quiz/ Viva	Total
CS 255	**Internet Web Technology Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	Course Outcomes		
To introduce the basics of Internet and basic concepts of web technology.		CO1	**Able to explain the basic concepts of Internet and web technology.**
To give knowledge of web designing principles.		CO2	**Able to design web pages with simpler HTML elements and their attributes.**
To train the students in writing code in HTML, CSS and JavaScript.		CO3	**Able to use links, images, multimedia, blocks, tables, frames, forms and HTML controls in web pages.**
		CO4	**Able to write CSS code and use inline, internal and external CSS styling.**
		CO5	**Able to write JavaScript code and use predefined JavaScript events.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	0	1	0	1	0	0	0	0	1	1	1	1	0	0
2	CO2	3	3	3	2	2	1	0	0	1	0	0	0	2	1	0
3	CO3	3	3	3	2	2	1	0	0	1	0	0	0	2	1	0
4	CO4	3	3	3	2	2	1	0	0	1	0	0	0	2	1	0
5	CO5	3	3	3	2	2	1	0	0	1	0	0	0	2	1	0

SYLLABUS

No.	Content	Hours	COs
1	Working with HTML - basic structure of an HTML document, creating an HTML document, markup tags, headings, paragraphs, line breaks	**01**	**CO1** **CO2** **CO3** **CO4** **CO5**
2	Working with HTML - attributes, metadata, working with text, tool tips, working with lists, tables	**01**	
3	Working with HTML - working with hyperlinks, images and multimedia, web page logo	**01**	
4	HTML blocks - div tag, HTML IDs, symbols	**01**	
5	Working with HTML - working with frames	**01**	
6	Working with HTML - working with forms and controls	**01**	
7	Introduction to CSS - sample examples for syntax introduction	**01**	
8	Concept of CSS - CSS styling (background, text format, fonts), CSS colours	**01**	
9	Concept of CSS - CSS IDs, classes and CSS Styling, working with lists and tables	**01**	
10	Concept of CSS - Box Model (introduction, border properties, padding properties, margin properties)	**01**	
11	Introduction to JavaScript - sample examples for syntax introduction	**01**	
12	JavaScript built-in functions, alert box, confirm box, prompt box	**01**	
13	Writing JavaScript user-defined functions	**01**	
14	Designing simple animations using JavaScript, JavaScript image slideshow	**01**	
	Total Hours	**14**	

Essential Readings

1. Laura Lemay, Rafe Colburn and Jennifer Kyrnin, “Mastering HTML, CSS & Javascript Web Publishing”, BPB Publications, 1st edition, 2016.
2. DT Editorial Services, “HTML 5 Black Book”, Dreamtech Press, 2nd edition, 2016.
3. P. Deitel, H. Deitel, A. Deitel, “Internet and World Wide Web: How to Program”, Pearson Education, 5th edition, 2018.
4. w3schools Tutorials, http://www.w3schools.com/

Supplementary Readings

1. Thomas Powell, “HTML & CSS: The Complete Reference”, McGraw Hill Education, 5th edition, 2017.
2. Jeffrey C. Jackson, “Web Technologies: A Computer Science Perspective”, Pearson Education India, 1st edition, 2008.
3. Uttam K. Roy, “Web Technologies”, Oxford University Press, 1st edition, 2010.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science & Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science & Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 202	**Computer Organization**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**COB1: To develop the student's ability to understand the concept of Instruction execution model, instruction set architecture and types, instruction formats and Addressing modes.**	Course Outcomes	CO1	Students should be able to Understand the how different functional units of a digital computer are organized and design, performance enhancement strategies that adopted in performance evolution of different components of computer, arithmetic logic design, cache memory and different I/O mechanism of data transfer.
	COB1: To develop the student's ability to understand the concept of control unit design based on hardwired as well as micro-programmed control approach.			
	COB3: To provide the students with some knowledge and analysis skills associated with the design of Arithmetic and Logic unit.		CO2	Students should be able to Solve the performance related problems of arithmetic logic unit, cache and virtual memory.
	COB4: To develop the student's ability to understand the concept of memory design, cache memory and its mapping techniques and virtual memory.			
	COB5: To provide the students with some basic knowledge of I/O mapping and control, interrupt and DMA mechanism.		CO3	Analyze the performance differences of different mapping techniques of cache memory, different adder circuits of ALU and different page replacement algorithms of virtual memory.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
Overview: (Hrs.: 4)	Block diagram of a computer system	**02**	**CO1**
	Instruction execution model.	**02**	**CO1**
Processor Organization: (Hrs.: 10)	Instruction set architecture- types, formats, addressing modes	**03**	**CO1 & CO2**
	Data path organization, Control unit design - Hardwired control, Microprogramming.	**04**	**CO1 & CO2**
	CISC and RISC architecture, Instruction pipelining.	**03**	**CO1 & CO2**
Arithmetic and Logic unit: (Hrs.: 8)	Computer arithmetic- Review of addition and subtraction	**03**	**CO1, CO2 & CO3**
	Multiplication- Booth's, Array; Division- Restoring and non-restoring	**03**	**CO1 & CO2**
	Floating point arithmetic	**02**	**CO1 & CO2**
Memory Organization: (Hrs.: 8)	Interfacing of memory with processor, Memory hierarchy, Multiple-module memory,	**02**	**CO1**
	Cache memory, Virtual memory.	**06**	**CO1, CO2 & CO3**
Input/output Organization: (Hrs.: 6)	Synchronization of data transfer- strobed and handshaking;	**02**	**CO1**
	I/O mapping and control- Program controlled, Interrupt driven, DMA, Interrupt and DMA mechanisms.	**04**	**CO1**
	Total Hours	**36**	

Essential Readings

1. Hamacher, Carl, Zvonko Vranesic, and Safwat Zaky. *Computer organization*. McGraw-Hill, 2002.
2. Mano, M. Morris. *Computer system architecture*. Prentice-Hall of India, 2003.
3. Stallings, William. *Computer organization and architecture: designing for performance*. Pearson Education India, 2003.

Supplementary Readings

1. Hennessy, John L., and David A. Patterson. *Computer architecture: a quantitative approach*. Elsevier, 2011.
2. Bryant, Randal E., O'Hallaron David Richard, and O'Hallaron David Richard. *Computer systems: a programmer's perspective*. Vol. 2. Upper Saddle River: Prentice Hall, 2003.
3. Ramachandran, Umakishore. *Computer systems: An integrated approach to architecture and operating systems*. Pearson Education India, 2011.

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 204	**Object Oriented Programming and Design**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To provide students in-depth theoretical base and fundamentals of Object Oriented Programming paradigm	CO1	**Able to demonstrate the procedural and object oriented paradigm with concepts of data, functions, classes and objects**
To prepare students to design and code various projects using Object Oriented Programming paradigm	CO2	**Able to illustrate dynamic memory management techniques using pointers, constructors, destructors etc.**
	CO3	**Able to make use of the concept of function overloading, operator overloading, type conversion and polymorphism**
	CO4	**Able to interpret the concept of Inheritance and its various types along with the understanding of late binding**
	CO5	**Able to compare the procedures of file handling and exception handling in C++**
	CO6	**Able to test the concept of templates and the use of Standard Template Libraries of C++**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	0	1	0	1	0	0	0	0	1	1	1	0	0	0
2	CO2	2	3	3	2	1	1	0	0	1	0	0	0	1	1	1
3	CO3	3	3	3	2	1	0	0	0	1	0	0	0	0	1	1
4	CO4	3	1	1	2	0	0	0	0	0	0	0	0	0	2	3
5	CO5	3	0	3	1	3	0	0	0	1	0	0	0	0	1	1
6	CO6	3	2	2	2	0	0	0	0	2	0	0	0	0	0	1

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** **Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation;**	**02**	**CO1**
II	**Beginning with C++:** **Getting started with C++ syntax, data types, variables, data types, type conversion – implicit and explicit, inline functions, string class, specifying classes and objects;**	**04**	**CO2**
III	**Classes and Objects:** **Data hiding, member function, memory allocation, static members, static objects, array of objects, friendly function, pointers to members, constructors and destructors;**	**06**	**CO2**
IV	**Concept of Overloading:** **Function overloading, operator overloading of unary, binary, special operators; Type conversion; Compile Time Polymorphism**	**04**	**CO3**
V	**Inheritance:** **Introduction to inheritance, different types; Single inheritance – public and private derivation, protected member, constructor and destructor in derived class; Multilevel and multiple inheritance; Ambiguity resolution; Hierarchical and hybrid inheritance; Virtual base class; Object slicing; Pointer to base and derived class; Virtual functions; Concept of VPTR and VTABLE;**	**12**	**CO4**
VI	**File Handling:** **Streams, classes for file stream, opening a file, detecting the EOF, file modes, file pointers and their functions, types of files, i/p and o/p functions for sequential and random access, error handling.**	**04**	**CO5**
VII	**Templates:** **Function templates, class templates, advantages and disadvantages, Standard Template Library.**	**04**	**CO6**
	Tutorials – Programming Practice with different C++ features	**12**	**CO2-CO6**
	Total Hours	**48**	

Essential Readings

1. Robert Lafore, “Object-Oriented Programming in C++”, 4th Edition, Sams Publishing, 2001.
2. E Balagurusamy, “Object-Oriented Programming in C++”, 8th Edition, McGraw-Hill Education India, 2020.
3. Yashvant Kanetkar, “Let Us C++ “, BPB Publication, 2020.

Supplementary Readings

1. P.J. Deitel and H.M Deitel ,”C++ How to Program”, 10th Edition, Pearson Publication, 2016.
2. Herbert Schildt, “C++: The Complete Reference”, 4th Edition, McGraw-Hill Education India, 2017.
3. Bjarne Stroustrup, “The C++ Programming Language”, 3rd Edition, Pearson Education India, 2002.

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CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS206	**Data Communication**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To introduce the components of Data Communication	CO1	**Able to learn the fundamentals of data communication**
To analyse the Analog and Digital Transmission	CO2	**Able to Understand the digital signal and analog signal transmission over different types of transmission media.**
To describe the structure of Physical and Data Link Layer	CO3	**Able to distinguish different techniques of error detection and correction and medium access control.**
To describe the function of wireless networks	CO4	**Able to acquire knowledge about the generations of wireless networks.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
3	CO3	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
4	CO4	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Overview** **Objectives and Applications of Computer Communication. Computer Communication Network Architecture: ISO - OSI reference model, design philosophy, layer, protocol, interface, and service concepts. Layer - wise functionality**	**06**	**CO1, CO4**
II	**Physical Layer** **Concepts of Data and Signals, Analog and Digital Data Transmission, Bandwidth utilization: Multiplexing techniques, Transmission Media, Switching Techniques and Telephone and Cable Networks for Data transmission.**	**12**	**CO2**
III	**Data Link Layer** **Framing and Coding techniques, Error Detecting and Correcting Codes, data link control protocols and their performances. Medium Access Control in broadcast networks : ALOHA, CSMA, CSMA/CD, token ring, token bus.**	**12**	**CO3**
IV	**Wired and Wireless LANs** **Ethernet, Connecting Devices, Backbone Networks, Standard LAN Protocols (IEEE 802.X). Wireless LANs and WANs : IEEE 802.11, Bluetooth, Cellular telephony, satellite networks. SONET/SDH, Frame Relay and ATM.**	**06**	**CO4**
Total Hours		**36**	

Essential Readings

1. Behrouz A Forouzan, “Data Communication and Networking”, 5th Edition, McGraw-Hill Education, 2018.
2. Andrew S Tanenbaum, David J. Wetherall “Computer Networks”, 5th Edition, Prentice Hall. 2011.
3. William Stallings, “Data and Computer Communication”, 10th Edition, Pearson, 2017.

Supplementary Readings

1. James F Kurose, Kaith W Ross, “Computer Networking | A Top-Down Approach”, 6th Edition, Pearson, 2017.
2. A L Garcia, I Widjaja, “Communication Networks: Fundamental Concepts and Key Architectures”, 2nd Edition, Tata McGraw Hill, 2017.
3. B. Buchanan, “The Handbook of Data Communications and Networks”, 1st Edition, Springer, 2004.
4. James F Kurose, Kaith W Ross, “Computer Networking | A Top-Down Approach”, 6th Edition, Pearson, 2017.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS212	**Analysis and Design of Algorithms**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To teach paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.		CO1	**Analyze the asymptotic performance of algorithms.**
To make students understand how asymptotic notation is used to provide a rough classification of algorithms.		CO2	**Write rigorous correctness proofs for algorithms.**
To explain different computational models and various complexity measures to analyze the complexity/performance of different algorithms.		CO3	**Apply important algorithmic design paradigms and methods of analysis.**
To teach various advanced design and analysis techniques such as greedy algorithms, dynamic programming.		CO4	**Synthesize efficient algorithms in common engineering design situations.**
Know the concepts of tractable and intractable problems and the classes P, NP and NP-complete problems.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	2	1	1	0	1	0	0	0	0	1	1	1	1	0	1
2	CO2	2	1	1	1	1	1	0	0	1	0	0	0	1	1	1
3	CO3	1	1	1	1	1	0	0	0	1	0	0	0	2	2	0
4	CO4	2	2	2	2	0	0	0	0	0	0	0	0	1	1	1

SYLLABUS

No.	Content	Hours	Cos
I	**Introduction** **Algorithm Specification, Algorithm Analysis, Analysis of Recursive Algorithms.**	**06**	**CO1** **CO2**
II	**Sorting and Selection** **Brute Force Approaches- Sequential Search, Bubble Sort, Selection Sort, Exhaustive Searching,** **Divide-and-Conquer Approach – Merge Sort, Quick Sort, Closest-pair Problem, Convex Hull Problem,** **Decrease-and-Conquer Approach – Insertion Sort, Topological Sort,** **Linear Sorting – Counting Sort, Bucket Sort, Radix Sort**	**09**	**CO2** **CO3**
III	**Greedy Algorithms** **Introduction, Knapsack Problem, Optimal Tree Problems – Optimal Merge, Huffman Coding; Optimal Graph Problems – Minimum Spanning Trees, Single-source Shortest-Path; Scheduling Problems – Scheduling without deadline, Scheduling with deadline**	**07**	**CO2** **CO3**
IV	**Dynamic Programming** **Basics of Dynamic Programming, Fibonacci Problem, Multistage Graph Problem, All Pairs Shortest-path Algorithm, Travelling Salesman Problem, Chain Matrix Multiplication, Knapsack Problem, Optimal Binary Search Trees,**	**08**	**CO2** **CO3**
V	**String processing** **String searching and Pattern matching, Knuth-Morris-Pratt algorithm and its analysis.**	**04**	**CO2** **CO4**
VI	**Computational Complexity Classes** **Upper and Lower Bound Theory, Class P, NP Class, NP- Complete**	**02**	**CO1** **CO4**
Total Hours		**36**	

Essential Readings

1. A. Aho, J. Hopcroft and J. Ullman, “The Design and Analysis of Computer Algorithms”, 4th Impression, Addison-Wesley, 2009.
2. E Horowitz, S Sahni, and S Rajasekhran, “Fundamentals of Computer Algorithms”, 2nd Edition, Universities Press, 2008.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, 3rd Edition, Pearson, 2010.
4. S. Sridhar, “Design and Analysis of Algorithms”, 1st Edition, Oxford University Press, 2015.

Supplementary Readings

1. J. Kleinberg, E Tardos, “Algorithm Design”, 1st Edition, Pearson, 2014.
2. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, “Algorithms”, 2nd Edition, Tata McGraw Hill, 2016.
3. Steven S Skiena, “The Algorithm Design Manual”, 2nd Edition, Springer, 2011.
4. H Bashin, “Algorithms Design and Analysis”, 1st Edition, Oxford University Press, 2015.

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Programme	**Bachelor of Technology in Computer Science & Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science & Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 214	**Computational Models for Real Time Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**COB1:** To develop the student's ability to understand the concepts of Real-Time Systems, their characteristics, requirements and architecture.	Course Outcomes	CO1	Students should be able to Understand the principles for modelling real-time tasks. The different scheduling policies, modelling complexities brought about by resource sharing among real-time tasks and scheduling among multiple processors.
	COB2: To develop the student's ability to understand different time of timing constraints and modelling various such timing constraints for model development.			
	COB3: To provide the students with some knowledge and analysis skills associated with the principles of real-time task scheduling.		CO2	Students should be able to Solve the scheduling and resource sharing related problems for real time systems.
	COB4: To develop the student's ability to understand the concepts of resource sharing and ways to handle dependencies among them.			
	COB5: To provide the students with some basic knowledge of multiprocessor scheduling modelling.		CO3	Analyze the performance of real-time systems with varying constraints and scenarios, including identifying performance bottlenecks.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
Module 1: Basic concepts and definitions related to Real Time Systems	Definition of Real-Time Systems, Applications of Real-Time Systems, Basic Model of a Real-Time System, Characteristics of Real-Time Systems, Safety and reliability, Taxonomy of Real-Time Systems, Timing constraints of Real-Time Systems, Events in Real-Time Systems, Modelling Timing Constraints in Real-Time Systems.	**6**	**CO1, CO2**
Module 2: Real-Time Task Scheduling	Basic concepts in real-time scheduling, Taxonomy of Real-Time Tasks and their characteristic, Tasks scheduling: Basic concepts and terminologies, Classification of Real-Time task scheduling algorithms, Clock-driven scheduling: Table-driven scheduling, Cyclic schedulers, Generalized Task schedulers, Cyclic Vs. Table-driven schedulers. Hybrid schedulers Event-driven schedulers: Earliest Deadline First (EDF), Rate Monotonic Scheduling (RMA), their comparative pros and cons. Other issues.	**16**	**CO1, 2 & 3**
Module 3: Handling resource sharing and dependencies among Real-Time Tasks	Resource sharing among real-time tasks, Priority inversion and means to handle priority inversion. Priority Inheritance Protocol (PIP) and Priority Ceil Protocol (PCP), Highest Locker Protocol (HLP). Different types of priority inversions under PCP, Handling Task dependencies.	**8**	**CO1, 2 & 3**
Module 4: Scheduling Real-Time Tasks in Multi-processor and Distributed Systems	Multi-processor task Allocation, Dynamic allocation of Tasks, Fault-tolerant allocation of tasks, Clocks in Distributed Real-Time Systems: Clock synchronization, centralized clock synchronization, Distributed clock synchronization	**6**	**CO1&3**
	Total Hours	**36**	

Essential Readings

1. Mall, Rajib. *Real-time systems: theory and practice*. Pearson Education India, 2009.
2. Liu, Jane W S, *Real-time systems,* Pearson Education India, 2000.
3. Williams, Rob, *Real-time Systems Development,* Butterworth-Heinemann, Elsevier, 2006.

Supplementary Readings

1. Krishna , C. M.; Shin, Kang G., *Real-time systems,* Tata McGraw Hill, India, 2010.
2. Kopetz, Hermann. *Real-time systems: design principles for distributed embedded applications*. Springer Science & Business Media, 2011.
3. Laplante, Philip A. "Real-Time Systems Design and Analysis: An Engineer's Handbook, Piscataway." 1996.

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Programme	**Bachelor of Technology in Computer Science & Engineering**	Year of Regulation: **2019-2020**
Department	**Computer Science & Engineering**	Semester: **IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 216	**Cyber Physical Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	COB1: To develop the student's ability to understand the concept of cyber physical systems' characteristics, requirements and architecture.		CO1	Students should be able to Understand the computer architectural design principles and performance enhancement strategies that adopted in performance evolution of different components of computer, microprocessor / microcontroller and Digital signal processor architecture and distributed memory architecture and distributed systems.
	COB2: To develop the student's ability to understand the fundamentals of microprocessor and micro-controller families and their architecture with special emphasis on Digital Signal Processors.			
	COB3: To provide the students with some knowledge and analysis skills associated with the principles of memory organisation and bus structure of cyber physical systems.		CO2	Students should be able to Solve the performance related problems of real time operating system.
	COB4: To develop the student's ability to understand the concepts of cyber physical system software with special emphasis on real time operating system and particularly real time job scheduling.			
	COB5: To provide the students with some basic knowledge of power aware architecture & hardware software co design.		CO3	Analyze the performance of embedded processing, memory, bus efficiencies, real time operating system performance h/w s/w codesign.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
Module 1: Fundamentals of - Cyber Physical Systems	Cyber-Physical Systems (CPS) in the real world Basic principles of design and validation of CPS, Industry 4.0 AutoSAR, IIOT implications, Building Automation, Medical CPS	**5**	**CO1**
Module 2: Platform Components for Cyber Physical Systems	CPS HW platforms - Processors, Sensors, Actuators CPS Network - WirelessHart, CAN, Automotive Ethernet Scheduling Real Time CPS tasks: Table-driven and Event driven schedulers Hybrid schedulers	**8**	**CO1, 2 & 3**
Module 3: **Principles of Dynmical Systems**	Dynamical Systems and Stability Controller Design Techniques Performance under Packet drop and Noise	**8**	**CO1 & 2**
Module 4: **CPS implementation issues**	From features to automotive software components Mapping software components to ECUs CPS Performance Analysis: Effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion Building real-time networks for CPS	**8**	**CO1&2**
Module 5: **Intelligent CPS**	Safe Reinforcement Learning: Robot motion control, Autonomous Vehicle control Gaussian Process Learning: Smart Grid Demand Response, Building Automation	**7**	**CO1, 2 & 3**
Total Hours		**36**	

Essential Readings

1. Suh, Sang C., U. John Tanik, John N. Carbone, and Abdullah Eroglu, eds. *Applied cyber-physical systems*. Springer New York, 2014.
2. Alur, Rajeev. *Principles of cyber-physical systems*. MIT Press, 2015.
3. Colombo, Armando W., Thomas Bangemann, Statmatis Karnouskos, Jerker Delsing, Petr Stluka, Robert Harrison, Francois Jammes, and Jose L. Lastra. "Industrial cloud-based cyber-physical systems." *The Imc-aesop Approach* 22 (2014): 4-5.

Supplementary Readings

1. Andrew M Sloss, Dominic Symes, Chris Wright, "ARM System Developers Guide: Designing optimizing System Software" (Online resource)
2. http://eee.guc.edu.eg/Courses/Electronics/ELCT912%20Advanced%20Embedded%20Systems/Lectures/ARM%20System%20Developer%27s%20Guide.pdf
3. https://ptolemy.berkeley.edu/projects/cps/

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 218	**Computer Arithmetic**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To teach different data representation used in a digital computer and device.		CO1	Identify, understand and apply different number systems and codes.
			CO2	Understand and use the different algorithms for addition/subtraction of binary numbers.
	To discuss different ways of hardware design for arithmetic operations.		CO3	Understand the concept of multipliers and their hardware realizations.
			CO4	Understand the concept of advanced dividers and their hardware realizations.
	To introduce techniques employed for real arithmetic operations.		CO5	Understand the concept of floating point number representations and algorithms used for real arithmetic operations.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**1**
2	CO2	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
3	CO3	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
4	CO4	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
5	CO5	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Numbers and Arithmetic: Different encoding of numbers, Fixed radix positional number system, Number radix conversion, Classes of number systems, Introduction to signed numbers.	**05**	**CO1**
II	Addition and subtraction: Bit-Serial and Ripple-Carry Adders, Conditions and Exceptions, Analysis of Carry Propagation, Carry Completion Detection, Addition of a Constant, Counters, Manchester Carry Chains and Adders, Carry Recurrence, Carry-Lookahead Adders, Adders and Related Designs, Carry Determination as Prefix Computation, Alternative Parallel Prefix Networks, Hardware Implementations.	**08**	**CO2**
III	Multipliers: Shift/Add Multiplication Algorithms, Programmed Multiplication, Basic Hardware Multipliers, Multiplication of Signed Numbers, Multiplication by Constants, Radix-4 Multiplication, Booth's multiplication, Modified Booth's Recoding, Using Carry-Save Adders, Radix-8 and Radix-16 Multipliers, The Special Case of Squaring, Combined Multiply-Add Units.	**09**	**CO3**
IV	Dividers: Basic division schemes, Shift/Subtract Division Algorithms, Programmed Division, Restoring Hardware Dividers, Nonrestoring and Signed Division, Division by Constants, Fast Dividers, Basics of High-Radix Division, Radix-2 SRT Division, Using Carry-Save Adders, Choosing the Quotient Digits, Radix-4 SRT Division, General High-Radix Dividers. Square-rooting methods: Pencil-and-Paper Algorithm, Binary Restoring Shift/Subtract Algorithm, Nonrestoring Algorithm, High-Radix Square-Rooting.	**08**	**CO4**
V	Floating-point: different representations, floating-point standards, basic floating-point algorithms, conversions and exceptions, rounding schemes, logarithmic number systems, Floating-point arithmetic: floating-point adders/subtractors, pre and post shifting, rounding and exceptions, floating-point multipliers, floating-point dividers, logarithmic arithmetic unit, errors and error control, sources of computational errors, invalidated laws of algebra, worst-case error accumulation, error distribution and expected errors, forward error analysis, backward error analysis.	**09**	**CO5**
Total Hours		**39**	

Essential Readings:

1. Behrooz Parhami, "Computer Arithmetic: Algorithms and Hardware Designs", 1st ed., 2000, Oxford university press.
2. Mi Lu., "Arithmetic and logic in computer systems", 1st ed., 2004, John Wiley and Sons.
3. Paul Zimmermann and Richard Brent, "Modern Computer Arithmetic", 1st ed. 2010, Cambridge university press.

Supplementary Readings:

1. Donald e. Knuth., "The art of computer programming", 2nd ed., 1985, Addison-Wesley publishing company.
2. M Ercegovac, T Lang, "Digital Arithmetic", Hardware and Programming", 1st ed., 2004, Morgan Kaufmann publishers.
3. Israel Koren, "Computer Arithmetic Algorithms", 2nd ed., 2002, A.K. Peters.

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Programme	**Bachelor of Technologyin Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 220	**Principles of Programming Languages**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes	
	To enable the students to learn about various constructs and their respective comparisons in different high-level languages so that he can choose a suitable programming language for solving a particular problem.	CO1	**Able to understand the history of programming languages and introduce abstraction, the concept of different language paradigms, and an overview of language design criteria.**
	To develop the student's ability to understand the salient features in the landscape of programming languages.	CO2	**Avail to understand how the syntactic structure of a language can be precisely specified using context-free grammar rules in Backus-Naur form (BNF).**
	To provide the students to gain experience with these paradigms by using example programming languages.	CO3	**Able to understand the abstractions of the operations that occur during the translation and execution of programs.**
	To develop the student's ability to gain experience with these paradigms by using example programming languages.	CO4	**Able to understand the usage of data types in various languages.**
		CO5	**Able to understand the procedure activation and parameter passing; and exceptions and exception handling.**
		CO6	**Able to understand the concepts like abstract data types, subprograms, and will be able to apply them in a realistic manner.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**1**	**1**	**0**	**0**	**2**	**1**	**1**
2	CO2	**2**	**3**	**1**	**1**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**2**	**1**	**2**	**2**
3	CO3	**3**	**2**	**1**	**0**	**2**	**3**	**0**	**1**	**0**	**1**	**3**	**1**	**3**	**2**	**2**
4	CO4	**1**	**0**	**3**	**2**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**1**	**2**	**2**
5	CO5	**2**	**0**	**1**	**0**	**2**	**3**	**1**	**0**	**1**	**2**	**1**	**0**	**3**	**2**	**3**
6	CO6	**1**	**2**	**0**	**3**	**1**	**2**	**0**	**2**	**0**	**1**	**0**	**0**	**2**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** **The Origins of Programming Languages, Abstractions in Programming Languages, Computational Paradigms, Language Definition, Language Translation, The Future of Programming Languages;**	**2**	**CO1**
II	**Language Design Criteria:** **Historical Overview, Efficiency, Regularity, Security, Extensibility, C++: An Object-Oriented Extension of C, Python: A General-Purpose Scripting Language;**	**2**	**CO1**
II	**Syntax and Analysis Parsing:** **Lexical Structure of Programming Languages, Context-Free Grammars and BNFs, Parse Trees and Abstract Syntax Trees, Ambiguity, Associativity, and Precedence, EBNFs and Syntax Diagrams, Parsing Techniques and Tools, Lexics vs. Syntax vs. Semantics, Case Study: Building a Syntax Analyzer for TinyAda;**	**6**	**CO2**
IV	**Basic Semantics:** **Attributes, Binding, and Semantic Functions, Declarations, Blocks, and Scope, The Symbol Table, Name Resolution and Overloading, Allocation, Lifetimes, and the Environment, Variables and Constants, Aliases, Dangling References, and Garbage, Case Study: Initial Static Semantic Analysis of TinyAda;**	**6**	**CO3**
V	**Data Types:** **Data Types and Type Information, Simple Types, Type Constructors, Type Nomenclature in Sample Languages, Type Equivalence, Type Checking, Type Conversion, Polymorphic Type Checking, Explicit Polymorphism, Case Study: Type Checking in TinyAda;**	**5**	**CO4**
VI	**Expressions and Statements:** **Expressions, Conditional Statements and Guards, Loops and Variations on WHILE, The GOTO Controversy and Loop Exits, Exception Handling, Case Study: Computing the Values of Static Expressions in TinyAda;**	**4**	**CO5**
VII	**Procedures and Environments:** **Procedure Definition and Activation, Procedure Semantics, Parameter-Passing Mechanisms, Procedure Environments, Activations, and Allocation, Dynamic Memory Management, Exception Handling and Environments, Case Study: Processing Parameter Modes in TinyAda;**	**5**	**CO5**
VIII	**Abstract Data Types and Modules:** **The Algebraic Specification of Abstract Data Types, Abstract Data Type Mechanisms and Modules, Separate Compilation in C, C++ Namespaces, and Java Packages, Ada Packages, Modules in ML, Modules in Earlier Languages, Problems with Abstract Data Type Mechanisms, The Mathematics of Abstract Data Types;**	**6**	**CO6**
Total Hours		**36**	

Essential Readings

1. Louden KC. Programming languages: principles and practices. Cengage Learning; 2011.
2. Sebesta RW. Concepts of programming languages. Pearson Education India; 2016.
3. Sethi R, Sethi R. Programming languages: concepts and constructs. Reading: Addison-Wesley; 1996 Feb 2.

Supplementary Readings

1. Gabbrielli M, Martini S. Programming languages: principles and paradigms. Springer Science & Business Media; 2010.
2. Dowek G. Principles of programming languages. Springer Science & Business Media; 2009.
3. Kedar S, Thakare S. Principles of Programming Languages. Technical Publications; 2009.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS222	**Programming in Java**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To introduce programming in the Java programming language, platform independence, bytecode, the concepts of JVM, JRE and JDK, and other basic features of Java.		CO1	**Able to explain and use the basic features and concepts of programming in Java.**
To train in object-oriented programming concepts w. r. t. to Java.		CO2	**Able to write object-oriented programs in Java.**
To train the students in using special programming features, collections, generics, exception handling, advanced I/O and multi-threading in Java.		CO3	**Able to use special programming features, collections and generics in Java.**
To give knowledge of Java API class libraries and collections in designing standalone desktop and web applications.		CO4	**Able to do exception handling, advanced I/O and multi-threading in Java.**
		CO5	**Able to write networking programs, database access programs and GUI programs in Java.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1	1	1	0	0	0	0	0	0	0	1	1	0
2	CO2	3	2	1	1	1	0	0	0	0	0	0	0	1	1	0
3	CO3	3	3	2	3	2	0	0	0	0	0	0	0	2	2	1
4	CO4	3	3	2	3	2	1	0	0	0	0	0	0	3	2	1
5	CO5	3	3	2	3	2	1	0	0	0	1	1	1	3	2	1

SYLLABUS

No.	Content	Hours	COs
I	**<u>Java fundamentals</u> Introduction; Structure of Java platform: JDK, JRE, JVM; Advantages of Java; All code in classes; Compiling source code into bytecode; Data types: primitive and reference types; Comments; Variables; Operators; Flow Control statements: if, else, switch, switch expressions, loops, enhanced for loop, labelled for loop, return, break and continue; Array declaration; Multidimensional arrays; Type conversion and Casting; Wrapper classes and Boxing; Enumerated types; Strings and utility string classes; Java Packages and Library**	**07**	**CO1, CO2**
II	**<u>Object-oriented programming in Java</u> Creating new data types: class, Local variables; Encapsulation; Java access specifiers; Abstraction; Method overloading; Constructors; Initialization and Cleanup; Cleanup: finalization and garbage collection; Member initialization; Array initialization; Reusing classes; Association; Aggregation; Composition; Delegation; Inheritance; Interfaces; Multiple inheritance; Upcasting; The final keyword; Method overriding; Constructors and Polymorphism; Abstract classes and methods; Nesting interfaces; Inner Classes; Using this and new; Anonymous inner classes**	**09**	**CO2, CO3**
III	**<u>Special features in Java</u> Collections: List, Set, Queue; Iterating collections; Maps; Generic collections in Java; Class Object; Class Class**	**06**	**CO3**
IV	**<u>Advanced topics</u> Arrays are first-class objects; Object serialization; Error handling with exceptions; Basic exceptions; Catching an exception; Creating user-defined exceptions; Performing cleanup with finally; Input and Output in Java; The File class; readers and writers; Typical uses of I/O streams; File reading and writing utilities; Basic threading: the Thread class; Creating, Starting and Stopping a thread; Sharing resources; Cooperation between tasks; Deadlocks**	**10**	**CO4**
V	**<u>Advanced programming in Core Java</u> Java networking fundamentals; Networking classes and interfaces; Java database connectivity (JDBC); Graphical user interfaces: AWT and Swing classes, Capturing events**	**08**	**CO5**
	Total Hours	**40**	

Essential Readings

1. E. Balagurusamy, “Programming with Java”, McGraw-Hill Education, 6th edition, 2019.
2. Herbert Schildt, “Java - A Beginner’s Guide”, McGraw-Hill Education, 7th edition, 2017.
3. Yashavant P. Kanetkar, “Let us Java”, BPB Publications, 4th edition, 2019.

Supplementary Readings

1. Herbert Schildt, “Java: The Complete Reference”, McGraw-Hill Education, 9th edition, 2017.
2. Cay S. Horstmann, “Core Java Volume II - Advanced Features”, Pearson Education; 10th edition, 2017.
3. Barry A. Burd, “Beginning Programming with Java for Dummies”, Wiley, 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS224	**GUI Design and Programming**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	
	To introduce GUI programming in Java, egronomic and usability principles of GUI design.
	To train the students in using Java AWT and Swing GUI containers and components.
	To train the students in event handling in GUI applications.
	To train in using different GUI layouts, look and feel, graphics and images in GUIs.

Course Outcomes	
CO1	**Able to explain fundamental concepts of GUI design and GUI design facilities in Java.**
CO2	**Able to use many Java GUI containers and components.**
CO3	**Able to do programming in Java for event handling.**
CO4	**Able to use different GUI layouts, look and feel, graphics and images in GUIs.**
CO5	**Able to do error and exception handling for GUI programming and use some advanced GUI components/ widgets.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1	1	1	0	0	0	0	0	0	0	1	1	0
2	CO2	3	3	2	3	2	1	0	0	0	0	0	0	2	1	0
3	CO3	3	3	2	3	2	1	0	0	0	0	0	1	2	2	1
4	CO4	3	3	2	3	2	1	0	**1**	0	0	1	1	2	2	1
5	CO5	3	3	2	3	2	1	0	0	0	0	1	0	2	2	1

SYLLABUS

No.	Content	Hours	COs
I	**Introduction; Principles and Motivation of GUI Design: Fundamental Human Computer Interaction principles, Ergonomics and usability; Java event-driven programming summary; Java IDEs; Overview of AWT and Swing packages; AWT and Swing - introductory examples**	**09**	**CO1**
II	**Components and containers: JComponent, JFrame, JWindow, JPanel, Content Pane; Introduction to event processing; Deployment of GUI application in jar and other executable formats; Some basic components: JButton, JLabel, JTextfield, JTextArea, combo boxes, JMenu, check boxes, option buttons; Simple Swing dialogues; setting borders and styles; keyboard and mouse access, tab control; file selection**	**14**	**CO2, CO3**
III	**Basic Layout Managers: Border, Flow, Grid, Card, Tabbed, GridBagLayout; Fonts; Colors; Spacing; Constraints; Dimensions; Look and Feel** **Drawing in Java: Graphics class; points; lines; shapes; affine transforms; colors; fills; working with images using BufferedImage**	**09**	**CO4**
IV	**Error and exception handling; Advanced widgets: Swing spinner, slider, toolbar; progress bar, JList, JScrollPane, JTable**	**08**	**CO5**
	Total Hours	**40**	

Essential Readings

1. E. Balagurusamy, “Programming with Java”, McGraw-Hill Education, 6th edition, 2019.
2. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, “Designing the User Interface: Strategies for Effective Human-Computer Interaction” Pearson Education India, 5th edition, 2014.
3. Paul Deitel, Harvey Deitel, “Java How to Program: Early Objects”, Pearson Education, 11th edition, 2018.

Supplementary Readings

1. Yashavant P. Kanetkar, “Let us Java”, BPB Publications, 4th edition, 2019.
2. Herbert Schildt, “Java: The Complete Reference”, McGraw-Hill Education, 9th edition, 2017.
3. Cay S. Horstmann, “Core Java Volume II - Advanced Features”, Pearson Education; 10th edition, 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS226	**Python Programming**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To develop the student's ability to understand the principles of python programming		CO1	**Able to acquire knowledge about the data types in Python programming**
To provide the students with fundamental concept of data types, loops, functions, files, object oriented for writing python programing.		CO2	**Able to understand and write python programing using conditions, loops etc.**
To develop the student's ability to design software using Python.		CO3	**Able to understand and write python programing using functions, tuples etc.**
To familiarize the student to write clear and effective python programming.		CO4	**Able to understand and write python programing using modules, packages, strings etc.**
		CO5	**Able to understand and write python programing using object oriented concepts and files handling.**
		CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
2	CO2	**3**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**2**
3	CO3	**3**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**2**
4	CO4	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**0**	**2**	**0**	**0**	**1**	**3**	**2**	**2**
5	CO5	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Python and Computer Programming, Data Types, Variables, Basic Input-Output Operations, Basic Operators**	**07**	**CO1**
II	**Boolean Values, Conditional Execution, Loops, Lists and List Processing, Logical and Bitwise Operations**	**08**	**CO2**
III	**Functions, Tuples, Dictionaries, and Data Processing**	**08**	**CO3**
IV	**Modules, Packages, String and List Methods, and Exceptions**	**08**	**CO4**
V	**The Object-Oriented Approach: Classes, Methods, Objects, and the Standard Objective Features; Exception Handling, and Working with Files**	**09**	**CO5**
	Total Hours	**40**	

Essential Readings

1. Mark Lutz,“ Programming Python”, Prentice Hall India, 7th Edition, 2017
2. Allen Downey, “Think Python”, O'Reilly Media, 1st Edition, 2012
3. Marl Pilgrim, “Dive into Python”, APress Media LLC, 1st Edition, 2005

Supplementary Readings

1. Mark Lutz, “Learning Python”, McGraw-Hill publication, 2nd Edition, 2010
2. Luciano Ramalho, “Fluent Python”, O'Reilly Media, 1st Edition, 2015
3. Brett Slatkin , “Effective Python: 59 Specific Ways to Write Better Python”, Pearson Education, Inc, 1st Edition 2015

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 272	**Object Oriented Programming**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To provide students in-depth theoretical base and fundamentals of Object Oriented Programming paradigm		CO1	**Able to demonstrate the procedural and object oriented paradigm with concepts of data, functions, classes and objects**
To prepare students to design and code various projects using Object Oriented Programming paradigm		CO2	**Able to illustrate dynamic memory management techniques using pointers, constructors, destructors etc.**
		CO3	**Able to make use of the concept of function overloading, operator overloading, type conversion and polymorphism**
		CO4	**Able to interpret the concept of Inheritance and its various types along with the understanding of late binding**
		CO5	**Able to compare the procedures of file handling and exception handling in C++**
		CO6	**Able to test the concept of templates and the use of Standard Template Libraries of C++**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	0	1	0	1	0	0	0	0	1	1	1	0	0	0
2	CO2	2	3	3	2	1	1	0	0	1	0	0	0	1	1	1
3	CO3	3	3	3	2	1	0	0	0	1	0	0	0	0	1	1
4	CO4	3	1	1	2	0	0	0	0	0	0	0	0	0	2	3
5	CO5	3	0	3	1	3	0	0	0	1	0	0	0	0	1	1
6	CO6	3	2	2	2	0	0	0	0	2	0	0	0	0	0	1

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** **Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation;**	**01**	**CO1**
II	**Beginning with C++:** **Getting started with C++ syntax, data types, variables, data types, type conversion – implicit and explicit, inline functions, string class, specifying classes and objects;**	**03**	**CO2**
III	**Classes and Objects:** **Data hiding, member function, memory allocation, static members, static objects, array of objects, friendly function, pointers to members, constructors and destructors;**	**04**	**CO2**
IV	**Concept of Overloading:** **Function overloading, operator overloading of unary, binary, special operators; Type conversion; Compile Time Polymorphism**	**03**	**CO3**
V	**Inheritance:** **Introduction to inheritance, different types; Single inheritance – public and private derivation, protected member, constructor and destructor in derived class; Multilevel and multiple inheritance; Ambiguity resolution; Hierarchical and hybrid inheritance; Virtual base class; Object slicing; Pointer to base and derived class; Virtual functions;**	**09**	**CO4**
VI	**File Handling:** **Streams, classes for file stream, opening a file, detecting the EOF, file modes, file pointers and their functions, types of files, i/p and o/p functions for sequential and random access, error handling.**	**02**	**CO5**
VII	**Templates:** **Function templates, class templates, advantages and disadvantages, Standard Template Library.**	**02**	**CO6**
Total Hours		**24**	

Essential Readings

1. Robert Lafore, “Object-Oriented Programming in C++”, 4th Edition, Sams Publishing, 2001.
2. E Balagurusamy, “Object-Oriented Programming in C++”, 8th Edition, McGraw-Hill Education India, 2020.
3. Yashvant Kanetkar, “Let Us C++ “, BPB Publication, 2020.

Supplementary Readings

1. P.J. Deitel and H.M Deitel ,”C++ How to Program”, 10th Edition, Pearson Publication, 2016.
2. Herbert Schildt, “C++: The Complete Reference”, 4th Edition, McGraw-Hill Education India, 2017.
3. Bjarne Stroustrup, “The C++ Programming Language”, 3rd Edition, Pearson Education India, 2002.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Quiz/Viva	Total
CS 252	**Computer Organization Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	
	Connect the theory of computer organization with hardware
	To develop knowledge about ALU operations
	Apply fundamentals of digital design and extend the learning to design sequential circuits
	To apply the concept of memory design, cache memory and its mapping techniques and virtual memory.

Course Outcomes	
CO1	Able to understand different operations on number systems
CO2	Able to acquire knowledge about assembly language code
CO3	Understanding of addition and subtraction, Multiplication-Booth's, Array
CO4	Introduce basics Division- Restoring and non-restoring; Floating point arithmetic
CO5	Able to Designing Adder, Multiplier, ALU on a simulator.
CO6	Exhibit the design of Registers and Counters on a simulator.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
1	Computer arithmetic	**02**	**CO1** **CO2** **CO3** **CO4** **CO5** **CO6**
2	Addition and subtraction, Multiplication	**02**	
3	Booth's, Array	**02**	
4	Division- Restoring	**02**	
5	Non-restoring	**02**	
6	Floating point arithmetic.	**02**	
7	Designing Adder, Multiplier	**02**	
8	Design of Registers and Counters	**02**	
9	Designing memory unit on a simulator.	**02**	
10	Designing CPU on a simulator.	**02**	
	Total Hours	**20**	

Essential Readings

1. Hamacher, Carl, Zvonko Vranesic, and Safwat Zaky. *Computer organization*. McGraw-Hill, 2002.
2. Mano, M. Morris. *Computer system architecture*. Prentice-Hall of India, 2003.
3. Stallings, William. *Computer organization and architecture: designing for performance*. Pearson Education India, 2003.

Supplementary Readings

1. Hennessy, John L., and David A. Patterson. *Computer architecture: a quantitative approach*. Elsevier, 2011.
2. Bryant, Randal E., O'Hallaron David Richard, and O'Hallaron David Richard. *Computer systems: a programmer's perspective*. Vol. 2. Upper Saddle River: Prentice Hall, 2003.
3. Ramachandran, Umakishore. *Computer systems: An integrated approach to architecture and operating systems*. Pearson Education India, 2011.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Quiz / Viva	Total
CS 254	**Object Oriented Programming and Design Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To provide students in-depth theoretical base and fundamentals of Object Oriented Programming paradigm		CO1	**Able to illustrate dynamic memory management techniques using pointers, constructors, destructors etc.**
	To prepare students to design and code various projects using Object Oriented Programming paradigm		CO2	**Able to make use of the concept of function overloading, operator overloading, type conversion and polymorphism**
			CO3	**Able to interpret the concept of Inheritance and its various types along with the understanding of late binding**
			CO4	**Able to compare the procedures of file handling and exception handling in C++ and test the concept of templates**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**1**	**1**
2	CO2	**2**	**2**	**2**	**1**	**2**	**0**	**0**	**2**	**0**	**2**	**0**	**1**	**2**	**2**	**1**
3	CO3	**3**	**2**	**2**	**3**	**0**	**0**	**2**	**1**	**0**	**1**	**1**	**1**	**2**	**1**	**1**
4	CO4	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**2**	**1**	**1**	**0**	**2**	**3**	**1**	**3**

Suggested List of Experiments

No.	Content	Hours	COs
I	Assignments and Tutorials on basic classes and objects	**02**	**CO1**
II	Assignments and Tutorials on friend function	**02**	
III	Assignments and Tutorials on different call-by techniques	**02**	
IV	Assignments and Tutorials on constructors and destructors	**04**	
V	Assignments and Tutorials on function and operator overloading	**02**	**CO2**
VI	Assignments and Tutorials on complie time polymorphism	**01**	
VII	Assignments and Tutorials on inheritance	**06**	**CO3**
VIII	Assignments and Tutorials on run-time polymorphism	**01**	
IX	Assignments and Tutorials on file handling	**02**	**CO4**
X	Assignments and Tutorials on templates	**02**	
	Total Hours	**24**	

Essential Readings

1. Robert Lafore, “Object-Oriented Programming in C++”, 4th Edition, Sams Publishing, 2001.
2. E Balagurusamy, “Object-Oriented Programming in C++”, 8th Edition, McGraw-Hill Education India, 2020.
3. Yashvant Kanetkar, “Let Us C++ “, BPB Publication, 2020.

Supplementary Readings

1. P.J. Deitel and H.M Deitel ,”C++ How to Program”, 10th Edition, Pearson Publication, 2016.
2. Herbert Schildt, “C++: The Complete Reference”, 4th Edition, McGraw-Hill Education India, 2017.
3. Bjarne Stroustrup, “The C++ Programming Language”, 3rd Edition, Pearson Education India, 2002.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Lab Test/ Viva	Total
CS256	**Data Communication Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	Course Outcomes	
To introduce the components of Data Communication	CO1	**Able to learn the fundamentals of data communication**
To analyse the Analog and Digital Transmission	CO2	**Able to Understand the digital signal and analog signal transmission over different types of transmission media.**
To describe the structure of Physical and Data Link Layer	CO3	**Able to distinguish different techniques of error detection and correction and medium access control.**
To describe the function of wireless networks	CO4	**Able to acquire knowledge about the generations of wireless networks.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
3	CO3	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
4	CO4	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Study and discussion on various Computer network commands such as Ping, Netstat, Tracert, ARP, Nbtstat, Netsh and execution of the commands.	**03**	**CO1 CO2 CO3 CO4**
II	Installation and Setup of Packet Tracer Tool. Study and execution of basic commands of Packet Tracer such as Traceroute, ifconfig, Telnet and others.	**03**	
III	Setting up a Local Area Network in Packet Tracer with Static Routing – (i) Static Routing without CLI and (ii) Static Routing with CLI.	**03**	
IV	Initialization and Setting up a Router with Encryption in Packet Tracer.	**03**	
V	Configuration of DHCP Server and Network Address Translation in Packet Tracer.	**06**	
VI	(i) To understand the working of LAN Trainer kit. (ii) Stop & Wait Protocol implementation on LAN Trainer kit. (iii) Go-Back N Protocol implementation on LAN Trainer kit. (iv) Selective-Repeat Protocol implementation on LAN Trainer kit.	**09**	
VII	Data Transmission through wired and wireless communication without any outside support.	**06**	
VII	Setting a local server for access of files	**03**	
	To be done necessarily as mini-project group-wise in groups of at least two/three students.		
	Total Hours	**36**	

Essential Readings

1. Behrouz A Forouzan, “Data Communication and Networking”, 5th Edition, McGraw-Hill Education, 2018.
2. Andrew S Tanenbaum, David J. Wetherall “Computer Networks”, 5th Edition, Prentice Hall. 2011.
3. William Stallings, “Data and Computer Communication”, 10th Edition, Pearson, 2017.
4. A Jesin, “Packet Tracer Network Simulator”, 1st Edition, Packt Publishing Ltd., 2014.

Supplementary Readings

1. James F Kurose, Kaith W Ross, “Computer Networking | A Top-Down Approach”, 6th Edition, Pearson, 2017.
2. A L Garcia, I Widjaja, “Communication Networks: Fundamental Concepts and Key Architectures”, 2nd Edition, Tata McGraw Hill, 2017.
3. B. Buchanan, “The Handbook of Data Communications and Networks”, 1st Edition, Springer, 2004.
4. James F Kurose, Kaith W Ross, “Computer Networking | A Top-Down Approach”, 6th Edition, Pearson, 2017.

National Institute of Technology Meghalaya

An Institute of National Importance

CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS301	**Operating Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To introduce the components of operating system	CO1	**Able to learn the fundamentals of Operating Systems**
To analyse the process scheduling and execution	CO2	**Able to acquire knowledge about different process scheduling techniques.**
To describe the structure of main memory, virtual memory	CO3	**Able to solve process synchronization and deadlock handling strategies**
To describe the function of file systems	CO4	**Able to acquire knowledge about different memory management techniques and page replacement algorithms.**
To explore the structure of an operating system's I/O subsystem and hardware.	CO5	**Able to describe file concepts and analyse various disk scheduling and storage strategies**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**
3	CO3	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**1**
4	CO4	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**
5	CO5	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** **Operating Systems Functionalities - Formal Definition - Evolution – Types of operating system, Services, Operating system Design and Implementation, Operating System Structure.**	**06**	**CO1**
II	**Process Management** **Process concept - Process control block, Process Hierarchy, Threads – Single Thread and Multi Thread Model, IPC models: shared memory and message passing. CPU Scheduling algorithms, Multiprocessor Scheduling, Process Synchronization - Peterson's Solution, Process Synchronization - Semaphores, Critical Regions, Monitors - Deadlock prevention- Deadlock avoidance and Deadlock Detection and Recovery - Bankers Algorithm.**	**16**	**CO2, CO3**
III	**Memory Management** **Overview of Swapping - Multiple Partitions – Paging, Page table, Segmentation, Demand paging- Fragmentation & Compaction- Page replacement algorithms, Memory allocation algorithms: first fit, Best fit, worst fit.**	**14**	**CO1, CO4**
IV	**File System** **Access Methods, Contiguous-Sequential and Indexed Allocation, File system interface - File System implementation, Secondary Storage Structure.**	**08**	**CO1, CO5**
V	**I/O System** **RAID-disk scheduling- Device drivers - block and character devices-streams, Character and Block device switch tables**	**04**	**CO1, CO5**
	Total Hours	**48**	

Essential Readings

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “Operating System Concepts”, 9th Edition, John Wiley & Sons Inc. 2012.
2. Andrew S Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice Hall. 2014
3. William Stallings, “Operating System: Internals and Design Principles”, 9th Edition, Pearson, 2018.

Supplementary Readings

1. Harvey M. Deitel, Paul J. Deitel, David R. Choffnes, “Operating System”, 3rd Edition, Pearson, 2013.
2. D M Dhamdhere, “System Programming and Operating Systems”, 2nd Edition, Tata McGraw Hill, 2009.
3. Gary Nutt, “ Operating Systems: A Modern Perspective”, 2nd Edition, Addison Wesley, 2001.
4. Achyut S Godbole, “Operating Systems”, 3rd Edition, Tata McGraw Hill, 2010.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation: **2019-2020**
Department	**Computer Science and Engineering**	Semester: **V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 303	**Database Management Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To understand the fundamentals concepts of database, operation of relational data model and its requirement in an organization.		CO1 **Able to describe the fundamental components of database systems, Relational Database Management System and its need towards an organization.**
To understand the various relational data models, application of relational data models to design logical database including E-R diagrams and database normalization. And also write the simple and optimized advanced database queries using Structured Query Language (SQL).		CO2 **Able to demonstrate the data models, analyse the real world problems and requirements, to give the appropriate solution using the principles of Entity Relationship Diagram.**
To develop and ability to design and implement a small database project using Structured Query Language (SQL).		CO3 **Able to attain the practical understanding of SQL, convert the Entity relationship model to relational tables, operations to store the data using queries.**
To understand the requirement of database tuning, concept of a database transaction, including concurrency control, backup & recovery, data object locking protocols and role of database administrator.		CO4 **Able to apply the principles of normalization to remove the redundancy and inconsistency to improve the performance using database tuning and query optimization.**
		CO5 **Able to understand the concurrent transactions, Problems such as failures, solutions to solve the concurrency problems & recovery from failure using protocols**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	3	0	0	0	0	0	0	2	0	0	0	3	0	3
2	CO2	3	3	3	1	2	0	0	0	1	0	0	0	2	3	2
3	CO3	1	2	3	3	2	2	0	0	0	0	0	0	2	3	3
4	CO4	1	2	3	3	3	2	3	0	2	0	0	1	2	3	2
5	CO5	2	3	3	2	2	3	2	0	2	0	0	1	3	3	3

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Database: Purpose of database systems, data abstraction and modeling, instances and schemes, database manager, database users and their interactions, data definition and manipulation language, data dictionary, overall system structure.**	**03**	**CO1** **CO2**
II	**Entity-relationship model:** **Entities and entity sets, relationships and relationship sets, mapping constraints, E-R diagram, primary keys, strong and weak entities, reducing E-R diagrams to tables, trees or graphs,** **generalization and specialization, aggregation.**	**06**	**CO1** **CO2**
III	**Brief Introduction to hierarchical and network model:** **Data description and tree structure diagram for hierarchical model, retrieval and update facilities, limitations;** **Database task group (DBTG) model, record and set constructs retrieval and update facilities, limitations.**	**05**	**CO2** **CO3**
IV	**Relational model and Query optimization:** **Structure of a relational database, operation on relations, relational algebra, tuple and domain relational calculus, salient feature of a query language, Structured query language: Description an actual RDBMS and SQL.** **Importance of query processing, equivalence of queries, cost Estimation for processing a query, general strategies, bi-relational and multi-relational join algorithms, algebraic manipulation.**	**09**	**CO2** **CO3** **CO4**
V	**Normalization:** **Pitfalls in RDBMS, importance of normalization, functional, multi-valued and join dependencies, 1NF to 5NF, limitations of RDBMS.**	**08**	**CO4** **CO5**
VI	**Database tuning:** **Index selection and clustering, tuning of conceptual schema, denormalization, tuning queries and views.**	**05**	**CO2** **CO4**
VII	**Crash recovery:** **Failure classification, transactions, log maintenance, check point implementation, shadow paging, example of an actual implementation**	**06**	**CO5**
VIII	**Concurrency Control in RDBMS:** **Testing for serializability, lock based and time-stamp based protocols; Deadlock detection and Recovery**	**08**	**CO4** **CO5**
	Total	**50**	

Essential Readings

1. Silberschatz, Korth and Sudarshan, Database system concepts, McGraw Hill, 7th Edition, 2019.
2. C.J. Date, An Introduction to Database Systems (8th Edition), Pearson, 8th Edition, 2004.
3. Steven Feuerstein, Bill Pribyl, “Oracle PL/SQL Programming,”, O'Reilly Media, 6th Edition, 2014.

Supplementary Readings

1. Elmasri and Navathe, Fundamentals of database systems; Pearson, 7th Edition, 2016.
2. Raghu Ramakrishnan and Gehrke, Database Management System, McGraw-Hill, 3rd Edition, 2014.
3. C. J. Date, SQL and Relational Theory: How to Write Accurate SQL Code, O'Reilly Media, 3rd Edition, 2015.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 305	**Computer Networks**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To develop the student's ability to understand the basic concept of networking, packet switching and circuit switching etc.		CO1	**Able to understand the brief of internet and also the concept of circuit switching and packet switching.**
To develop the student's ability to understand the application layer of the network model along with the ability to perform socket programming.		CO2	**Able to understand the purpose of application layer and various application layer protocols such as DNS, FTP, SMTP.**
To provide the students with some knowledge and analysis skills associated with transport layer protocols TCP and UDP.		CO3	**Able to understand various transport layer protocol like UDP, TCP, and various mechanisms to control TCP congestion.**
To develop the student's ability to understand the network layer of network model like IPv4 addressing NAT etc.		CO4	**Able understand the IPV4 addressing and forwarding mechanism and solve relevant problems.**
		CO5	**Able to understand the routing algorithms and protocols and solve relevant problems.**
		CO6	**Able to understand the concepts of network security and management, and the future trends of networking.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	2	0	0	0	0	1	0	2	0	0	0	2	1	1	1
2	CO2	2	2	2	1	2	0	0	2	0	2	0	1	2	2	1
3	CO3	3	2	2	3	0	0	2	1	0	1	1	1	2	1	1
4	CO4	1	1	0	1	0	0	0	2	1	1	0	2	3	1	3
5	CO5	0	1	1	1	2	3	0	2	1	1	1	1	1	2	1
6	CO6	2	0	3	0	1	1	1	1	1	2	1	1	3	3	3

SYLLABUS

No.	Content	Hours	COs
I	**Basics of Internet:** **Internet Service Providers (ISPs); protocols and standards; Network edge - access networks: dial-up, DSL, cable, FTTH, Ethernet, WiFi, WiMax; Network core - circuit switching: multiplexing; packet switching: traffic, congestion; delays; traffic intensity; throughput; protocol layering;**	**04**	**CO1**
II	**Application Layer:** **Architecture – client-server, peer-to-peer, hybrid; DNS: brief, hierarchical database; Internet transport services; The Web and HTTP - What actually happens, HTTP request and response, web cache; Process communication; Socket programming; File transfer: FTP; Electronic mail: SMTP, POP3, IMAP, Web-based e-mail;**	**05**	**CO2**
III	**Transport Layer:** **Real Life Analogy; Multiplexing and De-multiplexing; TCP and UDP sockets; Web Servers and TCP; Why UDP?; TCP UDP Examples; UDP Segment; TCP Segment; Flow Control - Stop and Wait, Go-Back-N, Selective Repeat; Transmission Control Protocol; TCP Connection Establishment - Three-Way Handshaking, Data Transfer, Connection Termination; SYN Flooding Attack; TCP Congestion Control - congestion window, congestion detection, Slow Start: Exponential Increase, Congestion Avoidance: Additive Increase, Additive Increase Multiplicative Decrease; TCP Variants - Tahoe and Reno;**	**06**	**CO3**
IV	**Network Layer – Part 1:** **Functions; Packet Switching - Virtual Circuit, Datagram; What's inside a router? - Input Processing, Switching, Output Processing; IPV4 Address - Classful Addressing, Classless Addressing - address mask, block allocation, subnetting; Special Addresses; IP Datagram, Fragmentation; Dynamic Host Configuration Protocol - properties, protocol steps; Network Address Translation;**	**08**	**CO4**
V	**Network Layer – Part 2 (Routing Algorithms and Protocols):** **Distance Vector Routing; Link State Routing; Path Vector Routing; Routing Information Protocol; Open Shortest Path First; Border Gateway Protocol; Multicast routing protocol; Wireless routing protocol;**	**09**	**CO5**
VI	**Security and Network Management:** **Cryptography and Network Security; Internet Security: IPSec, SSL/TLS and PGP; SNMP;**	**02**	**CO6**
VII	**Future Trends:** **Internet-of-Things (IoT); Software Defined Networking (SDN)**	**02**	**CO6**
	Total Hours	**36**	

Essential Readings

1. J. F. Kurose, K. W. Ross, "Computer Networking: A Top-Down Approach", Pearson Publication, 6th Edition, 2013.
2. B. Forouzan, "Data Communication and Networks", McGraw-Hill Publication, 5th Edition, 2012.
3. A. S. Tanenbaum, D. J. Wetherall, "Computer Networks", Pearson Publication, 5th Edition, 2011.

Supplementary Readings

1. W. Stalling, "Data and Computer Communications", Pearson Publication, 8th Edition, 2007.
2. L. L. Peterson, B. S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, 5th Edition, 2012.
3. A. L. Garcia and I. Widjaja, "Communication Networks Fundamental Concepts and Key Architectures", Tata McGraw-Hill Publication, 2nd Edition, 2004.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 311	**Microprocessors and Interfacing**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	Introduce students about the architecture, internal organization of an 8-bit (8085) processor in detail.		CO1	Recall and apply a basic concept of digital fundamentals to microprocessor based personal computer system.
	This subject also deals about interfacing an external device with the processors/ controllers.		CO2	Identify a detailed software & hardware structure of the 8085 Microprocessor.
	Introduce students to programming in assembly language.		CO3	Illustrate how the different peripherals (8255, 8253 etc.) are interfaced with Microprocessor.
			CO4	Distinguish and analyse the properties of different Microprocessors & Microcontrollers.
			CO5	Analyse the data transfer information through serial & parallel ports.
			CO6	Design and evaluate assembly language programs and the machine code that will provide solutions real-world problems.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**2**	**2**
2	CO2	**3**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
3	CO3	**3**	**3**	**3**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
4	CO4	**3**	**1**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
5	CO5	**3**	**2**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
6	CO6	**3**	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Computer architecture, Architecture of a typical Microprocessor, Bus configuration, The CPU module, The MPU and The microcontroller. Timing diagram, Memory Interfacing, Interfacing input output- port, Interrupt & interrupt handling, Serial & parallel data transfer scheme, Programmed & interrupt driven data transfer, Direct memory access, Programmable peripheral devices, Programmable interval timer, Analog input-output using AD & DA converter	**17**	**CO1, CO2, CO3, CO4**
II	Introduction to assembly language & machine language programming, Instruction set of typical microprocessor (e.g. 8085), Subroutine & stack.	**10**	**CO1, CO6**
III	Basic Interfacing Concepts, 8255 Programmable Peripheral Interface, Interfacing Display, Keyboards, 8279 Programmable Keyboard/Display Interface, 8253/54 Programmable Timer, DMA Controller, Interrupt Controller, ADC And DAC Interfacing.	**15**	**CO5, CO5**
IV	8086 Internal Architecture, Memory Segmentation, Addressing Modes, Basic Bus Timing During Read And Write Operation.	**06**	**CO1, CO4**
	Total Hours	**48**	

Essential Readings:

1. Gaonkar R. S., “Microprocessor Architecture, Programming and Applications with 8085”, 5th ed., 2000, Penram International.

2. Douglas Hall And S S S P Rao, “Microprocessor and Interfacing”, 3rd ed., 2012, Tata McGraw-Hill.

3. Ajay wadhwa,"microprocessor 8085: architecture, programming, and interfacing", 1st ed., 2010, PHI Learning.

Supplementary Readings:

1. Ram B., “Fundamental of Microprocessor & Microcomputers”, 6th ed., 2003, Dhanpat Rai Publications.
2. Leventhal Lance, “Introduction to Microprocessor - Software, Hardware and Programming”, 5th ed., 1992, PHI.
3. Barry B. Brey,"The Intel Microprocessor: Architecture, Programming, and Interfacing", 8th ed., 2008, Pearson.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Computer Science & Engineering**	Year of Regulation: **2019**
Department	**Computer Science & Engineering**	Semester: **VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 313	**Embedded Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	COB1: To develop the student's ability to understand the concept of embedded system's characteristics, requirements and architecture.		CO1	Students should be able to Understand the computer architectural design principles and performance enhancement strategies that adopted in performance evolution of different components of computer, microprocessor / microcontroller and Digital signal processor architecture and distributed memory architecture and distributed systems.
	COB2: To develop the student's ability to understand the fundamentals of microprocessor and micro-controller families and their architecture with special emphasis on Digital Signal Processors.			
	COB3: To provide the students with some knowledge and analysis skills associated with the principles of memory organisation and bus structure of embedded system.		CO2	Students should be able to Solve the performance related problems of real time operating system.
	COB4: To develop the student's ability to understand the concepts of embedded system software with special emphasis on real time operating system and particularly real time job scheduling.			
	COB5: To provide the students with some basic knowledge of power aware architecture & hardware software co design.		CO3	Analyze the performance of embedded processing, memory, bus efficiencies, real time operating system performance h/w s/w codesign.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
Module 0: Basic 8085 programming & Interfacing	Introduction to 8-Bit 8085 Microprocessor Architecture, Operation, Memory Interfacing, Interfacing I/O Devices, Instruction Classification, Overview of 8085 Instruction Set Timings And Operations Of Instruction Cycle, Assembly Language Programming Using Different Programming Techniques Like Looping, Counting and Indexing, Time Delay Programs, Stack And Subroutines, Basic Interfacing Concepts, 8255 Programmable Peripheral Interface, Interfacing Display, Keyboards, 8279 Programmable Keyboard/Display Interface.	**12**	**CO1**
Module1: Embedded systems	Introduction, Characteristics, Application dependent requirements, Architecture, Challenges, Development Process.	**02**	**CO1 & 2**
	Embedded System Hardware: Microprocessor, micro-controller, Von-Neumann and Harvard architecture, RISC, CISC.	**03**	**CO1, 2 & 3**
Module2: PIC Microcontroller Family	PIC architecture, Clocking scheme, Instruction execution, Instruction pipeline. PIC Instruction set, Instruction format, Addressing modes, PIC peripherals on chip, Interrupts, PIC timers.	**04**	**CO1 & 2**
Module3: Case Study	8051 micro-controller, ARM processor	**02**	**CO1&2**
Module4: Digital Signal Processors	Features, Application, Memory, Addressing. System on Chip (SoC): Evolution, Design, Platforms, Multi Processor SOC.	**03**	**CO1 & 2**
Module5: Memory	Basic organization, Embedded SRAM, Embedded DRAMS, Flash Memory, Virtual Memory, Memory Management Unit (MMU), Paging.	**04**	**CO1 & 2**
Module6: Bus Structures, interrupt handling	Bus Structures, interrupt handling	**04**	**CO1,2 &3**
Module7: Power Aware Architectures	Power Density, Power Dissipation, Power vs Speed, Power consumption of CMOS circuits, Gating, Dynamic Power Management.	**04**	**CO1,2 &3**
Module8: Software for Embedded systems	Features, Memory Allocation, Heap Management.	**02**	**CO1&2**
Module9: Fundamentals of Embedded Operating System	Real time operating system	**07**	**CO2&3**
Module10: Hardware-Software Co-design	Introduction, methodology and concepts	**03**	**CO1,2&3**
Total Hours		**50**	

Essential Readings

1. Wayne Wolf , “Computers as Components: Principles of Embedded Computing System Design”, Second Edition, Morgan Kaufmann, 2006.
2. M. A. Mazidi , J. G. Mazidi and R. D. Mckinlay others, “The 8051 Microcontroller and Embedded Systems”, Second Edition, Prentice Hall of India, 2008.
3.R. H. Barnett, L. O'Cull, S. Alison Cox, “Embedded C Programming and Microchip PIC”, First Edition, Thomson Learning Inc., 2008.
Supplementary Readings
1. Andrew M Sloss, Dominic Symes, Chris Wright, “ARM System Developers Guide: Designing optimizing System Software” (Online resource)
2. http://eee.guc.edu.eg/Courses/Electronics/ELCT912%20Advanced%20Embedded%20Systems/Lectures/ARM%20System%20Developer%27s%20Guide.pdf
3. T. Wilmshurst , “An introduction to design of small scale embedded systems”, First Edition, Palgrame Macmillan Publishers, 2001.
4. J. B. Peatman , “Design with PIC Microcontroller”, Second Edition, Pearson Education, 2002.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS315	**E-Commerce and Cyber Laws**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To develop the student's ability to understand the concept of e-commerce.		CO1	**Able to acquire knowledge about e-commerce and the network of e-commerce**
	To provide the students about electronic retailing		CO2	**Able to acquire knowledge about the background of economics of e-commerce, and understand Electronic Retailing**
	To develop the student's ability to analyse the security involved in the networking where e-commerce is done.		CO3	**Able to understand and analyse the network security which is the base of e-commerce.**
	To familiarize the student the need of security in electronic payment done in e-commerce.		CO4	**Able to understand and analyse the electronic payment system and its privacy and social impacts.**
	To familiarize the student the legal issues related to digital world.		CO5	**Able to understand and analyse the legal issues, public policies, international issues in the digital world.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
2	CO2	**3**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**0**	**3**	**2**	**2**
3	CO3	**3**	**3**	**3**	**1**	**2**	**1**	**2**	**0**	**2**	**0**	**0**	**0**	**3**	**3**	**2**
4	CO4	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**2**	**0**	**1**	**1**	**2**	**2**	**3**
5	CO5	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**2**	**0**	**3**	**1**	**1**	**2**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Electronic commerce: Defining e-commerce, History of money and electronic money. The Network Infrastructure for Electronic Commerce: The Internet and WWW Technology, digital convergence and commerce.	**06**	**CO1**
II	Economics of Electronic Commerce: Transactions and Accounting Costs, Pricing of Goods and Services on the Internet. Electronic Retailing: Web Based Business Models, Purchasing Agents, Online Shopping Marketing and Advertising on the Net: Emerging marketing and advertising models.	**10**	**CO2**
III	Network Security: Firewalls, Encryption and Transaction Security (Secret Key and Public Key Cryptography), Digital Signatures, Certificates, Certificate Authorities.	**10**	**CO3**
IV	Electronic Payment Systems: Tokenized vs. Notational systems, Credit Card based systems, Electronic Checks, Electronic Cash and Micro transactions, Smart Cards, Protocols and Standards. Privacy, Anonymity and Social Impacts of Electronic Cash Topics: Privacy, Anonymity, and traceable E-money.	**12**	**CO4**
V	Legal Issues: Electronic Contracting and Digital Signatures, Intellectual Property, Copyright, Trademark, and Patents, Cybercrime and Money Laundering. Public Policy Issues: What is the Government's role? Electronic Commerce and Financial Services Topics: Banking, Securities and Brokerage International Issues/Commerce, Copyright and Online Publishing Topics: Commodification of Information, Property Rights vs. Freedom of Information, Electronic publishing and digital copyrights	**10**	**CO5**
Total Hours		**48**	

Essential Readings

1. Lynch/Lundquist, Digital Money: The New Era of Internet Commerce, Wiley Publications, 1st Edition, 1996.
2. Joseph Migga Kizza, Computer Network Security and Cyber Ethics, McFarland & Company, 3rd Edition, 2011.
3. Jaynice Reynolds, The Complete E-commerce Book, CRC Press, 2nd Edition 2004.

Supplementary Readings

1. Henry Chan et. al, E-Commerce, Fundamentals and Applications, Wiley Publications, 1st Edition, 2001.
2. Jyoti Rattan, Vijay Rattan, Cyber Laws & Information Technology, Bharat Law House, 1st Edition, 2017.
3. Donna L. Hoffman, Thomas P.Novak, A New Marketing Paradigm for Electronic Commerce, The Information Society, Vol. 13, No. 1, 1997.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 317	**Machine Vision**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To Use mathematical modeling tools to represent digital images	Course Outcomes	CO1	Represent and interpret image in its numeric and graphical form
	To apply morphological operations for shape recognition and template matching		CO2	Understand geometric relationship of pixels
	To be able to use advanced algorithms such as support vector machines and artificial neural networks for object recognition and classification.		CO3	Able to understand the principle and use of Machine Vision system for industrial quality control.
	To apply stereo vision techniques and optical flow methods to study motion.		CO4	Able to acquire knowledge regarding shape identification and pattern recognition in industrial robotics application
	To give a clear idea of industrial quality control and inspection of end product.		CO5	Able to acquire knowledge about Automated Target Recognition

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**1**	**2**	**1**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**1**	**1**	**2**	**1**	**3**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**2**	**1**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Review of Mathematical Principles:** A brief review of probability, A review of Linear Algebra, Introduction to Function Minimization, Markov Models	**08**	**CO1**
II	Machine vision: Introduction to Machine Vision,, definition, Active vision system, Machine vision components, hardware's and algorithms, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions, m/c learning, application of machine vision such as in inspection of parts, identification, industrial robot control, mobile robot application, Competing technologies, CCD line scan and area scan sensor, Triangulation geometry, passive and active stereo imaging, laser scanner, data processing.	**12**	**CO2**
III	Industrial Machine Vision: Industrial Machine Vision in production and services, Structure of Industrial Machine Vision, Generic Standards, Interfacing Machine Vision System, vision system calibration. Shape Identification, Statistical Pattern Recognition and Syntactic Pattern Recognition	**10**	**CO1** **CO3**
IV	Automated Target Recognition (ATR): The hierarchy of levels of ATR, ATR System Components, and Performance Evaluation of ATR Systems Machine Vision issues to ATR, ATR Algorithms, Hugh Transform in ATR, Morphological Techniques in ATR.	**10**	**CO2** **CO3**
V	**Applications of Machine Vision:** Multispectral Image Analysis, Optical Character Recognition, Industrial Inspection and Quality Control, Security and Intruder identification, Robot Vision	**08**	**CO4** **CO5**
Total Hours		**48**	

Essential Readings

1. Machine Vision By Wesley E. Snyder, Cambridge University Press, 2012.
2. Machine Vision Algorithms and Applications, 2nd Edition , By Carsten Steger, Markus Ulrich, Christian Wiedemann, Wiley Publication, 2018.
3. Computer and Machine Vision: Theory, Algorithms, Practicalities, By E. R. Davies, 4th Edition, Academic Press, 2012.

Supplementary Readings

1. Computer Vision: Principles, Algorithms, Applications, Learning, 5th Edition By E. R. Davies, Academic Press, 2017.
2. Mechatronics and Machine Vision, By John Billingsley, Research Studies Press, 2000.
3. Mechatronics and Machine Vision in Practice, By John Billingsley, Robin Bradbeer, Springer Science & Business Media, 2007.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 319	**Automata and Formal Languages**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To introduce students to theory of computation: automata, computability, and complexity with application of mathematical techniques and logical reasoning to important problems,		CO1	Student will be able to demonstrate the fundamental understanding of the core concepts in automata theory and formal languages.
	To develop a strong background in reasoning about finite state automata and formal languages.		CO2	Student will be able to design grammars and automata for different language classes.
	To introduce students to different ways of parsing a formal language.		CO3	Student will be able to identify formal language classes and prove language membership properties.
			CO4	Student will be able to prove and disprove theorems establishing key properties of formal languages and automata.
			CO5	Student will be able to demonstrate a fundamental understanding of computation and computational models including decidability and intractability.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**1**
2	CO2	**2**	**2**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
3	CO3	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
4	CO4	**1**	**2**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
5	CO5	**3**	**3**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**3**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Basic Mathematical Objects: Sets Logic, Functions, Relations, Strings, Alphabets, Languages, Mathematical Induction: Inductive proofs, Principles; Recursive definitions.	**02**	**CO1**
II	Regular Languages and Finite Automata (FA), Deterministic and Nondeterministic Finite Automata, Equivalence and minimization of Automata, Finite Automata with output- Mealy and Moore Machines, Properties of Regular Sets: The Pumping Lemma for Regular sets, Closure properties and Decision properties of regular languages, Regular Expressions (RE), Relation Between RE and FA.	**14**	**CO1, CO2**
III	Grammar , Types of Grammar and Languages- Chomsky Hierarchy, Context Free Grammar (CFG), Derivation trees & Ambiguity, Inherent ambiguity, Parse tree, Application of CFG, Simplification of CFG, Normal form of CFG, Relations between classes of languages and Automata, Closure properties and Decision properties of CFG, Properties of Context Free Languages: The Pumping Lemma,	**13**	**CO1, CO2, CO3**
IV	Push Down Automata(PDA), Languages of PDA, Equivalence of PDA and CFG, Deterministic PDA	**04**	**CO1, CO2,CO4**
V	Turing Machine(TM) - Standard Model, Variations of TM (Multi-Track TM, Multi-Tape TM, Multi-Dimensional TM, Universal TM), Deterministic and Non deterministic TM, Turing Thesis, Halting Problem, Language of a Turing Machine- Recursively Enumerable Language, Unrestricted Grammar, Linear Bounded Automata(LBA), Computability and Decidability. Time and Space Complexity, Growth Rate, Complexity classes, Tractable and Non tractable Problems: P and NP, Cooks's theorem.	**6**	**CO1, CO4,CO5**
	Total Hours	**39**	

Essential Readings:

1. Peter Linz, "An Introduction To Formal Languages And Automata", 3rd ed., 2001, Narosa Publication.
2. K.L.P.Mishra, N. Chandrasekaran," Theory Of Computer Science: Automata, Languages and Computation", 3rd ed., 2016, PHI.
3. S. Kandar, "Introduction to Automata Theory, Formal Languages and Computation", 1st ed., 2013, Pearson.

Supplementary Readings:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey Ullman, "Introduction to Automata theory, languages computation ", 2nd ed., 2005, Pearson India, Indian Reprint.
2. Michael Sipser, "Introduction to the Theory of. Computation", 3rd ed., 2013, Cengage Learning.
3. H. R. Lewis, C. H. Papadimitriou, "Elements of the Theory of Computation", 2nd ed., 1998, Prentice-Hall.

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CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 321	**Formal Verification**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To understand the fundamental concepts of formal verification	CO1	**Able to understand the fundamental concept of formal verification**
To demonstrate the modeling of sequential systems, linear time properties, linear temporal logic, computation tree logic, model checking CTL and model checking LTL	CO2	**Able to demonstrate the modeling of sequential systems, linear time properties, linear temporal logic**
To explain binary decision diagrams, symbolic model checking, model checking with SAT, bounded model checking, craig interpolation	CO3	**Able to explain computation tree logic, model checking CTL and model checking LTL**
To understand decision procedures in model checking, practical industrial-scale verification	CO4	**Able to demonstrate binary decision diagrams, symbolic model checking**
	CO5	**Able to demonstrate model checking with SAT, bounded model checking, craig interpolation**
	CO6	**Able to explain decision procedures in model checking, practical industrial-scale verification**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	3	0	0	0	0	0	0	2	0	0	0	3	0	3
2	CO2	3	3	3	1	2	0	0	0	1	0	0	0	2	3	2
3	CO3	1	2	3	3	2	2	0	0	0	0	0	0	2	3	3
4	CO4	1	2	3	3	3	2	3	0	2	0	0	1	2	3	2
5	CO5	2	3	3	2	2	3	2	0	2	0	0	1	3	3	3
6	CO6	1	2	3	3	3	2	3	0	2	0	0	1	2	3	2

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Formal Verification**	**02**	**CO1**
II	**Modelling sequential systems as labelled transition systems (Kripke structures), Linear time properties, Linear temporal logic (LTL).**	**06**	**CO2**
III	**Computation tree logic (CTL) and CTL* , Model checking CTL , Model checking LTL**	**06**	**CO3**
IV	**Counterexamples and witnesses, Binary decision diagrams (BDD), Symbolic model checking**	**06**	**CO4**
V	**Model checking with SAT, bounded model checking, Completeness thresholds and k-induction, Craig interpolation**	**08**	**CO5**
VI	**Equivalences and abstractions, Decision procedures in model checking, Practical, industrial-scale verification, present challenges**	**08**	**CO6**
	Total	**36**	

Essential Readings

1. *Principles of Model Checking*, by C. Baier and J.-P. Katoen, The MIT Press, 2008 edition.
2. *Model Checking*, by Edmund M. Clarke, Jr., Orna Grumberg, and Doron A. Peled, The MIT Press, 2nd edition, 2000.
3. *Logic in Computer Science: Modelling and reasoning about systems*, by Michael Huth and Mark Ryan, Cambridge University Press, 2nd edition, 2004.

Supplementary Readings

1. *Introduction to Formal Hardware Verification*, by Thomas Kropf, Springer, 1999 edition.
2. *Formal Hardware Verification: Methods and Systems in Comparison*, Ed. by Thomas Kropf, Springer, 1997 edition.
3. *Advanced Formal Verification*, by Rolf Drechsler, Springer, 2004 edition.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

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Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 323	**COMPUTATIONAL GEOMETRY**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To introduce techniques for designing efficient algorithms for geometric problems.		CO1	Develop efficient algorithms by exploiting geometric properties, and using appropriate data structures and geometric techniques.
	To discuss data structures used for geometric problems		CO2	Apply techniques and algorithms for solving problems in diversified fields like database searching, data mining, graphics and image processing, pattern recognition, computer vision, motion planning and robotics.
	To introduce combinatorial complexity of geometric problems.		CO3	Perform complexity analysis of algorithms
	To study rigorous algorithmic analysis of geometric problems.		CO4	Identify properties of geometric objects, express them as lemmas or theorems, and prove their correctness
			CO5	Implement geometric algorithms
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Geometric Preliminaries, DCEL (Doubly Connected Edge List) data structure, Polygon, Planar Straight Line Graph (PSLG) Area of a triangle, area of a polygon, Determinant used to test position of a point with respect to a directed line. Convex polygons, properties and point location in convex polygon (inside-outside test) Plane sweep algorithm, Algorithm for Line segment intersection problem using plane sweep technique.	**06**	**CO1**
II	Point location in PSLG – Slab method, Chain method and complexity analysis. Range Searching – 1D Range search, Kd Trees.	**06**	**CO1, CO2**
III	Polygon Triangulation: Regularization of polygons, properties of triangulations –Proofs, triangulation of monotone polygon – algorithm and complexity analysis. Linear Programming – Half plane intersection, Incremental algorithm and Randomized algorithm	**08**	**CO1** **CO2** **CO3**
IV	Art Gallery Theorem, Guarding Art Gallery, Fisk's proof using three colouring. Arrangements of Lines – Duality, Combinatorics of arrangements, Zone Theorem, Algorithm for Constructing arrangements of lines.	**06**	**CO3** **CO4**
V	Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm.	**06**	**CO4** **CO5**
VI	Voronoi Diagrams- Properties and applications in the plane. Proofs of properties related to vertices and edges of voronoi diagrams, Algorithm for constructing voronoi diagram, Delaunay Triangulation.	**08**	**CO2** **CO5**
	Total Hours	**40**	

Essential Readings:

1. Franco P. Preparata and Michael Ian Shamos, Computational Geometry an Introduction. Texts and Monographs in Computer Science, Publisher: Springer-Verlag Berlin Heidelberg, 1985, 1st Edition.
2. Joseph O'Rourke, Computational Geometry in C. Cambridge University Press, 2nd Edition, 2012.
3. Mark. de Berg, Marc. van Kreveld, Mark. Overmars and Otfried Cheong, Computational Geometry- Algorithms and Applications. Publisher: Springer-Verlag Berlin Heidelberg, 3rd Edition, 2008.

Supplementary Readings:

1. Herbert Edelsbrunner, Algorithms in Combinatorial Geometry, EATCS Monographs on Theoretical Computer Science, Publisher: Springer-Verlag Berlin Heidelberg, 1987, 1st Edition.
2. Joseph O' Rourke, Art Gallery Theorems, Publisher: Oxford University Press, 1987, 1st Edition.
3. De Berg, van Kreveld, Overmars, and Schwarzkopf Computational, Geometry Algorithms and Applications, Publisher: Springer-Verlag Berlin Heidelberg, 2000, 2nd Edition.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 325	**Modern Digital Arithmetic**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To teach different data representation used in a digital computer and device.		CO1	Identify, understand and apply different number systems and codes.
			CO2	Understand and use the advanced addition algorithms for multioperand addition/subtraction.
	To discuss different ways of hardware design for arithmetic operations.		CO3	Understand the concept of advanced multipliers and their uses in different situations.
			CO4	Understand the concept of advanced dividers and their uses in different situations.
	To introduce different techniques employed to speed up the computer and processing unit.		CO5	Understand the concept of advanced pipelining and other methods used to increase the total throughput of an arithmetic circuit.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**1**
2	CO2	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
3	CO3	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
4	CO4	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
5	CO5	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Signed numbers: Signed-Magnitude Representation, Biased Representations, Complement Representations, Two's- and 1's-Complement Numbers, Direct and Indirect Signed Arithmetic, Using Signed Positions or Signed Digits. Redundant number systems: the Carry Problem, Redundancy in Computer Arithmetic, Digit Sets and Digit-Set Conversions, Generalized Signed-Digit Numbers, Carry-Free Addition Algorithms, Conversions and Support Functions. Residue number systems: RNS Representation and Arithmetic, the RNS Moduli, Difficult RNS Arithmetic Operations, Redundant RNS Representations, Limits of Fast Arithmetic in RNS.	**08**	**CO1**
II	Fast Addition and subtraction: Simple Carry-Skip Adders, Multilevel Carry-Skip Adders, Carry-Select Adders, Conditional-Sum Adder, Hybrid Adder Designs, Optimizations in Fast Adders. Multioperand addition: Using Two-Operand Adders, Carry-Save Adders, Wallace and Dadda Trees, Parallel Counters, Generalized Parallel Counters, Adding Multiple Signed Numbers.	**08**	**CO2**
III	Fast multipliers: Radix-4 Multiplication, Modified Booth's Recoding, Using Carry-Save Adders, Radix-8 and Radix-16 Multipliers. Tree and array multipliers: Full-Tree Multipliers, Alternative Reduction Trees, Tree Multipliers for Signed Numbers, Partial-Tree Multipliers, Array Multipliers, Pipelined Tree and Array Multipliers. Variations in multipliers: Divide-and-Conquer Designs, Additive Multiply Modules, Bit-Serial Multipliers, Modular Multipliers, The Special Case of Squaring, Combined Multiply-Add Units.	**09**	**CO3**
IV	Fast Dividers: Basics of High-Radix Division, Radix-2 SRT Division, Using Carry-Save Adders, Choosing the Quotient Digits, Radix-4 SRT Division, General High-Radix Dividers. Division by convergence: General Convergence Methods, Division by Repeated Multiplications, Division by Reciprocation, Speedup of Convergence Division, Hardware Implementation, Analysis of Lookup Table Size.	**07**	**CO4**
V	High-throughput arithmetic: Pipelining of Arithmetic Functions, Clock Rate and Throughput, Parallel and Digit-Serial Pipelines, On-Line or Digit-Pipelined Arithmetic. Low-power arithmetic: The Need for Low-Power Design, Sources of Power Consumption, Reduction of Power Waste, Transformations and Trade-Offs, Some Emerging Methods	**07**	**CO5**
	Total Hours	**39**	

Essential Readings:

1. Behrooz Parhami, "Computer Arithmetic: Algorithms and Hardware Designs", 1st ed., 2000, Oxford university press.
2. Mi Lu., "Arithmetic and logic in computer systems", 1st ed., 2004, John Wiley and Sons.
3. Paul Zimmermann and Richard Brent, "Modern Computer Arithmetic", 1st ed. 2010, Cambridge university press.

Supplementary Readings:

1. Donald e. Knuth., "The art of computer programming", 2nd ed., 1985, Addison-Wesley publishing company.
2. M Ercegovac, T Lang, "Digital Arithmetic", Hardware and Programming", 1st ed., 2004, Morgan Kaufmann publishers.
3. Israel Koren, "Computer Arithmetic Algorithms", 2nd ed., 2002, A.K. Peters.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 371	**Database System Concepts**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the fundamentals concepts of database, operation of relational data model and its requirement in an organization.		CO1	**Able to describe the fundamental components of database systems, Relational Database Management System and its need towards an organization.**
	To understand the various relational data models, application of relational data models to design logical database including E-R diagrams and database normalization. And also write the simple and optimized advanced database queries using Structured Query Language (SQL).		CO2	**Able to demonstrate the Entity Relationship Model, analyse the real world problems and requirements, to give the appropriate solution using the principles of Entity Relationship Diagram.**
	To develop and ability to design and implement a small database project using Structured Query Language (SQL).		CO3	**Able to attain the practical understanding of SQL, convert the Entity relationship model to relational tables, operations to store the data using queries.**
	To understand the requirement of database tuning, concept of a database transaction, including concurrency control, data object locking protocols and role of database administrator.		CO4	**Able to apply the principles of normalization to remove the redundancy and inconsistency to improve the performance.**
			CO5	**Able to understand the concurrent transactions, Problems such as failures, solutions to solve the concurrency problems using protocols**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**3**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**	**2**
3	CO3	**1**	**2**	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**3**
4	CO4	**1**	**2**	**3**	**3**	**3**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Database: Purpose of database systems, data abstraction and modelling, instances and schemes, database manager, database users and their interactions, data definition and manipulation language, data dictionary, overall system structure.**	**02**	**CO1** **CO2**
II	**Entity-relationship model:** **Entities and entity sets, relationships and relationship sets, mapping constraints, E-R diagram, primary keys, strong and weak entities, reducing E-R diagrams to tables, trees or graphs, generalization and specialization, aggregation.**	**04**	**CO1** **CO2**
III	**Relational model:** **Structure of a relational database, operation on relations, relational algebra, tuple and domain relational calculus, salient feature of a query language, Structured query language: Description an actual RDBMS and SQL.**	**07**	**CO2** **CO3** **CO4**
IV	**Normalization:** **Pitfalls in RDBMS, importance of normalization, functional, multi-valued and join dependencies, 1NF to 5NF, limitations of RDBMS.**	**05**	**CO4** **CO5**
V	**Concurrency Control in RDBMS:** **Testing for serializability, lock based and time-stamp based protocols; Deadlock detection and Recovery**	**06**	**CO4** **CO5**
	Total	**24**	

Essential Readings

1. Silberschatz, Korth and Sudarshan, Database system concepts, McGraw Hill, 7th Edition, 2019.
2. C.J. Date, An Introduction to Database Systems (8th Edition), Pearson, 8th Edition, 2004.
3. Steven Feuerstein, Bill Pribyl, “Oracle PL/SQL Programming,”, O'Reilly Media, 6th Edition, 2014.

Supplementary Readings

1. Elmasri and Navathe, Fundamentals of database systems; Pearson, 7th Edition, 2016.
2. Raghu Ramakrishnan and Gehrke, Database Management System, McGraw-Hill, 3rd Edition, 2014.
3. C. J. Date, SQL and Relational Theory: How to Write Accurate SQL Code, O'Reilly Media, 3rd Edition, 2015.

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CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Lab Test/ Viva	Total
CS351	**Operating Systems Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To introduce the components of operating system		CO1	**Able tolearn the fundamentals of Operating Systems**
	To analyse the process scheduling and execution		CO2	**Able to acquire knowledgeabout different process scheduling techniques.**
	To describe the structure of main memory, virtual memory		CO3	**Able to solve process synchronization and deadlock handling strategies**
	To describe the function of file systems		CO4	**Able to acquire knowledgeabout different memory management techniques and page replacementalgorithms.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**
3	CO3	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**1**
4	CO4	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Basic Commands of UNIX, Shell Programming,Implementation of CPU scheduling algorithms, Performance Comparison of CPU scheduling algorithms. Implementation of IPC.**	**12**	**CO1 CO2 CO3 CO4**
II	**Implementation of Peterson's Solution, Semaphores, Monitors**	**06**	
III	**Classical Process Coordination & Synchronization Problems like, Bounded Buffer, Producer-Consumer,Readers-Writers, Dinning philosophers, The Cigarette-Smokers Problem, Dining-Philosophers Solution Using Monitors**	**10**	
IV	**Implementation of Deadlock Avoidance Algorithms, Detection Algorithms**	**04**	
V	**Implementation of contiguous memoryallocation techniques, Paging Techniques, Page Replacement Algorithms, Disk Scheduling Algorithms**	**04**	
	To be done necessarily as mini-project group-wise in groups of at least two/three students.		
Total Hours		**36**	

Essential Readings

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", 9th Edition, John Wiley & Sons Inc. 2012.
2. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall. 2014
3. William Stallings, "Operating System: Internals and Design Principles", 9th Edition, Pearson, 2018.

Supplementary Readings

1. Harvey M. Deitel, Paul J. Deitel, David R. Choffnes, "Operating System", 3rd Edition, Pearson, 2013.
2. D M Dhamdhere, "System Programming and Operating Systems", 2nd Edition, Tata McGraw Hill, 2009.
3. Gary Nutt, " Operating Systems: A Modern Perspective", 2nd Edition, Addison Wesley, 2001.
4. Achyut S Godbole, "Operating Systems", 3rd Edition, Tata McGraw Hill, 2010.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Assessments	Quiz / Viva	Total
CS 353	**Database Management Systems Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives

- **To understand the concept of Database Management System in practical view and software specific tools for information processing oriented framework.**
- **To understand and demonstrate the E-R data model in formal way and implementation of relational data model (E-R data model) in relational data model using query and procedure.**
- **To understand the real time problem, design an application as the developer to accomplish the given task.**
- **To understand and implement JDBC/ODBC concept for the operations for the developing database, Concurrent transaction processing and recovery in multiuser database environment.**

Course Outcomes

CO1	**Able to understand and demonstrate the real time challenges in the Database Management Systems, components of various software tools.**
CO2	**Able to design, Normalize, and implement the database schema for the given problems.**
CO3	**Able to construct the query using the SQL commands i.e. DDL/DML, declare and keep the integrity constraints on the developing database using the concept of Relational Database Management System.**
CO4	**Able to improve the performance of query and write the programming SQL such as stored procedure, cursor, stored functions.**
CO5	**Able to design and develop the graphical user interface application using fourth generation language to access the database.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	3	0	0	0	0	0	0	2	0	0	0	3	0	3
2	CO2	3	3	3	1	2	0	0	0	1	0	0	0	2	3	2
3	CO3	1	2	3	3	2	2	0	0	0	0	0	0	2	3	3
4	CO4	1	2	3	3	3	2	3	0	2	0	0	1	2	3	2
5	CO5	2	3	3	2	2	3	2	0	2	0	0	1	3	3	3

SYLLABUS

No.	Content	Hours	COs
I	Assignment on Entity Relationship modeling of real world problems.	02	CO1
II	Assignment on creating relational databases with simple tables	02	CO1, CO2
III	Assignment on implementation of indexing structures	02	CO1, CO2
IV	Assignment on creating databases with indexing structures	02	CO3
V	Assignment on implementing SQL queries	02	CO3
VI	Assignment on creating views and queries based on views	02	CO3, CO4
VII	Assignment on write SQL queries using logical operations (=,<,>,etc)	02	CO3, CO4
VIII	Assignment on implementing embedded SQL queries	02	CO4
IX	Assignment on PL/SQL	02	CO4
X	Assignment on check pointing and recovery	02	CO4
XII	Assignment on implementing multi-user database.	02	CO5
XII	Mini Project using the selected RDBMS and front end tools.	02	CO5
	Total	24	

Essential Readings

1. Silberschatz, Korth and Sudarshan, Database system concepts, McGraw Hill, 7th Edition, 2019.
2. C.J. Date, An Introduction to Database Systems (8th Edition), Pearson, 8th Edition, 2004.
3. Steven Feuerstein, Bill Pribyl, “Oracle PL/SQL Programming,”, O'Reilly Media, 6th Edition, 2014.

Supplementary Readings

1. Elmasri and Navathe, Fundamentals of database systems; Pearson, 7th Edition, 2016.
2. Raghu Ramakrishnan and Gehrke, Database Management System, McGraw-Hill, 3rd Edition, 2014.
3. C. J. Date, SQL and Relational Theory: How to Write Accurate SQL Code, O'Reilly Media, 3rd Edition, 2015.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation: **2019-20**
Department	**Computer Science and Engineering**	Semester: **V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Quiz / Viva	Total
CS 355	**Computer Networks Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To develop the student's ability to understand the basic concept of networking, packet switching and circuit switching etc.		CO1	**Able to understand the brief of internet and also the concept of circuit switching and packet switching.**
	To develop the student's ability to understand the application layer of the network model along with the ability to perform socket programming.		CO2	**Able to understand the purpose of application layer and various application layer protocols such as DNS, FTP, SMTP.**
	To provide the students with some knowledge and analysis skills associated with transport layer protocols TCP and UDP.		CO3	**Able to understand various transport layer protocol like UDP, TCP, and various mechanisms to control TCP congestion.**
	To develop the student's ability to understand the network layer of network model like IPv4 addressing NAT etc.		CO4	**Able understand the IPV4 addressing and forwarding mechanism and solve relevant problems.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	2	0	0	0	0	1	0	2	0	0	0	2	1	1	1
2	CO2	2	2	2	1	2	0	0	2	0	2	0	1	2	2	1
3	CO3	3	2	2	3	0	0	2	1	0	1	1	1	2	1	1
4	CO4	1	1	0	1	0	0	0	2	1	1	0	2	3	1	3

Suggested List of Experiments

No.	Content	Hours	COs
I	Assignment on Error Detection using Single Parity Check	**02**	**CO1**
II	Assignment on Error Detection using CRC	**02**	**CO1**
III	Assignment on Error Detection using Checksum	**02**	**CO1**
IV	Assignment on UDP Socket Programming – UDP Echo	**02**	**CO2, CO3, CO4**
V	Assignment on TCP Socket Programming – Client and Server both in same machine	**02**	**CO2, CO3, CO4**
VI	Assignment on TCP Socket Programming – Client and Server in different machines	**02**	**CO2, CO3, CO4**
VII	Assignment on TCP Socket Programming – Students' Database	**02**	**CO2, CO3, CO4**
VIII	Assignment on TCP Socket Programming – English Dictionary	**02**	**CO2, CO3, CO4**
IX	Assignment on TCP Socket Programming – Involving Files	**02**	**CO2, CO3, CO4**
X	Assignment on TCP Socket Programming – Upload and Download	**02**	**CO2, CO3, CO4**
Total Hours		**20**	

Essential Readings

1. J. F. Kurose, K. W. Ross, "Computer Networking: A Top-Down Approach", Pearson Publication, 6th Edition, 2013.
2. B. Forouzan, "Data Communication and Networks", McGraw-Hill Publication, 5th Edition, 2012.
3. A. S. Tanenbaum, D. J. Wetherall, "Computer Networks", Pearson Publication, 5th Edition, 2011.

Supplementary Readings

1. W. Stalling, "Data and Computer Communications", Pearson Publication, 8th Edition, 2007.
2. L. L. Peterson, B. S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, 5th Edition, 2012.
3. A. L. Garcia and I. Widjaja, "Communication Networks Fundamental Concepts and Key Architectures", Tata McGraw-Hill Publication, 2nd Edition, 2004.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS302	**Software Engineering**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To introduce the Software Development life cycles Models	CO1	**Able to identify, formulate, and solve complex engineering problems**
To analyse the software requirements	CO2	**Able to recognize ethical and professional responsibilities in engineering situations**
To introduce various design methods for software Development	CO3	**Able to analyze, design, verify, validate, implement, apply, and maintain software systems**
To develop an ability and skill to test software systems	CO4	**Able to work in one or more significant application domain**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**
3	CO3	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
4	CO4	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** **Software process - software development life cycle models.**	**04**	**CO1**
II	**Software Requirement and Analysis** **Techniques: feasibility analysis, requirements elicitation, validation, rapid prototyping, OO paradigms vs. structured paradigm - OO analysis.**	**06**	**CO2**
III	**Software Specifications** **Specification document, specification qualities, uses, system modelling: context, interaction, structural, behavioural, DFD, specification techniques using UML, ER diagrams, logic, algebraic specifications: comparison of various techniques, formal specifications – model checking, introduction to binary decision diagrams.**	**14**	**CO2** **CO3**
IV	**Object Oriented Methodology** **Introduction to objects, relationships, unified approach to modelling, use-case modelling, activity, state and interaction diagrams, classification approaches, cohesion, coupling, reuse, case studies - object oriented paradigm, software design: architectural - distributed - data oriented design & object oriented design - real-time systems design techniques.**	**12**	**CO2** **CO3**
V	**Stepwise Refinement** **Stepwise refinement, software versions and configuration control.**	**04**	**CO1** **CO4**
VI	**Software Testing & Evolution** **Verification & validation – non-execution based testing – software inspections, code reviews, code walkthroughs – automated static analysis – Clean room software development – quality issues – execution based testing – module test-case selection, testing process: black-box, white-box, unit, integration.**	**08**	**CO3** **CO4**
Total Hours		**48**	

Essential Readings

1. Roger S Pressman: “Software Engineering – A Practitioner’s Approach”, 7th Edition, McGraw-Hill, 2009.
2. Rajib Mall, “Fundamentals of Software Engineering”, 5th Edition, PHI, 2018.
3. Ian Sommerville: “Software Engineering”. 9th Edition, Pearson Education, 2011.

Supplementary Readings

1. S.L. Pfleeger, Software Engineering – Theory and Practice, 2nd Edition, Pearson Education, 2015.
2. Paul Ammann, and Jeff Offutt, “Introduction to Software Testing”, 1st Edition, Cambridge University Press, 2008.
3. Eric Gamma, “Design Patterns: Elements of Reusable Object-Oriented Software”, 1st Edition, Addison-Wesley Longman Publishing, 1995.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 304	**Compiler Design**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	The Objectives of this course is to explore the principles, algorithms, and data structures involved in the design and construction of compilers.	Course Outcomes	CO1: Specify and analyse the lexical, syntactic and semantic structures of any computer programming language. CO2: Separate the lexical, syntactic and semantic analysis into meaningful phases for a compiler to undertake language translation. CO3: Write a scanner, parser, and semantic analyser for limited form of C like programming languages. CO4: Convert source code in simple language into machine code for a novel computer. CO5: Describe techniques for intermediate code and machine code optimisation. CO6: Design the structures and support required for compiling advanced language features.
	To discuss context-free grammars, and front-end phases of a compiler: lexical analysis, parsing techniques, symbol tables, error recovery.		
	To discuss back-end phases of a compiler: code generation, and different code optimization techniques.		

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
2	CO2	**3**	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**3**
3	CO3	**2**	**3**	**3**	**1**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**3**
4	CO4	**2**	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**3**
5	CO5	**2**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
6	CO6	**2**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Compiler, Phases and passes,	**02**	**CO1**
II	Finite state machines and regular expressions and their applications to lexical analysis, Implementation of lexical analyzers, lexical-analyzer generator, LEX-compiler: LEX/FLEX,	**06**	**CO1, CO2, CO3**
III	Formal grammars and their application to syntax analysis, BNF notation, ambiguity, YACC. The syntactic specification of programming languages: Context free grammars, derivation and parse trees, capabilities of CFG. Basic Parsing Techniques: Parsers, Shift reduce parsing, operator precedence parsing, top down parsing, predictive parsers Construction of efficient Parsers: LR parsers, the canonical Collection of LR(0) items, Constructing SLR parsing tables, constructing Canonical LR parsing tables, Constructing LALR parsing tables, Using ambiguous grammars, an automatic parser generator, implementation of LR parsing tables, constructing LALR sets of items.	**16**	**CO1, CO3**
IV	Syntax-directed Translation: Syntax-directed Translation schemes, Implementation of Syntax directed Translators, Intermediate code, postfix notation, Parse trees & syntax trees, three address code, quadruple & triples, Translation of assignment statements, Boolean expressions, statements that alter the flow of control, Postfix translation, translation with a top down parser. More about translation: Array references in arithmetic expressions, procedures call, declarations, case statements. Symbol Tables: Data structure for symbols tables, representing scope information.	**13**	**CO4,CO5**
V	Run-Time Administration: Implementation of simple stack allocation scheme, Storage allocation in block structured language. Error Detection & Recovery: Lexical Phase errors, syntactic phase errors semantic errors.	**11**	**CO1, CO6**

	Introduction to code optimization: Loop optimization, DAG representation of basic blocks, Value numbers and algebraic laws, Global Data-Flow analysis.		
Total Hours		**48**	

Essential Readings:

1. A.V. Aho, M. S. Lam, R. Sethi and J. D. Ullman, "Compilers-Principles, Techniques and Tools", 2nd ed., 2006, Pearson Education.
2. K. Muneeswaran, "Compiler Design", 1st ed., 2013, Oxford Publication.
3. P.H. Dave, H.B. Dave, "Compilers: Principles and Practice", 1st ed. 2012, Pearson Education.

Supplementary Readings:

1. Allen I. Holub, "Compiler Design in C", 1st ed.(Indian print), 2012, PHI.
2. John Levine, "Flex & Bison ", 1st ed., 2009, O'reilly.
3. Torben Ægidius Mogensen, "Basics of Compiler Design", 1st ed., 2007, DIKU, University of Copenhagen

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 312	**Computer Graphics**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To introduce the mathematical foundation of computer graphics like the basic principles of 2D and 3D concept of computer graphics.
3. To introduce Color perception, color models (RGB model), color transformations.
4. To provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
5. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
6. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.

Course Outcomes

CO1	Able to acquire knowledge about the basic concepts used in computer graphics
CO2	Able to interpret the mathematical foundation of the concepts like 2D and 3D geometrical concepts of computer graphics.
CO3	Able to implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
CO4	Able to describe the importance of viewing and projections.
CO5	Students will be able to acquire knowledge about rasterization: line drawing via Bresenham's algorithm, clipping, polygonal fill etc.
CO6	Students will be able to understand a typical graphics pipeline and 3D modelling.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**1**	**2**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**0**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**0**	**2**	**3**	**0**	**2**	**2**	**0**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**1**	**2**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Introduction Graphic areas, Major Applications, Graphic APIs, 3D Geometric Models, Graphics Pipeline, Numerical Issues, Efficiency	08	CO1 CO2
II	Miscellaneous Math Sets and Mappings, Solving Quadratic Equations, Trigonometry, Vectors, 2D Implicit and Parametric Curves, 3D Implicit and Parametric Curves, Linear Interpolation, Determinants and Matrices, Basic 2D and 3D transforms, Inverses of Transformation Matrices.	08	CO2 CO3
III	Raster Algorithms Raster Displays, Monitor Intensities, RGB color, Line Drawing, Simple Anti-aliasing, Image Capture and Storage, Graph Algorithms	05	CO2 CO3
IV	Ray Tracing The basic Ray Tracing Algorithm, Computing Viewing Rays, Ray-Object Intersection, A Ray Tracing Program, Shadows, Specular Reflection, Refraction, Instancing, Constructive Solid Geometry, Distribution Ray Tracing.	03	CO4 CO3 CO4
V	Data Structures for Graphics Triangle Meshes, Winged Edge Data Structure, Scene Graphs, Scene Graphs, Tiling Multidimensional Arrays.	04	CO4 CO5
VI	Sampling Integration, Continuous Probability, Monte Carlo Integration, Choosing Random Points.	08	CO5 CO6
VII	Reflection Models Real World Materials, Implementing Reflection Models. Specular Reflection Material, Smooth Layered Model, Rough Layered Model.	04	CO6
	Total Hours	40	

Essential Readings

1. Computer Graphics: Principles and Practice in C (3rd Edition), by James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, 2014.
2. Fundamentals of Computer Graphics, by Peter Shirley, Michael Ashikhmin, Steve Marschner, A K Peters/CRC Press; 3 edition, 2009.
3. Computer Graphics, C Version (2nd Edition) by Donald Hearn, M. Pauline Baker, Prentice Hall; 1996.

Supplementary Readings

1. Introduction to Computer Graphics, David J. Eck, Hobart and William Smith Colleges, Copyright Year: 2016, Publisher: David J. Eck.
2. Computer Graphics: using OpenGL / F.S. Hill, Jr., Prentice Hall ; 2001.
3. Interactive computer graphics: data structures, algorithms, languages, By W. K. Giloi, Prentice-Hall, 1989.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution			
			L	T	P	C	INT	MID	END	Total
CS 314	**Shell Programming**	**None**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To introduce basic concepts and principles of command line programming, the command structure, the types of commands, and the categorizations of commands for different operating systems.	Course Outcomes	**CO1**	Able to discuss the basic concepts and principles of command line programming, the command structure, the types of commands, and the categorizations of commands for different operating systems.
	To develop the skills for shell programming in different operating systems.		**CO2**	Able to use general commands, file and directory handling commands, process handling commands, network communication and user communication/ interaction related commands, some system administration related commands, and some special commands.
	To introduce several commands for working in different shells of different operating systems.		**CO3**	Able to familiarize with different shells for different operating systems, different text editors available in Unix - like operating systems for shell programming, working on the vi editor, and writing various shell scripts and windows bat scripts for simple applications.
			CO4	Able to use decision control, looping, different data types, functions and other programming features in shell programming.
			CO5	Able to use filters, piping and regular expressions in shell programming.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
2	CO2	**3**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**2**	**2**	**0**
3	CO3	**3**	**2**	**3**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**3**	**2**	**0**
4	CO4	**3**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**3**	**2**	**0**
5	CO5	**3**	**1**	**2**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**3**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Command structure for Unix - like and Windows operating systems (OSs); Command Line Interface (CLI) vs. Graphical User Interface (GUI); CLIs in different OSs: popular shells for Unix - like OSs, MS-DOS command.com shell, Windows Command Prompt, Windows Powershell; Types of CLI commands: internal and external commands for different OSs	**03**	**CO1**
II	Different commands in Unix/ Linux and Windows OSs: Simple Unix/ Linux commands, Simple Windows commands; file and directory handling utilities; process handling commands; network communication and user communication/ interaction related commands; system administration commands; special commands	**12**	**CO1, CO2**
III	Introduction to shells in different operating systems: Korn shell, Bash shell, C shell, Windows Command Prompt, Powershell; text editors in Unix - like operating systems; working on the vi editor; creating shell scripts in Unix/ Linux, creating bat files in Windows OSs; examples of shell scripts, bat scripts and powershell scripts	**08**	**CO1, CO3**
IV	Different programming features for shell programming in Unix/ Linux and Windows OSs:- decision control; looping; use of different data types: variables, arrays, files; use of functions; examples of shell scripts, bat scripts and powershell scripts	**12**	**CO4**
V	Other important concepts in shell programming in Unix/ Linux and Windows OSs:- use of filters; use of piping (redirection); use of regular expressions; examples of shell scripts, bat scripts and powershell scripts	**05**	**CO5**
Total Hours		**40**	

Essential Readings

1. Behrouz A. Forouzan, Richard F. Gilberg, “Unix and Shell Programming: A Textbook”, Cengage Learning, first edition, 2003.
2. Sumitabha Das, “Your UNIX/Linux: The Ultimate Guide”, McGraw-Hill Education, third edition, 2012.
3. Bruce Payette, Richard Siddaway, “Windows PowerShell in Action, Manning publications, third edition, 2017.

Supplementary Readings

1. Graham Glass, King Ables, “UNIX for Programmers and Users”, Pearson Education India, third edition, 2003.
2. Yashavant Kanetkar, “Unix Shell Programming”, BPB publications, first edition, 2003.
3. Lee Holmes, “Windows PowerShell Cookbook”, O’reilly Media, third edition, 2013.

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CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS316	**Augmented and Virtual Reality**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the basic concepts of augmented and virtual reality		CO1	**Able to analyse the components of Virtual Reality**
	To apply the various concepts of virtual reality.		CO2	**Able to assess and compare technologies of Virtual Reality**
	To explore the application area of augmented and virtual reality		CO3	**Able to design application of Virtual Reality**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
2	CO2	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
3	CO3	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** **The historical development of Virtual Reality, Fundamental concept and components of Virtual Reality, Primary features and present development on Virtual Reality, Virtual environment, Requirements of Virtual Reality**	**08**	**CO1**
II	**3D User Interface Input/output Hardware** **Input Device Characteristics, Desktop Input Devices, Tracking Devices, 3D Mice, Special-Purpose Input Devices, Direct Human Input, Choosing Input Devices for 3D Interfaces, Visual Displays, Auditory Displays, Haptic Displays, Choosing Output Devices for3D User Interfaces**	**10**	**CO1**
III	**3D Interaction Techniques** **Representation of the Virtual Worldand Rendering Systems- Visual Representation, Aural Representation, Haptic Representation, Manipulating a Virtual World, Navigating in a Virtual World, Wayfinding - Theoretical Foundations, User-CenteredWayfinding Support, Environment-CenteredWayfinding Support, Design Guidelines**	**10**	**CO2**
IV	**Applications** **What makes an application a good candidate for Virtual Reality, Business and manufacturing, Science, Medical, Education, Public Safety and Military, Entertainment**	**08**	**CO3**
	Total Hours	**36**	

Essential Readings

1. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, 1st Edition, AddisonWesley, USA, 2005.
2. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design”, 1st Edition, Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, 2nd Edition Morgan Kaufmann, 2009.

Supplementary Readings

1. Burdea, Grigore C and Philippe Coiffet, “Virtual Reality Technology”,1st Edition, Wiley Interscience, India, 2003.
2. John Vince, “Virtual Reality Systems”, 1st Edition, Addison Wesley, 1995.
3. Oliver Bimber, Ramesh Raskar, “Spatial Augmented Reality Merging Real and Virtual Worlds”, 1st Edition, CRC Press, 2005.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS318	**Information Theory and Coding**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To develop the student's ability to understand the concept of information theory.		CO1	**Able to acquire knowledge about concept of mutual information and entropy in information theory.**
	To provide the students about various codes used for data compression.		CO2	**Able to acquire knowledge about various data compression codes**
	To develop the student's ability to analyse the error correcting codes used for reliable transfer of data.		CO3	**Able to understand and analyse the various error correcting codes used for reliable transfer of data.**
	To familiarize the student with the various decoding techniques.		CO4	**Able to understand and analyse the decoding techniques.**
	To familiarize the student the cryptographic algorithms used in information theory.		CO5	**Able to understand and analyse some of the cryptographic algorithms used in information theory.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
2	CO2	**3**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**0**	**3**	**2**	**2**
3	CO3	**3**	**3**	**3**	**1**	**2**	**0**	**2**	**0**	**2**	**0**	**0**	**0**	**3**	**3**	**2**
4	CO4	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**2**	**0**	**1**	**1**	**2**	**2**	**3**
5	CO5	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**2**	**0**	**3**	**1**	**1**	**2**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Uncertainty, Information, Concept of mutual information, Entropy and their properties, Channel Capacity, Shannon's Theorems, Gaussian Channel	**06**	**CO1**
II	Noiseless coding, Huffman coding and its optimality, Kraft and McMillan's inequality, Shannon-Fano code, Elias code, Arithmetic coding and universal coding.	**10**	**CO2**
III	Algebraic codes-Linear Block codes, Cyclic codes-BCH codes, perfect code, galley codes, Finite geometry codes, Hadamard codes, Maximal distance separable codes, sphere packing and singleton bounds. Codes for random access memories, tapes and disc, fault tolerant computation with arithmetic codes and redundant number systems.	**10**	**CO3**
IV	Exact techniques of decoding, relationship between complexity of algorithms in poly-digital circuits and VLSI with algebraic coding.	**07**	**CO4**
V	Cryptographic codes-Random number generation, DES scheme, RSA scheme and Diffie & Hellman's Public Key Crypto systems.	**07**	**CO5**
Total Hours		**40**	

Essential Readings

1. Blahut, R.E, Theory and practice of error control codes, Addison Wesley, 1st Edition, 1983, reprint 1992.
2. Blahut, R.E, Principles of transmission of digital information, Addison Wesley, 1st Edition, 1990.
3. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill publication, 2nd Edition, 2010.

Supplementary Readings

1. James V Stone, Information Theory: A Tutorial introduction, Sebtel Press, 1st Edition, 2015.
2. Thomas M Cover and Joy A Thomas, Elements of Information Theory, Wiley India, 2nd Edition, 2006.
3. Jorge Castiñeira Moreira, Patrick Guy Farrell , Essentials of Error-Control Coding, Wiley, 1st Edition, 2006.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 320	**Machine Learning**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the different learning models and its usage in computer vision and data analytics.		CO1	Able to identify potential applications of machine learning in practice
	To understand the different classification algorithms and its application in image understanding and data clustering		CO2	Able to Describe the differences in approaches and applicability of regression, classification, and clustering
	To understand forecasting and different learning theory applied for prediction of desired conclusion in data analytics.		CO3	Able to use forecasting and prediction models using different learning theory
	Apply different unsupervised learning and reinforcement learning models in application areas like image forgery, image classification, data clustering and decision making process		CO4	Able to select the suitable machine learning models for decision making process
	To understand the dimension reduction process and handling of big data using machine learning models		CO5	Able to apply the dimension reduction process, feature selection process and use of machine learning models for big data

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction, Machine learning basics, Supervised Learning: Artificial Neural Network, classifying with k-Nearest Neighbour classifier, Support vector machine classifier, Decision Tree classifier, Naive Bayes classifier, Bagging, Boosting, Improving classification with the AdaBoost meta algorithm.	**10**	**CO1**
II	Forecasting and Learning Theory: Predicting numeric values: regression, Linear Regression, Logistic regression, Tree-based regression. Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, Vapnik–Chervonenkis (VC) dimension, Worst case (online) learning.	**10**	**CO2**
III	Unsupervised Learning: Grouping unlabeled items using k-means clustering, Association analysis with the Apriori algorithm, efficiently finding frequent item sets with FP-growth.	**8**	**CO1** **CO3**
IV	Reinforcement learning: Markov decision process (MDP), Bellman equations, Value iteration and policy iteration, Linear quadratic regulation, Linear Quadratic Gaussian, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.	**6**	**CO2** **CO3**
V	Dimensionality reduction: Feature extraction - Principal component analysis, Singular value decomposition. Feature selection – feature ranking and subset selection, filter, wrapper and embedded methods. Machine Learning for Big data: Big Data and MapReduce.	**06**	**CO4** **CO5**
	Total Hours	**40**	

Essential Readings

1. Title: Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Publisher: O'Reilly Media, Inc , 2nd Edition, 2019.
2. Title: Introduction to Machine Learning, Author E. Alpaydin, Publisher: MIT Press Edition, 2nd Edition, 2009.
3. Title: Machine Learning, Author: T. M. Mitchell, Publisher: McGraw-Hill, Edition 1997.

Supplementary Readings

1. Title: Machine learning in action, Author: P. Harrington, Publisher: Manning Publications, 2012 Edition.
2. Title: Pattern recognition and Machine Learning, Author C. M. Bishop, Publisher: Springer, 2007 Edition.
3. Title: Machine Learning for Big Data, Author: J. Bell, Publisher: Wiley, 2014 Edition.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation: **2019-20**
Department	**Computer Science and Engineering**	Semester: **VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS322	**Cryptography and Network security**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To develop the student's ability to understand the concept of security goals in various applications.		CO1	**Able to acquire knowledge about security goals, background of cryptographic mathematics and identification of its application**
To provide the students with some fundamental cryptographic mathematics used in various symmetric and asymmetric key cryptography.		CO2	**Able to acquire knowledge about the background mathematics of symmetric key cryptography and understand, analyse and implement – the symmetric key algorithm.**
To develop the student's ability to analyse the cryptographic algorithms.		CO3	**Able to acquire knowledge about the background mathematics of asymmetric key cryptography and understand and analyse – asymmetric key encryption algorithms, digital signatures**
To familiarize the student the need of security in computer networks.		CO4	**Able to understand and analyse the concept of message integrity and the algorithms for checking the integrity of data.**
		CO5	**Able to understand and analyse the existing cryptosystem used in networking**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
2	CO2	**3**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**3**	**2**
3	CO3	**3**	**3**	**3**	**1**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**3**	**2**
4	CO4	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**2**	**2**
5	CO5	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction Security goals, cryptographic attacks. Mathematics of cryptography: modular arithmetic, Euclidean and extended Euclidean algorithm. Traditional symmetric key ciphers; Monolithic ciphers: addition and multiplication ciphers, Polyalphabetic ciphers: Vigenere's ciphers, Hill ciphers, playfair ciphers.	**08**	**CO1**
II	Symmetric key cryptography Mathematics of symmetric key cryptography: Groups, Rings, Fields, GF, Inverse of a number and polynomial using extended Euclidean algorithm. Modern Block ciphers and its components, DES, AES	**08**	**CO2**
III	Asymmetric key cryptography Mathematics of asymmetric key cryptography: Euler's Phi-Function, Fermat's Little Theorem, Euler's theorem, Chinese remainder theorem. Diffie-Hellman, Digital signature: RSA, Elgamal, Entity authentication	**08**	**CO3**
IV	Message Integrity and authentication: MAC, HMAC. Cryptographic Hash Function: Merkle-Damgard, MD5, SHA512.	**06**	**CO4**
V	Network Security Key Management, PGP, IPSec, SSL, Firewalls, Intrusion Detection, Password management, Virus. Virtual Private Network.	**10**	**CO5**
	Total Hours	**40**	

Essential Readings

1. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill publication, 2nd Edition, 2010.
2. William Stallings ,"Cryptography and Network Security: Principles and Standards", Prentice Hall India, 7th Edition, 2017.
3. John R. Vacca, "Computer and Information Security Handbook", Morgan Kaufmann Publishers, 3rd Edition, 2017.

Supplementary Readings

1. Richard H. Baker, Network Security, McGraw Hill International 3rd Edition,1996.
2. B. Schneier, Applied Cryptography, John Wiley New York, 2nd Edition, 1996.
3. C. Kaufman et. al, Network Security, Prentice Hall International, 2nd Edition, 2002.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 324	**Data Analysis and Visualization**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To understand the need of data analysis and visualization techniques	CO1	**Able to analyse the different data representation and data pre-processing techniques**
To learn the different types of data analysis and visualization tools and techniques	CO2	**Able to assess and compare different data analysis and visualization techniques**
To apply the concept of data analysis and visualization to real life problems	CO3	**Able to implement data analysis and visualization based solutions for real life problems**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
3	CO3	**1**	**1**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** **Concepts and Need of data analysis and visualization in the era of data abundance** **Data Representation - Nominal, Binary, Ordinal, Numeric, Discrete and Continuous, Types of data - Record, Temporal, Spatial Temporal, Graph, Unstructured and Semi structured data**	**04**	**CO1**
II	**Data Statistical Properties and Data Pre-Processing** **Basic Statistical Descriptions of Data (mean, median, standard deviation, maximum, minimum, tests of significance), Probability and Random Variables, introduction to estimation theory , Correlation, Regression** **Data pre-processing- Attribute transformation, Sampling, Dimensionality reduction, Feature subset selection, Distance and Similarity calculation**	**08**	**CO1**
III	**Data Analysis Techniques** **Supervised and unsupervised learning, gradient descent, over fitting, regularization** **Unsupervised techniques - K-means, Gaussian mixture models and expectation-maximization, evaluation of clustering** **Supervised techniques - K-nearest neighbor, naive Bayes, logistic regression and Regularization, support vector machine, artificial neural networks (ANNs)**	**12**	**CO2**
IV	**Visualization and Applications** **Traditional Visualization, Multivariate Data Visualization, Principles of Perception, Color, Design, and Evaluation,** **Text Data Visualization, Network Data Visualization, Temporal Data Visualization and visualization Case Studies** **Data visualization in Python and R**	**12**	**CO2 & CO3**
	Total Hours	**36**	

Essential Readings

1. Han, Jiawei, Jian Pei, and Micheline Kamber. "*Data mining: concepts and techniques"*. Elsevier, 3rd edition, 2011
2. Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. "*The elements of statistical learning: data mining, inference, and prediction"*. Springer Science & Business Media, 2nd edition, 2009.
3. Embarak, Ossama. "*Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems"*. Apress, 1st edition, 2018.

Supplementary Readings

1. Bishop, Christopher M. "*Pattern recognition and machine learning"*. springer, 1st edition, 2006.
2. Tan, Pang-Ning, Michael Steinbach, and Vipin Kumar. "*Introduction to data mining"*. Pearson Education India, 2nd edition, 2016.
3. Knaflic, Cole Nussbaumer. "*Storytelling with data: A data visualization guide for business professionals"*. John Wiley & Sons,1st edition, 2015.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-2020**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 326	**Multimedia**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**To understand the fundamentals concepts of multimedia systems such as multimedia information collection, processing and rendering.**	Course Outcomes	CO1	**Able to describe the fundamental concepts, components of multimedia systems and multimedia tools.**
	To understand various technical aspects in terms of multimedia networking, signal processing, communication, file format, audio video, compression and its applications.		CO2	**Able to do the critical analysis and evaluation of internet applications, file format such as text, audio, video and compression techniques.**
	To design and develop multimedia based web design and networking applications.		CO3	**Able to design and develop the interactive multimedia systems for real time requirements.**
	To understand the real time requirement of multimedia systems, development multimedia software and performance analysis.		CO4	**Able to apply the principles to understand the protocols, multimedia information transmission, various storage techniques, standards.**
			CO5	**Able to design and develop the applications using networking protocols and also able to evaluate applications to achieve optimal performance.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	3	0	0	0	0	0	0	1	0	0	0	3	0	3
2	CO2	3	3	3	3	1	2	0	0	1	0	0	0	1	3	3
3	CO3	1	2	3	3	3	2	0	2	0	0	0	0	2	3	3
4	CO4	3	3	3	3	3	2	3	0	2	0	0	1	2	3	3
5	CO5	3	3	3	2	2	3	2	2	2	2	0	1	3	3	3

SYLLABUS

No.	Content	Hours	COs
I	**Introduction, Uses of multimedia, Analog & digital Presentation, Digitization , Nyquist Sampling Theorem Visual Display system, Overview of Multimedia Tools**	**04**	**CO1** **CO2**
II	**Introduction to Data compression, Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Huffman Coding, Dictionary based Compression, LZ78, LZW compression, compression ratio loss less & lossy compression**	**06**	**CO2** **CO3**
III	**Introduction to Text Using text in multimedia, Hypermedia and Hypertext, Introduction to image, Graphics, Image Data Types, Image File formats, Multiple monitors, bitmaps, Vector drawing, color principles, Raster Scan principles, color pallets, Dithering**	**06**	**CO2** **CO3**
IV	**Introduction to video, Broadcast television, HDTV, Analog display standards, digital display standards, Digital video, Video formats, Sound ,MIDI, Digital Audio, audio file formats, MIDI under windows environment Audio & Video Capture.**	**06**	**CO3** **CO4**
V	**Introduction to Animation, Animation file formats, Basic Software Tools, Multimedia Authoring tools.**	**04**	**CO2** **CO3** **CO4**
VI	**Introduction to multimedia networks, Quality of Multimedia Data Transmission, Multimedia over IP, RTP, RTSP, RTCP, Voice over IP,**	**04**	**CO4** **CO5**
VII	**Introduction to Image & Video Compression, J.P.EG, H.261, H.263, MPEG, Standards (MPEG1, MPEG 2, MPEG 4),GIF,TIFF**	**06**	**CO3** **CO4** **CO5**
	Total	**36**	

Essential Readings

1. Li & S.Drew "Fundamental of Multimedia "Pearson Prentice Hall, Volume 1st Edition, 2004.
2. Ranjan Paarekh "Fundamentals of Multimedia" TMH, 2nd Edition, 2017.
3. K.R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems Techniques, Standards and Networks", PHI, 1st Edition, 2002.

Supplementary Readings

1. Tay Vaughan "Multimedia, Making IT Work" TMH, 9th Edition, 2017.
2. Fred Halsal "Multimedia Communication" Pearson Education, 1st Edition, 2007.
3. K.R. Rao, Zoran S. Bojkovic, Bojan M. Bakmaz," Wireless Multimedia Communication Systems: Design, Analysis, and Implementation", CRC Press, 1st Edition, 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 328	**System Software**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes	
	To introduce the different system software for a general and simple computer architecture.	CO1	Student will be able to identify and distinguish among different system and application software.
	To implement different assemblers for a general and simple computer architecture.	CO2	Student will be able to design different types of assemblers for a simple microprocessor.
	To implement simple linker/loaders and macro for a general and simple computer architecture.	CO3	Student will be able to explain the requirements of linker/loader and also implement them for a simple system.
		CO4	Student will be able to explain the requirements of Macros and also implement them for a system.
		CO5	Student will be able to understand the working of different software like compiler, text editor and debuggers.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**2**	**2**
2	CO2	**3**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
3	CO3	**3**	**3**	**3**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
4	CO4	**3**	**1**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
5	CO5	**3**	**2**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**

SYLLABUS

No.	Content	Hours	COs
I	System and Application software, The Simplified Instruction Computer- SIC and SIC/XE,	**02**	**CO1**
II	Elements of Assembly Language Programming, Assembly Scheme, Machine-dependent Assembler Features, Pass Structure of Assembler, Design of Assembler -2 pass assemble for SIC, Data structure, Format of Database, Algorithm, Table processing: Searching and sorting, Machine-Independent Assembler Features, Multipass Assembler, A Single Pass Assembler for SIC.	**15**	**CO1, CO2**
III	Reallocation and Linking Concept, Design of Linker, Self Reallocation Programs, Loader, Absolute Loader, A Simple Bootstrap Loader, Reallocating Loader, Linking Loader, Design of a Loader.	**12**	**CO1, CO3**
IV	Macro Instructions, Features of Macro facility, Macro Instruction arguments, Generation of Unique labels, Conditional Macro Expansion, Keyword Macro parameters, Macro Instructions defining Macros, Recursive Macro Expansion, Macro Processor Algorithm and Data Structures.	**05**	**CO1, CO4**
V	Aspects of Compilation, Various phases of a compiler, Introduction to Language Processing Activity, Fundamental of Language Processing, Fundamental of Language Specification, Language Processor Development tool. Interactive Text Editor, Editing features, Type of Editor and user interface, Structure of a General Text Editor, Editor design and evaluation, Editors function in computing environments, Interactive Debugging System, Debugging Functions and Capabilities, Type of bugs, Debugging techniques, Debugging Tool, Command line Debugger, Types of analysis tool, Difficulties in Designing an Interactive Debugging System.	**05**	**CO1, CO5**
Total Hours		**39**	

Essential Readings:

1. Leland L. Beck , D. Manjula , " System Software -An Introduction to System Programming", 3rd ed., 1997, Addison Wesley.
2. M. Dhamdhere, " System Software and Operating System", 2nd ed. 1999, Tata McGraw-Hill.
3. Santanu chattopadhyay, "System software", 1st ed., 2007, PHI.

Supplementary Readings:

1. John J. Donovan, "System Programming", 1st ed., 2017, McGraw-Hill Education.
2. A.V. Aho, R. Sethi and J D. Ullman, "Compilers-Principles, Techniques and Tools", 2nd ed., 2006, Pearson Education.
3. J. Nithyashri, "System Software", 2nd ed., 2010, Tata McGraw Hill.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 372	**Introduction to Machine Learning**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To understand the different learning models and its usage in computer vision and data analytics.		CO1	Able to identify potential applications of machine learning in practice
To understand the different classification algorithms and its application in image understanding and data clustering		CO2	Able to Describe the differences in approaches and applicability of regression, classification, and clustering
To understand forecasting and different learning theory applied for prediction of desired conclusion in data analytics.		CO3	Able to use forecasting and prediction models using different learning theory
Apply different unsupervised learning and reinforcement learning models in application areas like image forgery, image classification, data clustering and decision making process		CO4	Able to select the suitable machine learning models for decision making process
To understand the dimension reduction process and handling of big data using machine learning models		CO5	Able to apply the dimension reduction process, feature selection process and use of machine learning models for big data

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction, Machine learning basics, Supervised Learning: Artificial Neural Network, classifying with k-Nearest Neighbour classifier, Support vector machine classifier, Decision Tree classifier.	**06**	**CO1**
II	Forecasting and Learning Theory: Predicting numeric values: regression, Linear Regression, Logistic regression, Tree-based regression. Bias/variance trade-off, Union and Chernoff / Hoeffding bounds, Vapnik–Chervonenkis (VC) dimension, Worst case (online) learning.	**08**	**CO2**
III	Unsupervised Learning: Grouping unlabeled items using k-means clustering, Association analysis with the Apriori algorithm, efficiently finding frequent item sets with FP-growth.	**05**	**CO1** **CO3**
IV	Reinforcement learning: Markov decision process (MDP), Bellman equations, Value iteration and policy iteration, Linear quadratic regulation, Linear Quadratic Gaussian, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.	**06**	**CO2** **CO3**
V	Dimensionality reduction: Feature extraction - Principal component analysis, Singular value decomposition. Feature selection – feature ranking and subset selection, filter, wrapper and embedded methods. Machine Learning for Big data: Big Data and Map Reduce.	**05**	**CO4** **CO5**
	Total Hours	**30**	

Essential Readings

1. Title: Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 2nd Edition, 2019, O'Reilly Media, Inc.
2. Title: Introduction to Machine Learning, Author E. Alpaydin, Publisher: MIT Press, 2nd Edition, 2009.
3. Title: Machine Learning, Author: T. M. Mitchell, Publisher: McGraw-Hill, 1997 Edition.

Supplementary Readings

1. Title: Machine learning in action, Author: P. Harrington, Publisher: Manning Publications, 2012 Edition.
2. Title: Pattern recognition and Machine Learning, Author C. M. Bishop, Publisher: Springer, 2007 Edition.
3. Title: Machine Learning for Big Data: Hands-On for Developers and Technical Professionals, Author: J. Bell, Publisher: Wiley, 2014 Edition.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology**	Year of Regulation	**2018-19**
Department	**Humanities and Social Sciences**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
HS 392	**Corporate Communication**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces the concepts of corporate communication		CO1	Able to explain the key concepts and roles of corporate communication
	This course explains the application of corporate communication to real-life corporations		CO2	Able to apply the concepts of corporate communication to real-life corporations
	This course familiarizes corporate communication strategies		CO3	Able to create corporate communication strategies
	This course illustrates the way corporations and organizations communicate		CO4	Able to explain the way corporations and organizations communicate, externally and internally
	This course explains the concept of Corporate Social Responsibility		CO5	Able to analyse the role of Corporate Social Responsibility in Image Management

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	0	0	0	0	0	2	0	2	3	3	3	2			
2	CO2	0	0	0	0	0	2	0	2	3	3	3	2			
3	CO3	0	0	0	0	0	2	0	2	3	3	3	2			
4	CO4	0	0	0	0	0	2	0	2	3	3	3	2			
5	CO5	0	0	0	0	0	2	0	2	3	3	3	2			

SYLLABUS

No.	Content	Hours	COs
I	Definitions and Concept of Corporate Communication; Role, Scope and Objectives of Corporate Communication; Kinds of communication in an organisation; Areas of strategic thinking in Corporate Communication; Ethics and Laws in Corporate Communication; Present state of Corporate Communication; Corporate Social Responsibility	05	All COs
II	Corporate Communication Tools; Lobbying; Sponsorship; Financial Communication; Corporate Reputation; Corporate Identity	03	CO2 CO3 CO4
III	Strategy in Corporate Communication; Defining Strategy and its Role; Campaign Planning; Areas of Strategic Consideration; Case studies in Corporate Communication Campaigns	06	CO2 CO3 CO4
IV	Internal Communication; Role and Scope of Internal Communication; Tools of Internal Communication; Kinds of writing for media; Understanding requirements of media writing; Crisis Communication; Defining Conflict; Defining Disasters; Kinds of disasters; Corporate Communication and damage salvage; Use of media in times of crisis	06	CO1 CO2 CO4
V	Corporate Social Responsibility; Defining Corporate Social Responsibility; Role, Scope and Need for Corporate Social Responsibility; Corporate Social Responsibility and Image Management; Case studies in Corporate Social Responsibility	04	CO1 CO2 CO4 CO5
	Total Hours	**24**	

Essential Readings

1. Richard R Dolphin, “The Fundamentals of Corporate Communication”, Routledge, 2011.
2. Paul Argenti & Janis Forman, “The Power of Corporate Communication: Crafting the Voice and Image of your Business”, McGraw-Hill Education, 1st edition, 2002.

Supplementary Readings

1. Pitman Jackson, “Corporate Communication for Managers”, Pitman Publishing, 1987.
2. David Chandler, “Corporate Social Responsibility: A Strategic Perspective”, Business Expert Press, 2014.

National Institute of Technology Meghalaya

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CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Lab Test/ Viva	Total
CS352	**Software Engineering Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	Course Outcomes		
To introduce the Software Development life cycles Models		CO1	**Able to identify, formulate, and solve complex engineering problems**
To analyse the software requirements		CO2	**Able to recognize ethical and professional responsibilities in engineering situations**
To introduce various design methods for software Development		CO3	**Able to analyze, design, verify, validate, implement, apply, and maintain software systems**
To develop an ability and skill to test software systems		CO4	**Able to work in one or more significant application domain**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
2	CO2	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**
3	CO3	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
4	CO4	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Software Development life cycles Models, Agile Process Models Software**	**06**	**CO1 CO2 CO3 CO4**
II	**Static program verification tool (SLAM) for verifying critical program behaviour, Data Modelling Concepts, Object Oriented Analysis, Flow-Oriented Modelling,**	**06**	
III	**Formal verification of concurrent systems using SPIN model checker.**	**06**	
IV	**DFD and UML Development for the requirements**	**06**	
V	**Design and coding using software development languages**	**06**	
VI	**Taxonomy of Quality Attributes, Perspectives of Quality, Quality System, Software Quality Assurance, Manual and automated testing tools.**	**06**	
	To be done necessarily as mini-project group-wise in groups of at least two/three students.		
Total Hours		**36**	

Essential Readings

1. Roger S Pressman: “Software Engineering – A Practitioner’s Approach”, 7th Edition, McGraw-Hill, 2009.
2. Rajib Mall, “Fundamentals of Software Engineering”, 5th Edition, PHI, 2018.
3. Ian Sommerville: “Software Engineering”. 9th Edition, Pearson Education, 2011.

Supplementary Readings

1. SLAM Reference- http://research.microsoft.com/en-us/projects/slam/
2. SPIN Model Checker Reference: http://spinroot.com/spin/whatispin.html
3. Paul Ammann, and Jeff Offutt, “Introduction to Software Testing”, 1st Edition, Cambridge University Press, 2008.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2020-21**
Department	**Computer Science and Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Lab Test / Viva	Total
CS 354	**Compiler Design Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	The Objectives of this course is to explore the principles, algorithms, and data structures involved in the design and construction of compilers.		CO1	Specify and analyse the lexical, syntactic and semantic structures of any computer programming language.
			CO2	Separate the lexical, syntactic and semantic analysis into meaningful phases for a compiler to undertake language translation.
	To implement some phases of the front-end of a general compiler.		CO3	Write a scanner, parser, and semantic analyser for limited form of C like programming languages.
			CO4	Convert source code in simple language into machine code for a novel computer.
	To implement some phases of the backt-end of a general compiler.		CO5	Describe techniques for intermediate code and machine code optimisation.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
2	CO2	**3**	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**3**
3	CO3	**2**	**3**	**3**	**1**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**3**
4	CO4	**2**	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**3**
5	CO5	**2**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**3**

SYLLABUS

No.	Content	Hours	COs
I	1) Using Lex/Flex , write a program to append line number before each (i) lines(empty/non-empty). (ii) non-empty lines Input/output streams may be files. 2) Using Lex/Flex , write a program to count number of lines, words, visible characters, total characters. Input/output streams may be files.	**4**	**CO1, CO2, CO3**
II	3) Using Lex/Flex , write a program to identify some keywords, identifiers, integers and real numbers from a simple C program. Input/output streams may be files. 4) Lex program to copy a file by replacing multiple sequences of white spaces with a single white space. [blanks/tab => blank, more than one " \n" => " \n"]. 5) Also add removal of comments in above program.	**2**	**CO1, CO2, CO3**
III	6) Lex program to copy a C program by replacing each instance of the keyword *float* by *double*. 7) Write a Lex program that converts a file to "Pig Latin". Specifically, assume the file is sequence of English words (group of letters) separated by white space. Every time a word is encountered: 1. If the first letter is consonant, move it to the end of the word and then add ay. 2. If the first letter is a vowel, just add ay to the end of the word.	**2**	**CO1, CO2, CO3**
IV	8) Using Lex/Flex , write a program to encode and decode.	**2**	**CO1, CO2, CO3**
V	9) Using Lex/Flex , write a program to (i) identify the Roman numbers (ii) add 2 Roman numbers.	**2**	**CO1, CO2, CO3**
VI	10) Create a recursive predictive parser for a grammar(as given in lab class).	**2**	**CO1, CO2, CO3**
VII	11) Create a non-recursive predictive parser(LL parser) for a grammar(as given in lab class).	**2**	**CO1, CO2, CO3**
VIII	12) Using Flex and Bison tools, create a calculator program that support addition,subtraction, multiplication, division, power operations on numbers and variables.	**4**	**CO1, CO2, CO3**
IX	13) Using Flex and Bison tools, create a translator to convert a simple program written in arbitrary language to a program in C language.	**2**	**CO1,CO4**
X	14) Using Flex and Bison tools, create a program to convert a simple assignment expression into intermediate code. Ex:- input: z = -(a+b-c) output: t1 = a + b t2 = t1 – c	**2**	**CO1,CO5**

	t3 = - t2 z = t3		
Total Hours		**24**	

Essential Readings:

1. A.V. Aho, M. S. Lam, R. Sethi and J. D. Ullman, "Compilers-Principles, Techniques and Tools", 2nd ed., 2006, Pearson Education.
2. K. Muneeswaran, "Compiler Design", 1st ed., 2013, Oxford Publication.
3. P.H. Dave, H.B. Dave, "Compilers: Principles and Practice", 1st ed. 2012, Pearson Education.

Supplementary Readings:

1. Allen I. Holub, "Compiler Design in C", 1st ed.(Indian print), 2012, PHI.
2. John Levine, "Flex & Bison ", 1st ed., 2009, O'reilly.
3. Torben Ægidius Mogensen, "Basics of Compiler Design", 1st ed., 2007, DIKU, University of Copenhagen

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS411	**Soft Computing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This Course introduces the soft computing techniques		CO1	**Able to appraise Soft Computing applications**
	This course illustrates to design the fuzzy logic controller		CO2	**Able to appraise Fuzzy Logic and choose applications**
	This course develop an ability and skill to implement optimization techniques		CO3	**Able to Examine the single-objective and multi-objective optimization problems**
	This course illustrates to design the various neural networks		CO4	**Able to examine Neural Network and demonstrate the applications**
	This course familiarizes the application area of soft computing techniques		CO5	**Able to solve various real time problems in different application domains**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	CO2	**2**	**2**	**1**	**1**	-	-	-	-	-	-	-	**1**	**3**	-	**1**
3	CO3	**2**	**1**	**1**	**1**	-	-	-	-	-	-	-	**1**	**2**	-	**1**
4	CO4	**2**	**2**	**2**	**2**	-	-	-	-	-	-	-	**1**	**3**	-	**1**
5	CO5	**2**	**2**	**1**	**2**	-	-	-	-	-	-	-	**1**	**3**	-	**1**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** **Characteristics of Soft Computing, Applications of Soft Computing.**	**02**	**CO1**
II	**Fuzzy Logic** **Fuzzy Sets And Membership Function, Set Operations on Fuzzy Sets, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzification and Defuzzification, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Fuzzy Logic Controller, Applications of Fuzzy Logic, Fuzzy–C-Means Clustering**	**12**	**CO2** **CO5**
III	**Genetic Algorithm and Optimization Techniques** **Genetic Algorithm: Encoding, Selection, Crossover, Mutation, Fitness Function, Convergence, Multi Objective Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization**	**08**	**CO3** **CO5**
IV	**Neural Networks** **The McCullock-Pitts Neural Model, Perceptron, Neural Network Architectures, Activation Functions, Learning by Neural Networks, Hebb Net, Backpropagation: Multi-layer Feedforward Net, Generalized Delta Rule, Backpropagation Algorithm**	**11**	**CO4** **CO5**
V	**Hybrid Systems** **Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, Genetic Algorithms Based Neural Networks, Fuzzy Neural Networks, Fuzzy Logic Controlled Genetic Algorithms.** **Applications to Solve Real Life Problems.**	**03**	**CO5**
	Total Hours	**36**	

Essential Readings

1. J-S. R. Jang, C-T Sun, E. Mizutani, “Neuro–Fuzzy and Soft Computing”, 1st Edition, Pearson India Education, 2015.
2. S. N. Deepa and S. N. Sivanandam,” Principles of Soft Computing”, 2nd Edition, Wiley, 2011.
3. S. Rajasekaran, G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications”, 1st Edition, Prentice Hall of India, 2003

Supplementary Readings

1. Samir Roy, Udit Chakraborty, “Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms”, 1st Edition, Pearson India Education, 2013.
2. Kwang H Lee, “First Course on Fuzzy Theory and Applications”, 1st Edition, Springer-Verlag Berlin Heidelberg, 2005.
3. Andries P Engelbrecht, “Computational Intelligence An Introduction”, 2nd Edition, Wiley, 2018.
4. Goldberg, David E.” Genetic Algorithms in Search, Optimization & Machine Learning”, 1st Edition, Pearson Education, 1989.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation: **2018-19**
Department	**Computer Science and Engineering**	Semester: **VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 413	Pattern Recognition	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the fundamentals of pattern recognition and its relevance to classical and modern problems	Course Outcomes	CO1	Able to explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
	To introduce the knowledge about state-of-the-art algorithms used in pattern recognition research		CO2	Able to summarize, analyze, and relate research in the pattern recognition area along with various parameter optimization technique.
	To introduce Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.		CO3	Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
	To provide an understanding of pattern recognition techniques in practical problems and a main objective is to be able to identify where, when and how pattern recognition can be applied.		CO4	Able to apply pattern recognition techniques to real-world problems such as document analysis and recognition.
	To provide knowledge regarding various application of pattern recognition using machine learning model.		CO5	Able to Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**2**	**3**
2	CO2	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**3**	**2**
3	CO3	**1**	**0**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**0**	**0**	**1**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**1**	**2**
5	CO5	**0**	**0**	**1**	**0**	**2**	**2**	**0**	**0**	**2**	**0**	**0**	**1**	**1**	**1**	**3**
6	CO6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Pattern recognition and learning (supervised, unsupervised), training and test sets, feature selection, Clustering vs. Classification; Applications; Linear Algebra, vector spaces, probability theory, estimation techniques.	08	CO1 CO2
II	**Classification** Univariate and multivariate density, discriminant functions for the normal Density different cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context, Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features **Parameter Estimation Methods:** Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case	08	CO2, CO3, CO4
III	**Clustering** Different distance functions and similarity measures, Criterion for clustering, Methods of clustering - partitional, hierarchical, graph theoretic, density based., Cluster validity	05	CO2 CO3
IV	Un-supervised learning and clustering: Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering	05	CO3 CO4
V	Pattern recognition using discrete hidden Markov models: Discrete-time Markov process, Extensions to hidden Markov models, three basic problems of HMMs, types of HMM, continuous observation densities, multiple mixtures per state, speech recognition applications.	10	CO4 CO5
	Total Hours	36	

Essential Readings

1. Pattern Recognition: An Algorithmic Approach, By M. Narasimha Murty and V. Susheela Devi, Springer; 2011 edition
2. Fundamentals of Pattern Recognition and Machine Learning, By Braga-Neto, Springer International Publishing, 2020
3. Pattern Recognition, By S. Theodoridis and K. Koutroumbas, 4th Ed., Academic Press, 2009

Supplementary Readings

1. Pattern Recognition and Machine Learning, By Christopher Bishop, Springer-Verlag New York, 2006
2. Combining Pattern Classifiers: Methods and Algorithms, By Ludmila I. Kuncheva, 2nd Edition, John Wiley, 2014
3. Pattern Classification, By R.O.Duda, P.E.Hart and D.G.Stork, John Wiley, 2001

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Programme	**Bachelor of Technologyin Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 415	**Complex Networks**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To provide the students with some knowledge about the definition of complex networks, graph theory, and the significance of graph theory.		CO1	**Able to demonstrate the basic concept of graph theory with an example like the bridge of Konigsberg.**
To develop the student's ability to understand the various centrality measures and their importance.		CO2	**Able to explain the centrality measures of network nodes based on the degree, such as degree centrality, eigenvector centrality, and α-centrality.**
To provide the students with some knowledge about various random graphs and generalised random graphs and their importance to connect multiple complex networks.		CO3	**Able to identify various random graphs and generalized random graph, degree of distributions, how average properties of a random graph changes with the number of links etc.**
To develop the student's ability to understand the correlation between various complex networks.		CO4	**Able to examine how the individuals of a social network discover shortest paths, even if they have local knowledge and the appearance of small-world behavior in the biological systems.**
To develop the student's ability to understand the general approach to define and detect the building blocks of various complex networks.		CO5	**Able to interpret the models of continuous growth of various networks such as Scientific papers Citation Networks, the World Wide Web network, etc.**
		CO6	**Able to construct graphs with positive or negative degree-degree correlations.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**1**	**1**	**0**	**0**	**2**	**1**	**1**
2	CO2	**2**	**3**	**1**	**1**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**2**	**1**	**2**	**2**
3	CO3	**3**	**2**	**1**	**0**	**2**	**3**	**0**	**1**	**0**	**1**	**3**	**1**	**3**	**2**	**2**
4	CO4	**1**	**0**	**3**	**2**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**1**	**2**	**2**
5	CO5	**2**	**0**	**1**	**0**	**2**	**3**	**1**	**0**	**1**	**2**	**1**	**0**	**3**	**2**	**3**
6	CO6	**1**	**2**	**0**	**3**	**1**	**2**	**0**	**2**	**0**	**1**	**0**	**0**	**2**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Graphs and Graph theory:** **Basic definitions, Directed graphs, Weighted graphs, Bipartite graphs, Trees, Graph Theory and the Bridge of Konigsberg, How represent a graph;**	**4**	**CO1**
II	**Centrality Measures:** **The importance of being central, Connected Graphs and Irreducible Matrices, Degree and Eigenvector Centrality, Measures based on Shortest Paths, Group Centrality;**	**6**	**CO2**
III	**Random Graphs:** **Erdos and Renyi (ER) Models, Degree Distribution, Trees, Cycles and Complete Subgraphs, Giant Connected Component, Scientific Collaboration Networks, Characteristic Path Length;** **Generalised Random Graphs:** **The World Wide Web, Power-Law Degree Distributions, The Configuration Model, Random Graphs with Arbitrary Degree Distribution, Scale-Free Random Graphs, Probability Generating Functions;**	**9**	**CO3**
IV	**Small-World networks:** **Six Degree of Separation, The Brain of a Worm, Clustering Coefficient, The Watts-Strogatz (WS) Model, Variations to the Theme, Navigating Small-World Networks;**	**6**	**CO4**
V	**Model of Growing Graphs:** **Citation Networks and the Linear Preferential Attachment, The Barabasi-Albert (BA) Model, The importance of being Preferential and Linear, Variations of the Theme, Can latecomers Make it? The Fitness Model, Optimisation Models;**	**6**	**CO5**
VI	**Degree Correlations:** **The Internet and Other Correlation Networks, Dealing with Correlated Networks, Assortative and Disassortative Networks, Newman's Correlation Coefficient, Models of Networks with Degree-Degree Correlations;**	**5**	**CO6**
Total Hours		**36**	

Essential Readings

1. Latora V, Nicosia V, Russo G. Complex networks: principles, methods and applications. Cambridge University Press; 2017.
2. Cohen R, Havlin S. Complex networks: structure, robustness and function. Cambridge university press; 2010.
3. Estrada E. The structure of complex networks: theory and applications. Oxford University Press; 2012.

Supplementary Readings

1. Boccaletti S, Latora V, Moreno Y, Chavez M, Hwang DU. Complex networks: Structure and dynamics. Physics reports. 2006 Feb 1;424(4-5):175-308.
2. Meyn S, Meyn SP. Control techniques for complex networks. Cambridge University Press; 2008.
3. Ganguly N, Deutsch A, Mukherjee A. Dynamics on and of complex networks: Applications to biology. Computer Science, and the Social Sciences. Birkhäuser. 2009.

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Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 417	**Blockchain Technologies**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	
	This course explains the need and working principle of blockchain systems, cryptocurrency, cryptographic primitives.
	This course describes the in-depth knowledge and concept of recent technologies, tools, and implementation strategies.
	This course provides the validation and verification techniques of transaction through miners and Consensus Algorithms.
	This course provides the mechanism for the development of smart contract using solidity language for distributed applications.

Course Outcomes	
CO1	**Able to explain the need of Blockchain system and demonstrate the fundamentals of cryptocurrency, cryptographic primitives.**
CO2	**Able to demonstrate the tools, Nakamoto consensus and demonstrate the working principals of payment verification protocol**
CO3	**Able to describe and analyse the various consensus algorithm as per the application requirements.**
CO4	**Able to design and develop the communication model for sending and receiving the messages in transaction.**
CO5	**Able to design, develop and analyse the real time distributed real time applications.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**2**
3	CO3	**1**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**
4	CO4	**1**	**2**	**3**	**3**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Blockchain Introduction and Overview: Background and evolution of technology, Distributed systems, Distributed Ledger: DLT concept, features, benefits and relevance in application, Security and Privacy: Cryptography, Hash, Permission**	**03**	**CO1**
II	**Cryptographic primitives: Symmetric cryptography, A Symmetric cryptography, DES, Hash functions, Patricia trees, Distributed hash tables (DHTs), Digital signatures, Sign then encrypt, Encrypt then sign Elliptic Curve Digital signature algorithm (ECDSA), How to generate a digital signature, ECDSA using OpenSSL Homomorphic encryption, Signcryption, Zero knowledge proofs, Blind signatures, Encoding schemes**	**04**	**CO1** **CO2**
III	**Bitcoin, Bitcoin definition, Keys and addresses, Public keys in bitcoin, Private keys in bitcoin, Bitcoin currency units, Base58Check encoding, Vanity addresses**	**04**	**CO2**
IV	**Transactions, The transaction life cycle, The transaction structure, The script language, Commonly used Opcodes, Types of transaction, Transaction fee, Contracts, Transaction malleability, Transaction pools**	**04**	**CO3**
V VI	**Blockchain ,The structure of a block, The structure of a block header, The genesis block Mining, Task of miners Synching up with the network,Proof of Work, The mining algorithm, The hashing rate, Mining systems CPU, GPU, FPGA, ASICs, Mining pools**	**05**	**CO3** **CO4**
VII	**The bitcoin network: Wallets, Payments: Bitcoin investment and buying and selling bitcoins,Bitcoin installation, Bitcoin programming and the command-line interface, Bitcoin improvement proposals (BIPs)**	**04**	**CO3** **CO4**
	Alternative Coins: Theoretical foundations, Alternatives to Proof of Work, Non-outsourceable puzzles Difficulty adjustment and retargeting algorithms, Bitcoin limitations, Extended protocols on top of bitcoin Development of altcoins, Consensus algorithms, Coin, Mining guide, Zcash	**05**	**CO4**
VIII	**Smart Contracts: Definition, Ricardian contracts, Ethereum 101 Introduction: Ethereum blockchain, Transactions, Contract creation transaction, Message call transaction, Elements of the Ethereum blockchain, Ethereum virtual machine (EVM), Precompiled contracts, Accounts, Blocks, Transaction and Block validation mechanism**	**04**	**CO5**
IX	**Ethereum Development: Tools and Client, Introduction to Solidity, Hyperledger, Protocols, Applications outside the currencies.**	**03**	**CO5**
	Total	**36**	

Essential Readings

1. Imran Bashir, Mastering Blockchain,1/E,Packt, 2017.
2. Melanie Swan, Blockchain: Blueprint for New Economy, 1/E, O'Reilly Media, 2015.
3. Sam Goundar, Blockchain Technologies, Applications And Cryptocurrencies: Current Practice And Future Trends, 1/E Word Scientific, 2020

Supplementary Readings

1. Alan T. Norman, Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts,1/E, [United States?] : Alan T. Norman,2017
2. Jan Veuger, Blockchain Technology and Applications, 1/E, Nova Publisher,2019
3. Andreas Bolfing, Cryptographic Primitives in Blockchain Technology : A Mathematical Introduction, 1/E, Oxford University Press, 2020.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science & Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science & Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 419	**High Performance Architecture**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**COB1:** To develop the student's ability to understand the concept of reduced and complex instruction set architecture and its performance.	**Course Outcomes**	CO1	Able to understand the computer architectural design principles and performance enhancement strategies that adopted in performance evolution of different components of computer, multiprocessor architecture and distributed memory architecture and distributed systems.
	COB2: To develop the student's ability to understand the fundamentals of pipelining, identify the cause of hazards and apply different approaches for possible hazard free solutions.			
	COB3: To provide the students with some knowledge and analysis skills associated with the principles of superscalar technique and speculative execution.		CO2	Able to solve the performance related problems of pipeline structures, interconnect networks and memory.
	COB4: To develop the student's ability to understand the concept of shared-memory, distributed-memory, cache coherence problem and multiprocessor architecture.			
	COB5: To provide the students with some basic knowledge of distributed system with its design principles.		CO3	Able to analyze the performance differences of computing evolution on pipeline structures, interconnect networks, memory and distributed memory architecture

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
Module 1: Review of Basic Organization and Architectural Techniques	RISC processors, Characteristics of RISC processors, RISC vs. CISC, Classification of instruction set architectures.	**02**	**CO1**
	Review of performance measurements, Basic parallel processing techniques: instruction level, thread level and process level.	**03**	**CO1, 2 & 3**
Module 2: Instruction Level Parallelism	Basic concepts of pipelining, Arithmetic pipelines, Instruction pipelines, Hazards in a pipeline: structural, data and control hazards.	**04**	**CO1**
	Overview of hazard resolution techniques, Dynamic instruction scheduling, Branch prediction, techniques and solution of its related problems. Instruction-level parallelism using software approaches.	**04**	**CO2**
	Job scheduling using reservation tables	**04**	**CO1, CO2, CO3**
	Superscalar techniques, Speculative execution, Case study: Intel family of processors.	**02**	**CO1**
Module 3: Multi-Processors	Understand and design of Centralized vs. distributed shared memory, Interconnection topologies.	**03**	**CO1,2 &3**
	Multiprocessor architecture, Symmetric Multiprocessors.	**03**	**CO1**
	Cache coherence problem, memory consistency.	**02**	**CO2&3**
	Multi-core architecture, Case study: multiprocessors, co-processors like GPU	**02**	**CO1**
Module 4: Process Level Parallelism	Distributed Computers, Clusters	**05**	**CO1**
	Grid Computing: understand features of grid computing and implement of it.	**02**	**CO1&2**
Total Hours		**36**	

Essential Readings

1. Hamacher, Carl, Zvonko Vranesic, and Safwat Zaky. *Computer organization*. McGraw-Hill, 2002 edition.
2. Hennessy, John L., and David A. Patterson. *Computer architecture: a quantitative approach*. Elsevier, 2011 edition.
3. Hwang, Kai, and Naresh Jotwani. *Advanced computer architecture, 3e*. McGraw-Hill Education, 2016 edition.

Supplementary Readings

1. Hwang, Kai. *Advanced Computer Architecture with Parallel Programming*. McGraw-Hill, 1993 edition.
2. "Intel® 64 and IA-32 Architectures Optimization Reference Manual", http://www.intel.com/content/www/us/en/architecture-and-technology/64-ia-32-architectures-optimizationmanual.html
3. "Intel® 64 and IA-32 Architectures Software Developer Manuals", http://www.intel.com/content/www/us/en/processors/architectures-software-developer-manuals.html
4. Nvidia Kepler Compute Architecture White Paper", http://www.nvidia.com/object/nvidia-kepler.html

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 421	Image Processing	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the use of the components of digital image processing fundamentals	Course Outcomes	CO1	Able to acquire knowledge about the basic concepts used in Image processing.
	To introduce the mathematical foundation related in this domain.		CO2	Able to interpret the image processing fundamentals: hardware, software, digitization
	To introduce ability to apply image processing techniques in both the spatial and frequency (Fourier) domains.		CO3	Able to implement various algorithms for various edge detection, feature detection.
	To provide an understanding of description and analysis of how digital images are represented, manipulated, encoded and processed.		CO4	Able to describe the importance of image segmentation and restoration.
			CO5	Students will be able to acquire knowledge about various distributed Programming Model.
	Provide an understanding with emphasis on algorithm design, implementation and performance evaluation.		CO6	Students will be able to understand the Comparison of various Compression methods.
	To be able to discuss the real life application of image processing in various problems.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**1**	**2**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**0**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**0**	**2**	**3**	**0**	**2**	**2**	**0**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**
6	CO6	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**1**	**2**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Background, definition, Origin of DIP, Digital image representation, fundamental steps in image processing, elements of digital image processing systems, image acquisition, storage, processing, communication and display, effect of Aliasing and Jaggles, Advantages of high resolution systems DDA line algorithms: Bresenhams line and circle derivations and algorithms. Metric and topological properties of Digital Images, Histogram, entropy, Visual Perception, Image Quality, image smoothing, Edge detectors and quantification measures	08	CO1 CO2
II	**Segmentation:** Threshold detection methods, Optimal Thresholding, Edge based Segmentation-Edge image thresholding, Edge relaxation, Border tracing, Hough Transforms, Region based segmentation: Region Splitting, Splitting and Merging, Watershed Segmentation.	07	CO2 CO3
III	**Image Enhancement in the spatial domain:** Basic gray level transformations, histogram processing, Enhancement using arithmetic/logic operations, Basics of spatial filtering-comparison between smoothing and sharpening spatial filters. **Image Enhancement in the frequency domain:** 1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering.	10	CO2 CO3
IV	**Mathematical Morphology**: Basic Mathematical Concepts, Binary dilation and Erosion, Opening and closing, Gray Scale dilation and erosion, Skeleton, Thinning , Thickening Ultimate erosion, Geodesic transformations, Morphology and reconstruction, Morphological Segmentation	05	CO4 CO3 CO4
V	**Cyber Image Analysis:** Image Forgery, Types of image forgery, different tampering methods, detection and classification of image forgery	06	CO4 CO5
	Total Hours	36	

Essential Readings

1. Digital Image Processing, By Rafael C. Gonzalez, Richard E. Woods,PHI, 3rd edition
2. Fundamentals of Digital Image Processing, by A.K. Jain, Prentice Hall of India, 2011
3. Digital Image Processing and Analysis: Application with MATLAB and CVIP tools, 3rd Edition, SE Umbaugh, Taylor&Francis/CRC Press, 2018

Supplementary Readings

1. Digital Image Processing and Pattern Recognition, By Malay K. Pakhira, First Edition, PHI Learning Pvt. Ltd., 2011.
2. Hands-On Image Processing with Python, by Sandipan Dey, Publisher: Ingram short title, 2018
3. Digital Image Processing, By Willliam K Pratt, John Willey, 2002.

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Department	**Computer Science and Engineering**	Semester: **VII**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution			
			L	T	P	C	INT	MID	END	Total
CS423	**Artificial Intelligence**	**None**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	
	This course familiarizes the basic principles, techniques and applications of Artificial Intelligence (AI).
	This course explains the basic principles to solve problems using Artificial Intelligence.
	This course introduces logic based AI technique, planning algorithms, probability based AI technique and some machine learning models for problem solving.

Course Outcomes	
CO1	**Able to analyze concepts and principles of Artificial Intelligence (AI) for their proper selection for applications of AI.**
CO2	**Able to appraise AI techniques based on their strengths and limitations and decide their applicability to human-centered problems.**
CO3	**Able to develop formal representations of problems w. r. t. different algorithms of AI techniques to solve those problems.**
CO4	**Able to solve problems using logic based algorithms and planning algorithms.**
CO5	**Able to solve problems using probability based algorithms.**
CO6	**Able to solve problems using basic supervised and unsupervised machine learning models.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1	1	1	0	0	0	0	0	0	1	1	1	1
2	CO2	3	2	1	1	1	0	0	0	0	0	0	1	1	1	1
3	CO3	3	3	3	3	2	0	0	0	1	1	1	0	3	2	0
4	CO4	3	3	3	3	2	0	0	0	1	1	1	0	3	2	0
5	CO5	3	3	3	3	2	0	0	0	1	1	1	0	3	2	0
6	CO6	3	3	3	3	2	0	0	0	1	1	1	0	3	2	0

SYLLABUS

No.	Content	Hours	COs
I	**Overview; Types of AI; Turing test; Intelligent agents; Knowledge representation; AI technique** **Solving Problems by Searching: AND/OR Graphs; Uninformed search - Depth First Search, Breadth First Search, DFID; Heuristic search - Generate and Test, Hill Climbing, stochastic heuristic search :- Simulated Annealing, Best First Search, Beam Search, A*, Problem reduction search, AO*** **Constraint satisfaction problems - constraint satisfaction search; Means-ends analysis** **Stochastic search methods - Particle Swarm Optimization** **Game Playing - Minimax algorithm, Alpha-beta pruning**	**20**	**CO1, CO2, CO3**
II	**Building a knowledge base: Propositional logic, first order predicate logic (FOPL); Inference in first order predicate logic; Resolution - refutation proofs strategies in FOPL; Theorem Proving in First Order Logic** **Planning; goal stack planning; partial order planning**	**06**	**CO4**
III	**Uncertain knowledge and reasoning; Knowledge representation using probabilities; Bayesian Networks**	**03**	**CO5**
IV	**Overview of different forms of learning: unsupervised, supervised, semi-supervised; K-means clustering algorithm; Decision Trees; Naive Bayes' Classifier; Artificial Neural Networks**	**05**	**CO6**
V	**Introduction to Expert Systems**	**02**	**CO1, CO2, CO3, CO6**
	Total Hours	**36**	

Essential Readings

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach," Pearson, 4th edition, 2020.
2. E. Rich, K. Knight and S. B. Nair, "Artificial Intelligence," McGraw Hill Education, 3rd edition, 2017.
3. C. Bishop,"Pattern Recognition and Machine Learning," Springer, 1st ed. 2006. Corr. 2nd printing 2011 edition.

Supplementary Readings

1. D. W. Patterson, "Introduction to artificial intelligence and expert systems," Pearson Education India, 1st edition, 2015.
2. I. Bratko, "Prolog Programming for Artificial Intelligence," Addison Wesley, 4th edition, 2011.
3. S. O. Haykin, "Neural Networks and Learning Machines," Pearson Education India, 3rd edition, 2016.
4. D. Jurafsky and J. H. Martin, "Speech and Language Processing," Pearson Education India, 2nd edition, 2013.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS425	**Advanced Web Technology**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
This course familiarizes web hardware and software architectures, different growth stages of world wide web - web 2.0 and web 3.0 and technologies for web application development.	CO1	**Able to analyze the underlying computing hardware and software architectures for suitability of web application development and deployment.**
This course introduces different distributed object models.	CO2	**Able to compare different distributed object models for proper selection as per need.**
The course introduces different e-commerce models and relevant protocols.	CO3	**Able to design styled HTML web pages using various HTML elements, CSS, XML, XSL and XQuery.**
This course familiarizes the use of HTML, CSS, XML, XSL, XQuery, and client side and server side programming using JavaScript, AJAX, PHP, JSP and Servlets.	CO4	**Able to construct JavaScript and AJAX code for client side scripting.**
	CO5	**Able to construct code for server side programming using PHP, JSP and Servlets.**
	CO6	**Able to propose web application designs for different e-business models.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1	1	1	0	0	0	0	0	1	0	1	1	0
2	CO2	3	3	2	1	2	1	0	0	0	0	1	0	3	2	1
3	CO3	3	3	3	2	2	1	0	0	1	0	1	0	3	2	1
4	CO4	3	3	3	2	2	1	0	0	1	0	1	0	3	2	1
5	CO5	3	3	3	2	2	1	0	0	1	0	1	1	3	2	1
6	CO6	3	2	2	2	2	1	0	0	1	0	1	1	2	1	1

SYLLABUS

No.	Content	Hours	COs
I	**Introduction; Basics of Internet; Recent Web technologies: A case study on WWW, web 2.0; Client/Server Computing: C/S Computing, Fat client VS Fat Servers, Middleware, N-tiered Software Architecture**	**03**	**CO1**
II	**Protocols: HTTP, FTP, SMTP, POP**	**01**	**CO1**
III	**Web Browser: Browser Architecture, Configuration of Netscape and IE**	**01**	**CO1**
IV	**Apache Tomcat Web Server Architecture: Architecture, Server Features, Configuration of Apache Tomcat**	**02**	**CO1**
V	**Semantic web and supporting technologies**	**02**	**CO1**
VI	**Distributed Object Models: CORBA, DCOM, EJB**	**02**	**CO2**
VII	**Markup Languages and their grammars: SGML, DTD Resources, HTML, CSS, XML, XSL, Query Languages for XML**	**15**	**CO3**
VIII	**Introduction to responsive web design**	**01**	**CO3**
IX	**Client side scripting: JAVASCRIPT, AJAX; Server side programming using PHP, JSP and Servlets**	**06**	**CO4, CO5**
X	**E-business models; E-commerce and WWW; secure electronic payment protocols; e-commerce payment systems; web based marketing** **Search engine and directory registration; e-commerce site designing tools**	**03**	**CO6**
Total Hours		**36**	

Essential Readings

1. Jeffrey C. Jackson, “Web Technologies: A Computer Science Perspective”, Pearson Education India, 1st edition, 2008.
2. Luke Welling, Laura Thomson, “PHP and MySQL Web Development”, Pearson Education India, 5th edition, 2016.

3. Joel Murach, Michael Urban, “Murach's Java Servlets and JSP”, Mike Murach & Associates, 3rd edition, 2014.
4. David Whiteley, “e-Commerce: Strategy, Technologies and Applications”, McGraw Hill Education, 1st edition, 2017.
5. w3schools Tutorials, http://www.w3schools.com/
Supplementary Readings
1. P. Deitel, H. Deitel, A. Deitel, “Internet and World Wide Web: How to Program”, Pearson Education, 5th edition, 2018.
2. Dino Esposito, “Modern Web Development: Understanding Domains, Technologies, And User Experience”, 1st edition, PHI Learning, 2016.
3. Budi Kurniawan, “Servlet & JSP: A Beginner's Tutorial”, Brainy Software, 1st edition, 2016.
4. Uttam K. Roy, “Web Technologies”, Oxford University Press, 1st edition, 2010.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science & Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science & Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 427	**Software Defined Networking**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**COB1:** To develop students' ability to understand the concepts of traditional networks with its limitations and the need to move to Software Defined Networks.	Course Outcomes	CO1	Able to Understand the design principles and performance enhancement strategies that adopted in performance evolution of different network components.
	COB2: To develop the students' ability to understand the fundamentals of SDN, its planar architecture and to understand the flexibility of multilevel pipeline processing.		CO2	Able to Solve the performance related problems of SDN, including those in routing, optimizing traffic engineering.
	COB3: To provide the students with knowledge of the working of SDN between the controller and data plane and emphasis on the table matching.		CO3	Able to Analyze the performance of routing, optimizing traffic engineering using SDN.
	COB4: To create switches and designing networks by manually adding/deleting flow entries inside the table and learning to dissect the packets.			
	COB4: To create switches and designing networks by manually adding/deleting flow entries inside the table and learning to dissect the packets.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	-	-	-	-	1	1	-	-	2	-	1	-
2	CO2	3	3	2	2	2	-	-	1	1	-	-	2	1	1	-
3	CO3	3	3	3	2	2	-	-	2	2	-	-	2	2	2	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Traditional networks**: Traditional networks, Control Plane, Data Plane and Management Plane , Flow table, Limitations of traditional networks- Need for simplification, Lowering operating costs ,Single flow table, Flexibility issues, Proprietary protocols and Destination based forwarding. ,ForCES .	**8**	**CO 1, 2 & 3**
II	**Introduction to SDN**: Software defined networks, SDN Planes-Dataplane, Control Plane, Application Plane, OpenFlow, Open Network Foundation, Protocol-Encryption, Northbound & Southbound-API, Multi-level flow table and pipeline processing, Group table, Meter table-Meter bands, OpenFlow version- 1.0,1.1,1.2,1.3	**8**	**CO 1 & 2**
III	**SDN Messages and Table matching**: Messages-Controller-Switch, Symmetric & Asynchronous messages Counters, OpenFlow Ports, Table matching in SDN, Network Automation and Virtualization.	**8**	**CO 1, 2 & 3**
IV	**Mininet Emulator**: Introduction to Mininet, Custom topologies of OpenFlow and Legacy Networks, Flow table manipulation-Adding & Deleting Flow entries, Packet Dissection via Wireshark	**8**	**CO 1 & 2**
V	**SDN Applications and UseCases**: SDN Controllers-Ryu, POX, Floodlight, SDN Applications, SDN-UseCases, SDN in the DataCenter and WAN, SDN-OpenSource and its Features	**4**	**CO 1, 2 & 3**
	Total Hours	**36**	

Essential Readings

1. Nadeau, Thomas D., and Ken Gray. *SDN: Software Defined Networks: an authoritative review of network programmability technologies*. " O'Reilly Media, Inc.", 2013.
2. Chuck Black and Paul Goransson, " Software Defined Networks: A Comprehensive Approach", Morgan Kaufman.
3. Coker, Oswald, and Siamak Azodolmolky. *Software-defined Networking with OpenFlow: Deliver Innovative Business Solutions*. Packt Publishing Ltd, 2017.

Supplementary Readings

1. https://www.opennetworking.org/wp-content/uploads/2014/10/openflow-spec-v1.3.0.pdf (OpenFlow version 1.3)
2. http://mininet.org/ (Mininet Network Emulator).
3. Kreutz, D., Ramos, F. M., Verissimo, P. E., Rothenberg, C. E., Azodolmolky, S., & Uhlig, S. (2014). Software-defined networking: A comprehensive survey. *Proceedings of the IEEE*, *103*(1), 14-76.
4. https://www.opennetworking.org/ (Open Network Foundation)

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 429	Robotics and Automation	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the knowledge in basic models of robot and their workspace.	Course Outcomes	CO1	Able to acquire knowledge about the basic concepts explain the fundamentals of robotics and its components
	To introduce the concepts of Robotic system, its components and instrumentation and control related to robotics.		CO2	Able to identify the electrical, electronics and mechanical components and use of them design or machine elements and transmission system.
	To be able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their workspace.		CO3	Able to design the workspace of control mechanism of robot.
	To provide and illustrate the movement of robotic joints with computers/microcontrollers.		CO4	Able to understand the features and operation of robotic automation.
	To be able to discuss and explain sensors and instrumentation in robotics		CO5	Students will able to use and implement the robot programming software.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**0**	**3**
2	CO2	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**2**
3	CO3	**1**	**2**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**2**
4	CO4	**0**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**2**
5	CO5	**0**	**2**	**3**	**0**	**2**	**2**	**0**	**0**	**2**	**0**	**0**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Robotics and Automation** Automation and robotics, Robot anatomy, Basic structure of robots, Resolution, Accuracy and repeatability, and Classification and Structure of robots, Point to point and continuous path systems.	07	CO1 CO2
II	**Robotic System and Control Systems:** Components of robotic system, Hydraulic systems, d.c. servo motors, Basic control systems concepts and models, Control system analysis, Robot activation and feedback components. Positional and velocity sensors, actuators. Power transmission systems,	08	CO2 CO3
III	**Robot arm Kinematics and Dynamics:** Robot joints, The direct kinematics problem, The inverse kinematics solution, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit Hartenberg convention and its applications.	08	CO2 CO3
IV	**Sensors and Instrumentation in robotics:** Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics. Vision equipment, Image processing, Concept of low level and high level vision. Computer based Robotics: Method of robots programming, GUI based robotic arm control, Interfacing with computer, communication and data processing, Introduction to Artificial Intelligence.	06	CO4 CO3 CO4
V	**Computer based Robotics:** Method of robots programming, GUI based robotic arm control, Interfacing with computer, communication and data processing, Introduction to Artificial Intelligence.	07	CO4 CO5
	Total Hours	36	

Essential Readings

1. Robotics & Control, By R.K. Mittal & I.J. Nagrath, TMH, 2007
2. Introduction to Robotics – Analysis, Systems and Application, By Saeed B. Niku, PHI 2006
3. Fundamentals of Robotics: Analysis and Control, By Criag, J., Prentice–Hall of India Private Limited 2006.

Supplementary Readings

1. Automation, Production Systems and Computer Integrated Manufacturing, By M.P.Grover, Pearson Education
2. Robotics Engg-an Integrated Approach, By Richard D, Klafter, Thomason A Chmiel Owski, Michel Nagin, PHI 2005
3. Fundamentals of Robotics: Analysis and Control, By Schilling. R. J., Prentice Hall of India Private Limited 2006.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 471	**Data Analytics using Python**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces understand the importance of data analytics		CO1	**Able to analyse the different data representation and data pre-processing techniques**
	This course explains the different types of data analytics techniques		CO2	**Able to assess and compare different data analytics techniques**
	This course familiarizes the data analytics techniques using python programming for publically available datasets		CO3	**Able to determine data analytics techniques using python libraries for real life applications**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
2	CO2	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
3	CO3	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction: Data analytics and its importance, introduction of python programming and installing Python, understanding operators, variables, data types, conditional statements , looping constructs , functions, lists and dictionaries in Python, Importing and exporting data in python**	**06**	**CO1**
II	**Data pre-processing : Handling missing values, data transformation, normalization, discretization** **Data Analysis Techniques: Supervised and unsupervised learning, Unsupervised techniques - K-means, Hierarchical clustering, Density based clustering, evaluation of clustering, Supervised techniques - Linear Regression, Logistic Regression, K-nearest neighbor, naive Bayes, support vector machine, artificial neural networks (ANNs)**	**10**	**CO2**
III	**Learn and installing Jupyter Notebook, Understanding the concept of Standard Libraries in python : Numpy, Pandas, sci-kit learn, MatplotLib,** **Case studies: Predicting loan defaulters, Customer segmentation, Time series forecasting etc.**	**08**	**CO3**
Total Hours		**24**	

Essential Readings

1. A.C. Müller and S. Guido. "*Introduction to machine learning with Python: a guide for data scientists*". O'Reilly Media, Inc. 1st edition, 2016
2. D. Beazley and B.K. Jones. " *Python Cookbook: Recipes for Mastering Python".* O'Reilly Media, Inc. 2nd edition, 2013
3. J. Han, J. Pei, and M. Kamber. "*Data mining: concepts and techniques".* Elsevier, 3rd edition, 2011

Supplementary Readings

1. W. McKinney. "*Python for data analysis: Data wrangling with Pandas. NumPy, and IPython".* O'Reilly Media, Inc. 2nd edition, 2017
2. P.N.Tan, M. Steinbach, A. Karpatne, and Vipin Kumar. "*Introduction to data mining"*. Pearson Education India, 2nd edition, 2016.
3. S. Raschka and V. Mirjalili. "*Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow"*. Packt Publishing Ltd. 2nd edition, 2019.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Civil Engineering**	Year of Regulation	**2020-21**
Department	**Civil Engineering**	Semester	**VII**

Course Code	Course Name	Pre requisite	Credit Structure				Marks Distribution			
			L	T	P	C	INT	MID	END	Total
CE 491	**Disaster Management**	**Nil**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To provide basic conceptual understanding of disasters and its relationships with development.	Course Outcomes	CO1	Able to understand the concepts of hazards, disasters and associated natural/social phenomena.
	To provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.		CO2	Able to understand the types, trends, causes and consequences of Disasters.
			CO3	Able to understand Disaster Management cycle, Risk Mapping, prevention and mitigation of Disasters and Framework of action.
	To enhance awareness of Disaster Risk Management institutional processes in India and to build skills to respond to disasters.		CO4	Able to familiarize with Disaster Management in India.
			CO5	Able to understand the application of Science and Technology for Disaster Management.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**
2	CO2	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**3**	**0**
3	CO3	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**
4	CO4	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**
5	CO5	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction on Disasters**: Understanding the concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.	**02**	**CO1**
II	**Types, Trends, Causes and Consequences of Disasters:** Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.	**06**	**CO2**
III	**Disaster Management Cycle and Framework:** Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.– Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment.	**06**	**CO3**
IV	**Disaster Management in India:** Disaster Profile of India – Mega Disasters of India and Lessons Learnt, Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter Governmental Agencies.	**04**	**CO4**
V	**Applications of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management, Disaster Communication System (Early Warning and Its Dissemination), Land Use, Planning and Development, Regulations, Disaster Safe Designs and Constructions, Structural and Non Structural Mitigation of Disasters, S&T Institutions for Disaster Management in India. Study of Recent Disasters (at local, state and national level) And Preparation of Disaster Risk Management Plan of an Area or Sector Role of Engineers in Disaster Management.	**06**	**CO5**
	Total Hours	**24**	

Essential Readings

1. Pandey, M., “Disaster Management”, Wiley India Pvt. Ltd.

2. J. P. Singhal, “Disaster Management”, Laxmi Publications.

3. M. C. Gupta, “Manual on natural disaster management in India”, NIDM, New Delhi.

Supplementary Readings

1. H. N. Srivastava & G.D. Gupta, “Management of Natural Disasters in developing countries”, Daya Publishers.

2. Singh, J., “Disaster Management: Future Challenges and Opportunities”, K W Publishers Pvt. Ltd.
3. Bhattacharya, T., “Disaster Science and Management” McGraw Hill Education (India) Pvt. Ltd.
4. Coppola D. P., “Introduction to International Disaster Management”, Elsevier Science (B/H).

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continuous Evaluation	Lab Test/ Viva	Total
CS461	**Computational Intelligence Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To introduce about current computational intelligence techniques		CO1	**Able to understand different computational techniques**
	To impalement computational techniques for different types of data		CO2	**Able to apply different computational techniques in different domains**
	To analyze the performance of computational techniques for different applications		CO3	**Able to analyze the performance of different computational techniques**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
2	CO2	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
3	CO3	**1**	**1**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Getting familiar with Python Programming and its different packages	**02**	**CO1 CO2 CO3**
II	Implementation and analysis of ANN for Numeric data	**02**	
III	Implementation and analysis of CNN and RNN.	**04**	
IV	Implementation and analysis of GAN, LSTM and its variants.	**04**	
V	Text data processing using ANN, CNN, LSTM and its variants.	**04**	
VI	Hands-on on Hadoop and file management	**04**	
VII	Data stream processing on Apache Spark	**04**	
	To be done necessarily as mini-project group-wise in groups of at least two/three students. **Note:- The topics and experiments need to be updated as per the current industry trends and upcoming new techniques.**		
	Total Hours	**24**	

Essential Readings

1. C.C. Aggarwal, and C. Zhai. “Mining text data”, 1st edition, Springer, 2012.
2. A, Gulli, and A Kapoor, “TensorFlow 1.x Deep Learning Cookbook”, 1st Edition, Packt Publishing, 2017
3. T White, “Hadoop: The Definitive Guide”, 4th Edition, O’Reilly, 2015.

Supplementary Readings

1. J. Dean. “Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners”, 1st edition, John Wiley & Sons, 2014.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, 1st Edition, MIT Press, 2016
3. D Dev, “Deep Learning with Hadoop”, 1st Edition, Packt Publishing, 2017

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-2019**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 412	**Mobile Computing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	**This course explains the basics, Issues and challenges in Wireless communication networks area and its applications communication Systems**	Course Outcomes	CO1	**Able to explain the issues challenges and need of wireless communication system and comparison with mobile environment.**
	This course provides the broad and in-depth knowledge, and a critical understanding of mobile computing with different viewpoints such as infrastructures, principles and theories, technologies.		CO2	**Able to demonstrate and analyse mobile computing concepts, basic and advanced infrastructure, technologies, and applications with different viewpoints.**
	This course provides the knowledge of various terminology, principles, devices, schemes, concepts, algorithms, protocols, and different data management methodologies used in wireless mobile communication networks		CO3	**Able to describe and analyse the devices, methodologies, algorithms, Protocols in Mobile communication networks**
	This course provides the mechanism to develop mobile data access, Transaction and e-commerce principles over mobile devices and social and ethical issues of mobile computing, including privacy.		CO4	**Able to design and develop the data management and security algorithm in Mobile communication networks.**
			CO5	**Able to analyse and evaluate the various data access methodologies and security scheme for e-commerce for mobile devices, and social, ethical and privacy issues.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	3	-	-	-	-	-	-	2	-	-	-	3	-	3
2	CO2	3	2	3	1	2	-	-	-	1	-	-	-	2	3	2
3	CO3	1	2	3	2	3	2	-	-	-	-	-	-	2	2	3
4	CO4	2	3	3	3	3	2	2	-	2	-	-	1	3	3	2
5	CO5	3	3	3	2	2	3	2	-	2	-	-	1	3	2	3

SYLLABUS

No.	Content	Hours	COs
I	**Introduction: Introduction, issues in mobile computing, Overview of wireless telephony: Cellular concept, GSM, channel structure, location management: HLR-VLR, Hierarchal, Hands off, Channel allocation in cellular systems, CDMA, GPRS.**	**05**	**CO1**
II	**Wireless Networking, wireless LAN overview: Mac issues, IEEE 802.11, Wireless multiple access protocols**	**05**	**CO1** **CO2**
III	**Wireless Communication: TCP over wireless applications. Data broadcasting, Mobile IP.**	**06**	**CO2**
IV	**Wireless Application Protocol : Architecture, Protocol stack, Application environment, Applications.**	**06**	**CO3**
V	**Data Management: Data management issues, Data replication for mobile computers, Adaptive clustering for mobile wireless networks, File system, Disconnected operations, Security.**	**07**	**CO3** **CO4**
VI	**Mobile data Access system: Mobility issues, Mobile Agent, On demand services, Broadcast service, Transaction processing, Security and Fault tolerance.**	**07**	**CO4** **CO5**
	Total	**36**	

Essential Readings

1. William Stallings, Wireless Communications & Networks, 2/E, Pearson Education India, 2007.
2. Raj Kamal , Mobile Computing, Oxford Higher Education/Oxford University Press, 2/E, 2014
3. J.Schiller, Mobile Communication" Pearson Education India, 2/E, 2009.
4. Sandeep Singhal,The Wireless Application Protocol , Pearson India, 1/E, 2001

Supplementary Readings

1. Sandeep Singhal, The Wireless Application Protocol, Pearson India, 1/E, 2001
2. Charles E Perkins, Mobile IP: Design Principles and Practices, Pearson Education, 1/E, 1998
3. T S Rappaport, "Wireless Communications: Principles & Practice, 2/E, Pearson Education, 2002

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS414	**Cloud Computing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces the concept of cloud computing and background technologies.		CO1	**Able to acquire knowledge about cloud computing, its vision, and history, characteristics.**
	This course summarizes the background cryptographic mathematics which will be applied in Cloud computing		CO2	**Able to acquire knowledge about the background technologies and cryptographic mathematics of Cloud Computing.**
	This course explain about architecture, types and the security flaws in Cloud computing.		CO3	**Able to acquire knowledge about the Cloud architecture, Cloud types and its various services.**
	This course describes the concept of various cloud computing platform available.		CO4	**Able to analyse the security of cloud computing.**
			CO5	**Able to analyse the various cloud platform available.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
2	CO2	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**3**	**2**
3	CO3	**3**	**3**	**3**	**1**	**-**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**2**
4	CO4	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**3**	**2**	**2**
5	CO5	**2**	**3**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction Definition, vision, characteristics, historical development, building cloud computing environment.	**07**	**CO1**
II	Technology of Cloud Computing Elements of parallel and distributed computing, Virtualization-characteristics, taxonomy, pros and cons, case study of some types of virtualization.	**07**	**CO2**
III	Cloud Computing architecture Cloud Computing reference model, services- IaaS, PaaS, SaaS, Types of Cloud-Public, Private, Hybrid, Community	**08**	**CO3**
IV	Cloud Security Security challenges in Cloud Computing such as integrity and privacy of data stored at cloud servers, authentication etc. Various attacks and their prevention.	**07**	**CO4**
V	Cloud Platforms in Industry Case study of some of the cloud platform available such as Amazon web services, Google AppEngine, Microsoft Azure.	**07**	**CO5**
	Total Hours	**36**	

Essential Readings

1. Rajkumar Buyya, Christian Vecchiola , S.Thamarai Selvi, "Mastering Cloud Computing Foundations and Applications Programming", Morgan Kaufmann, 1st Edition, 2013
2. Barrie Sosinsky, "Cloud Computing Bible", Wiley Publishing, 1st Edition, 2011
3. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing", Morgan Kaufmann Publishers, 1st Edition, 2012

Supplementary Readings

1. Ricardo Puttini, Thomas Erl, Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", , Prentice Hall International 1st Edition, 2013
2. Borko Furht, Armando Escalante, "Handbook of Cloud Computing", Springer US, 1st Edition, 2010.
3. K. Chandrasekaran,"Essentials of Cloud Computing",CRC Press Talyor & Francis, 1st Edition, 2015

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Programme	**Bachelor of Technologyin Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 416	**Wireless Sensor Network**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To provide the students with some knowledge about WSN, application of WSN in real life.		CO1	**Able to understand the fundamental concept of wireless sensor network and its applications and challenges.**
	To develop the student's ability to understand the challenges of WSN implementation and possible solutions.		CO2	**Able to explain various tasks and components of sensor nodes and the architecture of wireless sensor networks.**
	To develop the student's ability to understand different communication protocols and their underlying design.		CO3	**Able to identify the physical layer design of wireless sensor networks.**
	To develop the student's ability to understand time synchronization algorithms and localization and positioning procedures.		CO4	**Able to examine MAC protocols and concepts of Error control, Framing, Link management.**
	To provide the students with some knowledge about the various topology-control algorithms and routing protocols.		CO5	**Able to interpret various time synchronization protocols and different localization and positioning algorithms.**
			CO6	**Able to elaborate topology control mechanisms and routing protocols for wireless sensor networks and main design issues.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**0**	**0**	**1**	**0**	**2**	**1**	**0**	**1**	**1**	**0**	**2**	**0**	**1**	**2**	**1**
2	CO2	**1**	**2**	**0**	**1**	**0**	**0**	**1**	**2**	**2**	**1**	**0**	**1**	**3**	**2**	**2**
3	CO3	**0**	**3**	**2**	**2**	**1**	**0**	**0**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**2**
4	CO4	**3**	**2**	**0**	**1**	**2**	**1**	**0**	**1**	**2**	**3**	**0**	**2**	**3**	**2**	**3**
5	CO5	**3**	**3**	**2**	**1**	**0**	**2**	**0**	**2**	**3**	**1**	**1**	**0**	**1**	**2**	**1**
6	CO6	**2**	**1**	**0**	**2**	**3**	**2**	**2**	**0**	**1**	**2**	**0**	**1**	**3**	**1**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** **The vision of Ambient Intelligence, Application of WSN, Challenges for WSNs, Mobile ad hoc networks and wireless sensor networks, Fieldbuses and wireless sensor networks, Enabling technologies for wireless sensor networks;**	**1**	**CO1**
II	**Single-node architecture:** **Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, Examples of sensor nodes;**	**1**	**CO2**
II	**Network architecture:** **Sensor network scenarios, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts;**	**3**	**CO2**
IV	**Physical layer:** **Introduction, Wireless channel and communication fundamentals, Physical layer and transceiver design considerations in WSNs;**	**3**	**CO3**
V	**MAC protocols:** **Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols, The IEEE 802.15.4 MAC protocol, IEEE 802.11 and Bluetooth;**	**6**	**CO4**
VI	**Link-layer protocols:** **Error control, Framing, Link management;**	**3**	**CO4**
VII	**Naming and addressing:** **Fundamentals, Address and name management in wireless sensor networks, Assignment of MAC addresses, Distributed assignment of locally unique addresses, Content-based and geographic addressing;**	**3**	**CO5**
VIII	**Time synchronization:** **Introduction to the time synchronization problem, Protocols based on sender/receiver synchronization (LTS and TPSN), Protocols based on receiver/receiver synchronization (RBS and HRTS);**	**4**	**CO5**
IX	**Localization and positioning:** **Properties and approaches of localization and positioning procedures, Mathematical basics for the lateration problem, Single-hop localization, Positioning in multihop environments, Impact of anchor placement;**	**4**	**CO5**
X	**Topology control:** **Motivation and basic ideas, Controlling topology in flat networks – Power control, Hierarchical networks by dominating sets, Hierarchical networks by clustering, Combining hierarchical topologies and power control, Adaptive node activity;**	**4**	**CO6**
XI	**Routing protocols:** **Forwarding and routing, Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, Geographic routing, Mobile nodes**	**4**	**CO6**
Total Hours		**36**	

Essential Readings

1. Karl H, Willig A. Protocols and architectures for wireless sensor networks. John Wiley & Sons; 2007.
2. Dargie W, Poellabauer C. Fundamentals of wireless sensor networks: theory and practice. John Wiley & Sons; 2010.
3. Yang K. Wireless sensor networks. 2014.

Supplementary Readings

1. Khan S, Pathan AS, Alrajeh NA, editors. Wireless sensor networks: Current status and future trends. CRC press; 2016.
2. Güngör VÇ, Hancke GP, editors. Industrial wireless sensor networks: Applications, protocols, and standards. Crc Press; 2013.
3. Forster A. Introduction to wireless sensor networks. John Wiley & Sons; 2016.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS418	**Natural Language Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
This course introduces foundational linguistic and mathematical concepts and algorithms for analysis of natural languages.	CO1	**Able to choose techniques for basic linguistic processing for phonetic analysis, phonological analysis and morphological analysis.**
This course introduces the advantages and disadvantages of different NLP technologies in different real-life applications.	CO2	**Able to construct computational models of natural language text data in order to gain broader understanding of text data.**
This course familiarizes some statistical approaches and machine learning techniques used in Natural Language Processing (NLP) tasks.	CO3	**Able to solve common NLP tasks using models, methods, and algorithms for statistical NLP.**
	CO4	**Able to create software implementations of relevant pre-processing steps for different NLP problems.**
	CO5	**Able to solve common NLP tasks using machine learning algorithms.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	1	1	0	0	0	1	0	0	0	0	1	0	0	0
2	CO2	3	3	3	2	2	0	0	0	0	0	0	0	1	1	1
3	CO3	3	3	3	2	2	1	0	0	1	0	1	0	0	1	1
4	CO4	3	3	3	2	1	1	0	0	0	0	0	0	0	2	3
5	CO5	3	3	3	2	2	1	0	0	1	1	1	0	0	1	1

SYLLABUS

No.	Content	Hours	COs
I	**Introduction; Motivation and challenges of Natural Language Processing (NLP); Tokenisation and Sentence Segmentation**	**02**	**CO1**
II	**Lexical Analysis: Morphology, Finite State Morphology**	**03**	**CO1, CO2**
III	**Syntactic Analysis: Linguistic Background - An outline of English Syntax, Grammars for Natural Language, Parsing techniques, Linking Syntax and Semantics; Semantic Analysis: Lexical Semantics, Word Sense Disambiguation; Pragmatics and Discourse Analysis: Dialogue and Conversational agents, Co-reference resolution; Natural Language Generation**	**12**	**CO2, CO3**
IV	**Overview of NLP applications: POS tagging, Information Retrieval, Question Answering, Information Extraction, Dialogue Systems, Text and Intent Mining, Machine Translation; Data pre-processing for NLP tasks**	**11**	**CO3**
V	**Empirical techniques for NLP tasks; machine learning techniques for NLP tasks; NLP application examples in real-life; Performance evaluation metrics for NLP systems**	**08**	**CO4, CO5**
	Total Hours	**36**	

Essential Readings

1. D. Jurafsky and J. H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition,” Pearson Education India, 2nd edition, 2013.
2. Akshar Bharati, Vineet Chaitanya, Rajeev Sangal, “Natural Language Processing: A Paninian Perspective”, PHI Learning Pvt. Ltd., 1st edition, 1995.
3. Daniel M. Bikel, “Multilingual Natural Language Processing Applications: From Theory to Practice”, Pearson Education India, 1st edition, 2012.
4. C. D. Manning, H. Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1st edition, 1999.

Supplementary Readings

1. Jacob Perkins, “Python 3 Text Processing with NLTK 3 Cookbook”, Packt Publishing Limited, 1st edition, 2014.
2. Breck Baldwin, Krishna Dayanidhi, “Natural Language Processing with Java and LingPipe Cookbook”, Packt Publishing Limited, 1st edition, 2014.
3. Nitin Indurkhya and Fred J. Damerau, “Handbook of Natural Language Processing”, Taylor and Francis, 2nd edition, 2010.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 420	Cyber Forensics and Analysis	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces the knowledge in various robot structures and their workspace.		CO1	Able to acquire knowledge about the basic concepts used in Cyber Forensics and Analysis.
	This course illustrate digital investigation and digital evidence		CO2	Able to interpret the computer forensics
	This course illustrates with File System Analysis & file recovery.		CO3	Able to implement with forensics tools
	This course explains the information hiding & steganography time, registry & password recover.		CO4	Able to analyse and validate forensics data.
	This course familiarize with the Email & database forensics and Memory acquisition.		CO5	Able to analyse and identify the vulnerabilities in a given network infrastructure.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**
3	CO3	**1**	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**0**	**-**	**-**	**-**	**2**	**3**	**2**
4	CO4	**-**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**-**	**2**	**3**	**-**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Cyber forensics:** Information Security Investigations, Corporate Cyber Forensics, Scientific method in forensic analysis, investigating large scale Data breach cases. Analysing Malicious software. Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime. Introduction to Identity Theft & Identity Fraud. Types of CF techniques – Incident and incident response methodology – Forensic duplication and investigation. Preparation for IR: Creating response tool kit and IR team. – Forensics Technology and Systems -Understanding Computer Investigation – Data Acquisition.	10	CO1 CO2
II	**EVIDENCE COLLECTION AND FORENSICS TOOLS** Processing Crime and Incident Scenes – Working with Windows and DOS Systems. Current Computer Forensics Tools: Software/ Hardware Tools. Introduction to Cyber forensics: Information Security Investigations, Corporate Cyber Forensics, Scientific method in forensic analysis, investigating large scale Data breach cases. Analysing Malicious software.	08	CO2 CO3
III	**ANALYSIS AND VALIDATION** Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition –Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics	08	CO2 CO3
IV	**ETHICAL HACKING** Introduction to Ethical Hacking – Foot printing and Reconnaissance – Scanning Networks -Enumeration – System Hacking – Malware Threats – Sniffing	05	CO4 CO3 CO4
V	**ETHICAL HACKING IN WEB** Social Engineering – Denial of Service – Session Hijacking – Hacking Web servers – Hacking Web Applications – SQL Injection – Hacking Wireless Networks – Hacking Mobile Platforms.	05	CO4 CO5
	Total Hours	36	

Essential Readings

1. Computer Forensics and Investigations, By Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, Cengage Learning, India Edition, 2016.
2. Cyber Forensics, By Dejey & S. Murugan, Oxford University Press, 2018.
3. Fundamentals of Digital Forensics: Theory, Methods, and Real-Life Applications, By Joakim Kävrestad, Springer International Publishing, 2018

Supplementary Readings

1. Computer Forensics, By John R.Vacca, Cengage Learning, 2005
2. Computer Forensics and Cyber Crime: An Introduction, By Marjie T.Britz, 3rd Edition, Pearson, 2013.
3. Ethical Hacking and Penetration Testing Guide, By Rafay Baloch , CRC Press, 2015

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Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 422	**Data Mining**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
This course illustrates the need of data mining and data pre-processing techniques	CO1	**Able to experiment with different data pre-processing techniques**
This course explains the different types of data mining techniques as association rule mining, classification, clustering and outlier detection techniques	CO2	**Able to estimate and compare different data mining techniques**
This course explains the different data mining techniques to real life applications	CO3	**Able to design data mining solution framework for real life problems**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
2	CO2	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
3	CO3	**1**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction: Data Mining, Motivation, Applications, Data Mining Approaches, Data Types, Data Objects and Attributes, Challenges in Data Mining, Data Similarity and Dissimilarity Measures** **Data —Preprocessing: Data Quality Issues, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization**	**06**	**CO1**
II	**Mining Frequent Pattern Mining and Association Rules: Basic Concepts, Apriori Algorithm, Frequent Pattern growth (FP-growth) Algorithm, Mining Closed and Max Patterns, Pattern Evaluation Methods, Constraint-Based Frequent Pattern Mining**	**08**	**CO1**
III	**Classification Techniques: Basic Concepts, Decision Tree Classifier, Rule-Based Classifier, Nearest Neighbor Classifiers, Naive Bayes Classifier, Artificial Neural Network (ANN), Support Vector Machine (SVM), Model Over fitting, Model Evaluation and Selection**	**10**	**CO2**
IV	**Clustering Techniques: Overview, Types of Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Performance Parameters, Clustering with Constraints** **Outlier Detection: Basic Concepts, Outlier Detection Methods, Statistical Approaches, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches**	**12**	**CO2 & CO3**
Total Hours		**36**	

Essential Readings

1. J. Han, J. Pei, and M Kamber. "*Data mining: concepts and techniques"*. Elsevier, 3rd edition, 2011
2. P.N. Tan, M. Steinbach, A. Karpatne, and V. Kumar. "*Introduction to data mining"*. Pearson Education India, 2nd edition, 2016.
3. C.C. Aggarwal. "*Data mining: the textbook"*. Springer, 1st edition, 2015.

Supplementary Readings

1. C.C. Aggarwal, and C. Zhai. "*Mining text data"*. Springer, 1st edition, 2012.
2. J. Leskovec, A. Rajaraman, and J.D. Ullman. " *Mining of massive datasets"*. Cambridge University Press, 3rd edition, 2019
3. J. Dean. "*Big data, data mining, and machine learning: value creation for business leaders and practitioners"*. John Wiley & Sons, 1st edition, 2014.

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Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-2019**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 424	**Distributed Computing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
This course explains the advantages and challenges in designing distributed operating system, algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc.		CO1	**Able to describe the fundamental components of distributed operating system such as algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc**
This course describes the details of distributed computing techniques, synchronous and processes, minimum spinning tree and communication protocol algorithms.		CO2	**Able to design and demonstrate the distributed computing techniques for process synchronization and construction of minimum spinning tree for message forwarding and receiving.**
This course provides the methodologies to design and implement distributed mutual exclusion algorithm and distributed deadlock detection and termination algorithms		CO3	**Able to develop the practical understanding of Distributed mutual exclusion and deadlock detection for various processes.**
This course provides the techniques to design and develop applications based on requirements of various fault tolerance system, algorithm for failure recovery and fault tolerance in distributed systems.		CO4	**Able to design and analyse the fault tolerant system to achieve high reliability and accuracy using the principle of fault tolerant algorithms.**
		CO5	**Able to develop, analyse and evaluate the failures and failure recovery algorithm to recover the system.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**2**
3	CO3	**1**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**
4	CO4	**1**	**2**	**3**	**3**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction: Distributed System, Theoretical Foundations of Distributed Systems, Operating system and types, Distributed Computing Model, Characteristics, and Issues.**	**04**	**CO1** **CO2**
II	**Wave and Traversal Algorithms: Echo Algorithm, Sequential Polling, Awerbuch's DFS Algorithm, Cidon's DFS Algorithm.**	**04**	**CO1** **CO2**
III	**Minimal Spanning Tree Algorithms: Gallager-Humblet-spira Algorithm, Testing the edge optimization, Reorientation of tree**	**04**	**CO2** **CO3**
IV	**Communication Protocol and Routing Algorithm: Balanced Sliding Window Protocol, Ordering, Communication Protocols, Agreement Protocols, Commit Protocols, Leader Election Algorithms. Properties, Routing Algorithms, Destination based forwarding, Toueg's observation, Candy-Mishra and The Netchange Algorithms.**	**05**	**CO3** **CO4**
V	**Deadlock Free Packet Switching: Deadlock free packet: Model, Buffer graph, Requirements and Destination Schemes, Switching, Logical Clocks and Causal, Framework and implementation**	**05**	**CO4** **CO5**
VI	**Distributed Mutual Exclusion and Algorithms: Distributed Mutual Exclusion Lamport's algorithm, Ricart–Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm**	**06**	**CO3** **CO4**
VII	**Distributed Deadlock Detection and Termination Algorithms: System model, Preliminaries, Models of deadlocks, Knapp's classification of distributed deadlock detection, algorithms,**	**04**	**CO5**
VIII	**Failure Recovery and Fault tolerance in distributed systems: Unreliable failure detectors, The consensus problem, Atomic broadcast, A solution to atomic broadcast, The weakest failure detectors to solve fundamental agreement problems, An implementation of a failure detector, An adaptive failure detection protocol. Distributed File System (DFS), Distributed Shared Memory**	**04**	**CO4** **CO5**
	Total	**36**	

Essential Readings

1. A S Tanenbaum & Martin Steen, Distributed Systems: Principles and Paradigms, 2/E,PHI, 2006.
2. Colouris, Dollimore, Kindberg, Distributed Systems Concepts & Design, 4/ E Pearson, 2005.
3. G. Tel, "Introduction to Distributed Algorithms", 2/E Cambridge University Press,2012.

Supplementary Readings

1. Ajay D. Kshemkalyani and Mukesh Singhal "Distributed System; Principles, Algorithms, Systems 1/E, Cambridge University Press, 2010
2. S. Ghosh, "Distributed Algorithms, An Algorithmic Approach", Chapman and Hall, 1/E,2006.
3. P. K. Sinha , "Distributed Operating Systems –Concepts and Design", IEEE CS Press, 2/E, PHI,2007

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 426	**Bioinformatics**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces the importance of bioinformatics and analysis of biological databases		CO1	**Able to discover different problems prevailing in bioinformatics domain**
	This course explains the different types of bioinformatics techniques		CO2	**Able to assess different bioinformatics techniques**
	This course introduces the different bioinformatics and machine learning techniques to different application domains		CO3	**Able to design computational framework for solving problems related to biological data analysis**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**
2	CO2	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**
3	CO3	**1**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction: Bioinformatics, goals, scope, applications and limitations, Basic cell architecture, The structure, content and scale of deoxyribonucleic acid (DNA), Genes and proteins, Central dogma, Importance of proteins, Gene and cell regulation, Biological Databases, Information Retrieval from Biological Databases**	**06**	**CO1**
II	**Sequence Alignment: Pair-wise sequence alignment, Sequence homology versus sequence similarity, Sequence similarity versus sequence identity, Methods for sequence alignment, Statistical significance of sequence alignment** **Multiple Sequence Alignment : Scoring function, Exhaustive algorithms, Heuristic algorithms, practical Issues**	**08**	**CO1, CO2**
III	**Database similarity searching : Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST** **Protein motifs and domain prediction :Identification of motifs and domains in multiple sequence alignment, Motif and domain databases using regular expressions, Motif and Domain Databases Using statistical models** **Gene Prediction : Gene prediction in prokaryotes and in eukaryotes** **Phylogenetics : Terminology, Gene phylogeny versus species phylogeny, Phylogenetic tree construction, Distance – based methods, Character- based methods, Phylogenetic tree evaluation**	**14**	**CO2**
IV	**Functional Genomics : Sequence-based approaches, Microarray-based approaches, Comparison of SAGE and DNA microarrays** **Case studies for machine learning techniques based analysis of biological datasets**	**08**	**CO2 & CO3**
Total Hours		**36**	

Essential Readings

1. J. Xiong. "*Essential bioinformatics*". Cambridge University Press, 1st edition, 2006.
2. E. Keedwell, and A. Narayanan. "*Intelligent bioinformatics: The application of artificial intelligence techniques to bioinformatics problems"*. John Wiley & Sons, 1st edition, 2005
3. J.M. Claverie, and C. Notredame. "*Bioinformatics for dummies"*. John Wiley & Sons, 2nd edition, 2007

Supplementary Readings

1. S. Mitra, S. Datta, T. Perkins, and G. Michailidis. "*Introduction to machine learning and bioinformatics*". CRC Press, 1st edition, 2008.
2. Z.R. Yang. "*Machine learning approaches to bioinformatics"*. World scientific, 1st edition, 2010
3. Y.Q. Zhang, and J.C. Rajapakse. "*Machine learning in bioinformatics",* Wiley, 1st edition, 2009

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technologyin Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 428	**Internet of Things**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To provide the students with some knowledge about the definition and significance of the Internet of Things.		CO1	**Able to demonstrate the basic concept of IoT, the architecture of IoT, and applications of IoT in the real life.**
To develop the student's ability to understand the architecture, operation, and business benefits of an IoT solution.		CO2	**Able to explain the mechanism of various protocols used in different layers of IoT.**
To develop the student's ability to understand different protocols used for communication between various IoT devices.		CO3	**Able to identify the challenges of Interoperability and techniques used for Interoperability in IoT.**
To develop the student's ability to understand the relationship between IoT, cloud computing, and big data.		CO4	**Able to examine different Service and Resource Discovery in IoT.**
To provide knowledge to students about various privacy and security issues in IoT.		CO5	**Able to interpret about various privacy and security issues in IoT communication.**
		CO6	**Able to imagine and improve the relationship between IoT, cloud computing, fog computing and big data.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**1**	**1**	**0**	**0**	**2**	**1**	**1**
2	CO2	**2**	**3**	**1**	**1**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**2**	**1**	**2**	**2**
3	CO3	**3**	**2**	**1**	**0**	**2**	**3**	**0**	**1**	**0**	**1**	**3**	**1**	**3**	**2**	**2**
4	CO4	**1**	**0**	**3**	**2**	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**1**	**2**	**2**
5	CO5	**2**	**0**	**1**	**0**	**2**	**3**	**1**	**0**	**1**	**2**	**1**	**0**	**3**	**2**	**3**
6	CO6	**1**	**2**	**0**	**3**	**1**	**2**	**0**	**2**	**0**	**1**	**0**	**0**	**2**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** **What is IoT, Ad-hoc and Sensor Networks, Architecture of IoT, Application of IoT: Smart home, Intelligent transportation systems, Industrial aumtomation, Smart healthcare, Smart grids;**	**4**	**CO1**
II	**IoT Standards:** **Designing the architecture of an IP-based IoT, Application Protocols: Constrained Application Protocol (CoAP), CoSIP, Message Queue Telemetry Transport (MQTT), Extensible Message and Presence protocol (XMPP), Advanced Message Queuing Protocol (AMQP), Data Distribution Service (DDS); Service Discovery Protocols: Multicast DNS (mDNS), DNS Service Discovery (DNS-SD); Infrastructure Protocols: Routing Protocol for Low Power and Lossy Networks (RPL), 6LoWPAN, IEEE 802.15.4 and ZigBee, Bluetooth Low Energy (BLE), Low-power Wi-Fi, IEEE 802.15.6, EPCglobal, LTE-A, Z-Wave;**	**11**	**CO2**
III	**Interoperability:** **Applications in the IoT, The verticals: Cloud-based solutions, REST Architecture: The Web of Things, Messaging Queues and Publish/Subscribe Communications, Session initiations for the IoT, Optimized Communications: the Dual-network Management Protocol, Discoverability in Constrained Environments, Data Formats: Media types for sensor markup language;**	**5**	**CO3**
IV	**Discoverability:** **Service and Resource Discovery, Local and Large-scale Service Discovery, Sclable and self-configuring Architecture for Discovery in the IoT, Lightweight Service Discovery in Low-power IoT Networks;**	**3**	**CO4**
V	**Security and Privacy in the IoT:** **Security issues in the IoT: Traditional vs Lightweight security, Lightweight Cryptography, Key Agreement, Distribution and Security Bootstrapping, Processing data in the encrypted domain: Secure data aggregation, Authorization mechanisms for secure IoT services;** **Privacy issues in the IoT: The role of Authentication, IoT-OAS: Delegation-based authorization for the IoT, IoT-OAS application scenarios, Hybrid gateway-based communication;**	**7**	**CO5**
VI	**Cloud and Fog Computing for IoT:** **Cloud computing, Big data processing pattern, Big stream, Big stream and security, Fog computing and the IoT, Role of the IoT hub: Virtualization and replication, Operational scenarios, Synchronization protocol;**	**6**	**CO6**
	Total Hours	**36**	

Essential Readings

1. Cirani S, Ferrari G, Picone M, Veltri L. Internet of Things: Architectures, Protocols and Standards. John Wiley & Sons; 2018.
2. Lea P. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Packt Publishing Ltd; 2018.
3. Buyya R, Dastjerdi AV, editors. Internet of Things: Principles and paradigms. Elsevier; 2016.

Supplementary Readings

1. Chou T. Precision-Principles, Practices and Solutions for the Internet of Things. McGraw-Hill Education; 2017.
2. Santos M, Moura E. Hands-On IoT Solutions with Blockchain: Discover how converging IoT and blockchain can help you build effective solutions. Packt Publishing Ltd; 2019.
3. Al-Fuqaha A, Guizani M, Mohammadi M, Aledhari M, Ayyash M. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE communications surveys & tutorials. 2015 Jun 15;17(4): 2347-76.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Academic Year of Regulation	**2018-19**
Department	**Computer Science and Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS430	**Human Computer Interaction**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	This course introduces the concept of human computer interaction.		CO1	**Able to acquire knowledge about the basic concept on human computer interaction.**
	This course illustrates the various software process and design of human computer interaction.		CO2	**Able to acquire knowledge about the design of human computer interaction and its software process.**
	This course describes the various existing models of interacting human with computer.		CO3	**Able to acquire knowledge about the various models and theories on human computer interaction.**
	This course explains the designing of human computer interaction using mobile and web interface.		CO4	**Able to design the human computer interaction using the mobile platforms.**
			CO5	**Able to design the human computer interaction in web interface.**

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
2	CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**1**
3	CO3	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**2**
4	CO4	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**2**
5	CO5	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	Introduction The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	**06**	**CO1**
II	Design of Human Computer Interaction and the Software Process Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design	**07**	**CO2**
III	Models and Theories Cognitive models –Socio-Organizational issues and stake holder requirements – Communication and collaboration models-Hypertext, Multimedia and WWW.	**07**	**CO3**
IV	Mobile Human Computer Interaction Mobile system: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	**08**	**CO4**
V	Web Interface Design Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.	**08**	**CO5**
	Total Hours	**36**	

Essential Readings

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004
2. Brian Fling, "Mobile Design and Development", 1st Edition , O'Reilly Media Inc., 2009
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", 1st Edition, O'Reilly, 2009

Supplementary Readings

1. K. Meena and R. Sivakumar, "Human-Computer Interaction",Prentice Hall India, 1st Edition,2014
2. Mike van Drongelen, Adam Dennis, Richard Garabedian, Alberto Gonzalez, Aravind Krishnaswamy "Lean Mobile App Development", O'Reilly 1st Edition, 2017.
3. Jenifer Tidwell, Charles Brewer, Aynne Valencia, "Designing Interfaces", O'Reilly Media, Inc., 3rd Edition, 2020

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology**	Year of Regulation	**2018-19**
Department	**Humanities and Social Sciences**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
HS 492	**Entrepreneurship**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	This course introduces the basic concepts of entrepreneurship	Course Outcomes	CO1	Able to understand the basic concepts in the area of entrepreneurship
	This course explains the importance of entrepreneurship		CO2	Able to apply their understanding of the role and importance of entrepreneurship for economic development
	This course familiarizes personal creativity and entrepreneurial initiative		CO3	Able to analyze personal creativity and entrepreneurial initiative
	This course explains the elaboration of business idea		CO4	Able to evaluate the key steps in the elaboration of business idea
	This course describes how to create a business plan		CO5	Able to create their own business plan by understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	0	0	1	0	0	2	1	1	3	2	3	3			
2	CO2	0	0	2	0	0	2	1	1	3	2	3	3			
3	CO3	0	0	1	0	0	2	1	1	3	2	3	3			
4	CO4	0	0	1	0	0	2	1	1	3	2	3	3			
5	CO5	0	0	2	0	0	2	1	1	3	2	3	3			

SYLLABUS

No.	Content	Hours	COs
I	Definition of Innovation, Entrepreneurs and Entrepreneurship, Historical Development of Entrepreneurship, Entrepreneurship in Economic Theory, Entrepreneurial Practice, Entrepreneurial Economy, Entrepreneurship and Economic Development, Types of Entrepreneurship, Contributions of Entrepreneurs to the Society, Entrepreneurship in India.	05	All COs
II	Features and Types of Businesses and Entrepreneurs, Entrepreneurship and Small Business, The Importance of Small Business, The Life Cycle of a Small Company, Small Business Enterprises, Small Business Sector in India.	03	CO2 CO3
III	Forms of Entrepreneurial Organization, Sources of Capital, Entrepreneurial Process, Entrepreneurial Strategies, Entrepreneurial Project, Basics of Venture Marketing, Fundamentals of Entrepreneurial Management.	06	CO2 CO3 CO4
IV	Business Process, Product Design, Operational Art, Stock Management, Technical and Technological Analysis of Entrepreneurial Projects, Sources of Business Ideas, Designing a Business Investment, Knowledge Economy, Business Model Canvas, Developing an Effective Business Model, Legal Forms of Business.	06	CO2 CO3 CO4
V	Starting a New Company, Buying an Existing Business, Franchising, Family Business, Opportunity Identification, Defining the Business Concept, Writing a Business Plan, Risk-opportunities Perspective, Mitigation of Risks, Funding New Ventures, Strategic Guidelines and Objectives for the Development of Small Business Enterprise in India, Entrepreneur Biographies.	04	CO3 CO4 CO5
	Total Hours	**24**	

Essential Readings

1. Robert D. Hisrich, Michael P. Peters, and Dean A. Shepherd, “Entrepreneurship”, McGraw Hill Education, Tenth edition, 2018.
2. D. F. Kuratko and R. M. Hodgetts, “Entrepreneurship: A Contemporary Approach”, The Dryden Press, Harcourt Brace College Publishers, 1998.

Supplementary Readings

1. D. H. Holt, “Entrepreneurship: New Venture Creation”, Prentice-Hall of India, 1999.
2. L. M. Bhole, “Financial Institutions and Markets”, Tata McGraw-Hill, 2001.