RASHTRIYA RAKSHA UNIVERSITY

An Institution of National Importance under Ministry of Home Affairs, Govt. of India
(Pioneering National Security and Police University of India)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

Syllabus and Examination Evaluation Scheme

as per Choice Based Credit System (CBCS)

(For the candidates to be admitted from the academic year 2023 - 2024 onwards)

Name of the School	**SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICIAL INTELLIGENCE AND CYBER SECURITY**
Name of the Programme	**BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)**
Syllabus Approval Granted as per	• Minutes of First Board of Studies Meeting of School of Information Technology, Artificial Intelligence and Cyber Security dated on
Programme Coordinator	**Mr. Manishkumar Rai,** Assistant Professor, School of Information Technology, Artificial Intelligence and Cyber Security, Rashtriya Raksha University, Lavad-Dehgam, Gandhinagar-382305, Gujarat, India

Programme Structure

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

Name of the School: **SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICIAL INTELLIGENCE AND CYBER SECURITY**

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Short Name: **B.TECH: CSE (CS)** (Under SITAICS)

TEACHING AND EXAMINATION SCHEME

Programme	B.TECH in CSE	**Specialization**	CYBER SECURITY
Semester	**I**		
Programme Duration	Four year Programme		
Effective from Academic Year	2021-22	**Effective for the batch Admitted in**	2023

Code	**Subject Name**	**Teaching scheme**										**Examination scheme (Marks)**					
		Credit					**Hours (per week)**					**Theory**			**Practical/ Viva Examination**		
		Lecture			Practical		Lecture			Practical (Lab.)		**Int**	**Ext**	**Total**	**Int**	**Ext**	**Total**
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G1A01ENM	Engineering Maths	3	1	4	0	0	3	2	5	0	0	20	50	70	10	20	30
G1A02FOE	Fundamentals of Electronics	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G1AD03CFC	Computer Fundamentals & Cyber World	3	0	3	0	0	3	0	3	0	0	30	70	100	00	00	00
G1AD04COP	Computer Programming	3	0	3	2	2	3	0	3	4	4	20	50	70	10	20	30
	Mandatory Subject: Health & Fitness	4	0	4	0	0	4	0	4	0	0	*	*	*	*	*	*

	Management																
As per CBCS	University Elective Skill	2	0	2	0	0	2	0	2	0	0	*	*	*	*	*	*
TOTAL		**18**	**1**	**19**	**3**	**3**	**18**	**2**	**20**	**6**	**6**						

Semester	**II**

Code	**Subject Name**	**Teaching scheme**										**Examination scheme (Marks)**					
		Credit					**Hours (per week)**					**Theory**			**Practical/ Viva Examination**		
		Lecture			Practical		Lecture			Practical (Lab.)		**Int**	**Ext**	**Total**	**Int**	**Ext**	**Total**
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G2A05LDE	Linear Algebra & Differential Equations	3	1	4	1	1	3	2	5	2	2	20	50	70	10	20	30
G2A06DGS	Digital Systems	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G2A07DCM	Data Communication	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G2AD08OOP	Object Oriented Programming with C++	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G2AD09DSA	Data Structures & Algorithms	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
	Mandatory Subject: National Security & Security Architecture	4	0	4	0	0	4	0	4	0	0	*	*	*	*	*	*
TOTAL		**19**	**1**	**20**	**5**	**5**	**19**	**2**	**21**	**10**	**10**						

Semester	**III**

Code	Subject Name	Teaching scheme										Examination scheme (Marks)					
		Credit					Hours (per week)					Theory			Practical/ Viva Examination		
		Lecture			Practical		Lecture			Practical (Lab.)		Int	Ext	Total	Int	Ext	Total
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G3A10OPS	Operating Systems	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G3A11PSN	Probability, Statistics & Numerical Analysis	3	1	4	1	1	3	2	5	2	2	20	50	70	10	20	30
G3AD12JPM	Java Programming	3	0	3	2	2	3	0	3	4	4	20	50	70	10	20	30
G3A13DBM	Database Management System	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G3A14COM	Computer Organization & Microprocessor	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G3A15DMM	Discrete Mathematics	3	0	3	0	0	3	0	3	0	0	20	50	70	10	20	30
	Skill Enhancement	2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TOTAL		**20**	**1**	**21**	**6**	**6**	**20**	**2**	**22**	**12**	**12**						

Semester	**IV**

Code	Subject Name	Teaching scheme										Examination scheme (Marks)					
		Credit					Hours (per week)					Theory			Practical		
		Lecture			Practical		Lecture			Practical (Lab.)		Int	Ext	Total	Int	Ext	Total
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G4A16SEN	Software Engineering	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30

G4AD17PPL	Python Programming Language	3	0	3	2	2	3	0	3	4	4	20	50	70	10	20	30
G4AD18DAA	Design & Analysis of Algorithms	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G4A19ITC	Introduction to Cryptography	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G4A20LSS	Linux & Shell Scripting	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
As per CBCS	Ability Enhancement	4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TOTAL		**19**	0	**19**	**6**	**6**	**19**	0	**19**	**12**	**12**						

Semester	**V**																
Code	**Subject Name**	**Teaching scheme**										**Examination scheme (Marks)**					
		Credit					**Hours (per week)**					**Theory**			**Practical/Viva Examination**		
		Lecture			Practical		Lecture			Practical (Lab.)		**Int**	**Ext**	**Total**	**Int**	**Ext**	**Total**
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G5AD21DAV	Data Analytics & Visualization	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G5AD22CNW	Computer Networks	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G5A23DIP	Digital Image Processing	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G5AD24ARI	Artificial Intelligence	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30

G5A25TOC	Theory of Computation	3	1	4	0	0	3	2	5	0	0	20	50	70	10	20	30
TOTAL		**15**	**1**	**16**	**4**	**4**	**15**	**2**	**17**	**8**	**8**						

Semester	**VI**

Code	**Subject Name**	**Teaching scheme**										**Examination scheme (Marks)**					
		Credit					**Hours (per week)**					**Theory**			**Practical/ Viva Examination**		
		Lecture			Practical		Lecture			Practical (Lab.)		**Int**	**Ext**	**Total**	**Int**	**Ext**	**Total**
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G6AD27IOT	Internet of Things	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G6A28LNT	Language Translators	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G6A29SCS	Selected Topics from CS	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G6B30WSV/ G6B31SWS	**Elective I -** Web Security & Vulnerability Assessment / Software Security	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G6B32DBS/ G6B33ISM	**Elective II** - Database Security / Information Security Management Systems	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
TOTAL		**15**	**0**	**15**	**5**	**5**	**15**	**0**	**15**	**10**	**10**						

Semester	**VII**

Code	**Subject**	**Teaching scheme**	**Examination scheme (Marks)**

	Name	Credit					Hours (per week)					Theory			Practical/Viva Examination		
		Lecture			Practical		Lecture			Practical (Lab.)		Int	Ext	Total	Int	Ext	Total
		L	Tu	Total	P	Total	L	Tu	Total	P	Total						
G7AD34MLR	Machine Learning	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G7A35NWS	Network Security	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G7AD36BDA	Big Data Analytics	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G7B37REM / G7B38XWS/ G7B39ACR	**Elective III** -Reverse Engineering & Malware Analysis / XML & Web Services/ Advanced Cryptology	3	0	3	1	1	3	0	3	2	2	20	50	70	10	20	30
G7A40MIP	Mini Project	0	0	0	7	7	0	0	0	14	14	0	0	0	30	70	100
G7A41INT	**Industry Tour**	0	0	0	0	0	0	0	0	0	0	0	0	0	00	00	00
TOTAL		**12**	**0**	**12**	**11**	**11**	**12**	**0**	**12**	**22**	**22**						

Semester	**VIII**

Code	**Subject Name**	**Teaching scheme**										**Examination scheme (Marks)**		
		Credit					**Hours (per week)**							
		Lecture			Practical		Lecture			Practical (Lab.)		**Internal**	**External**	**Total**
		L	Tu	Total	P	Total	L	Tu	Total	P	Total			
G8A42MAP	Major Project	0	0	0	8	8	0	0	0	16	16	30	70	100
TOTAL		**0**	**0**	**0**	**8**	**8**	**0**	**0**	**0**	**16**	**16**	30	70	100

Programme Structure

Semester	I	II	III	IV	V	VI	VII	VIII
Total Credits	22	25	27	25	20	20	23	8
Theory+Practical								
Total Marks of Entire Programme	*							

Note: ***** **-** Not possible to reflect marks and credit break down because students will opt elective subjects from different schools in the university.

SYLLABUS
SEMESTER - I

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Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	I	**Version**	I
Effective from Academic Year	2023-24	**Effective for the batch Admitted in**	2023
Subject Code	G1A01ENM	**Subject Name**	Engineering Maths

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	01	00	04	Theory	20	50	70
Hours	03	02	00	05	Practical	10	20	30

Content:

Unit	Subject Content	75 Hrs
1	**Differential Calculus – I:** Successive Differentiation, Leibnitz's theorem, Limit, Continuity and Differentiability of functions of several variables, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Change of variables, Curve tracing: Cartesian and Polar coordinates	
2	**Differential Calculus – II:** Taylor's and Maclaurin's Theorem, Expansion of function of several variables, Jacobian, Approximation of errors, Extrema of functions of several variables,Lagrange's method of multipliers (Simple applications).	
3	**Matrix Algebra:** Types of Matrices, Inverse of a matrix by elementary transformations, Rank of a matrix (Echelon & Normal form), Linear dependence, Consistency of linear system of equations and their solution, Characteristic equation, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization, Complex and Unitary Matrices and its properties	

4	**Multiple Integrals:** Double and triple integrals, Change of order of integration, Change of variables, Application of integration to lengths, Surface areas and Volumes – Cartesian and Polar coordinates. Beta and Gamma functions, Dirichlet's integral and its applications	
5	**Vector Calculus:** Point function, Gradient, Divergence and Curl of a vector and their physical interpretations, Vector identities, Tangent and Normal, Directional derivatives. Line, Surface and Volume integrals, Applications of Green's, Stoke's and Gauss divergence theorems	

Practical Content:

- 10-15 tutorials being taught in relevant subject content

Text Books/Reference Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. E. Kreyszig, Advanced Engineering Mathematics,John-Wiley & Sons
3. B. V. Ramana, Higher Engineering Mathematics, Tata Mc Graw- Hill Publishing Company Ltd.
4. R.K.Jain & S.R.K. Iyenger, Advance Engineering Mathematics, Narosa Publishing House.
5. Peter V. O' Neil, Advanced Engineering Mathematics, Thomas (Cengage) Learning
6. Thomas & Finley, Calculus, Narosa Publishing House
7. Rukmangadachari, Engineering Mathematics – I, Pearson Education. A.C.Srivastava & P.K.Srivastava, Engineering Mathematics, Vol.I, PHI Learning Pvt. Limited, New Delhi

Subject Code	G1A02FOE	**Subject Name**	Fundamentals of Electronics

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	**Electronics Components and Signals:** Difference between Active and Passive Components, Descriptions of Passive Components, Measurement of Passive Components, Semiconductor Components, Voltage and Current Source, Signal Parameters, Signal Spectrum in Time and Frequency Domain, Test Signals: unit step, unit impulse and unit ramp, Types of Signals: sinusoidal, triangular and saw tooth, square	

2	**Diodes and its Applications:** P-N junction diode, Bridge Rectifier, 'T' and 'π' Filter circuits, Zener diode, Zener diode as voltage regulator **Transistors:** PNP and NPN transistor (working principle), Transistor as switch, FET, working of PMOS and NMOS, Working of CMOS Logic Family	
3	**Oscillators:** Types of feedback (Positive and Negative), Principle of oscillation, Oscillators: Hartley and Colpitts, Application of Oscillators in Communication.	
4	**Circuit Theorems and Their Application in Electric Networks:** Linearity of a Circuit and Superposition Theorem-Substitution Theorem-Compensation Theorem - Thevenin's Theorem and Norton's Theorem - Determination of Equivalents for Circuits with Dependent Sources – Reciprocity Theorem - Maximum Power Transfer Theorem - Millman's Theorem-Duality Theorem -Duality between Electricity and Magnetism.	
5	**Cables, Connectors and Measuring Instruments:** Analog and Digital display. Cables: coaxial cable, twisted pair cable and fiber optic cable, Connectors: coaxial cable connectors, RJ-45, RS-232, HDMI connectors Multimeters: Analog and digital multimeter, CRO: front panel controls and application	

Practical Content:

- 10-15 practicals being taught from subject content

Text Books/Reference Books:

1. Electronics Principles Albert Paul Malvino McGraw Hill, latest edition
2. Electronics Devices and Circuit Theory, Robert L. Boylestad Pearson, latest edition
3. Electronic Instrumentation, H. S. Kalsi, McGraw Hill, latest edition
4. Cables and Connectors, John Kadick, AVO International, latest edition
5. Muhammad Ali Mazidi, "The 8051 Microcontroller and Embedded. Systems. Using Assembly and C." Second Edition, 2011, Pearson India.

Subject Code	G1AD03CFC	**Subject Name**	Computer Fundamentals & Cyber World

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	00	03	Theory	30	70	100
Hours	03	00	00	03	Practical	00	00	00

Content:

Unit	Subject Content	45 Hrs
1	Introduction to Computer Systems; Data representation: Number systems, character representation codes, Binary, hex, octal codes and them inter conversions. Binary arithmetic, Floating point arithmetic, signed and unsigned numbers IEEE standards	

2	CPU organization, ALU, registers, memory, the idea of program execution at micro level. Concept of computing, contemporary Operating Systems such as DOS, Windows, UNIX etc. Introduction to organization and architecture of mainframe, mini and micro systems.	
3	Concept of flow chart and algorithm; Algorithms to programs: specification, top- down development and stepwise refinement, Introduction to the design and implementation of correct, efficient and maintainable programs, structured Programming, Use of high level programming language for the systematic development of programs, programmability and programming languages, Object codes, compilers.	
4	Introduction to IT and Cyber Space, Definition Cyber Space, E-commerce, E- governance, Actors, Elements, Roles, Cybernetics, Differed between Conventional and Cyber threats, Introduction and Overview of Cyber Crime/Threats/Vulnerabilities, Reasons of Cyber Crime, Sources of Cyber Threats, Categories of Cyber Threats, Method and Tools of Cybercrime, Challenges of Cyber Threats, Nature and Scope of Cyber Crime - Types of Cyber Crimes.	
5	Types of Crimes, Planning of Cybercrime, Cyber Crime against Individuals, Cyber Crime against Society, Crime against Organization, Introduction to Cybercrimes like Hacking Introduction to hacking, Classification of hackers: White hat hacker, Black hat hacker, grey hat hacker, Hacking Privacy: How can we prevent against Hack ,Viruses and Worms ,Phishing and Identify theft.	

Practical Content:

- No Practical/Tutorial

Text Books/Reference Books:

1. Pradeep K.Sinha and Priti Sinha, "Computer Fundamentals: Concepts, Systems and Applications", BPB Publications
2. Rajaraman, "Fundamentals of Computers", Prentice Hall of India, 3rd Edition.
3. Alexis Leon & Mathews Leon, "Fundamentals of Computer Science & Communication Engineering", Leon Techworld, 1998.
4. Cyber Security, Nina Godbole & Sumit Belapur
5. Cyber Security Challenges and Opportunity: Prof. Ranjendra Parasad
6. Cyber Crime and Society: Edition 2: Majid Yar

Subject Code	G1AD04COP	**Subject Name**	Computer Programming

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	02	05	Theory	20	50	70
Hours	03	00	04	07	Practical	10	20	30

Content:

Unit	**Subject Content**	**165 Hrs**

1	**Fundamentals of 'C':** Features of C language, structure of C Program, comments, header files, data types, constants and variables, operators, expressions, evaluation of expressions, type conversion, I/O functions	
2	**Concept of Array, String and Functions:** Control structure in c 'Simple statements, Decision making statements, looping statements, nesting of control structures, break and continue, go to statement Array & String Concepts of array, one and two dimensional arrays, declaration and initialization of arrays, string, string storage, Built-in-string functions. Functions Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing	
3	**Structure:** Structure Basics of structure, structure members, accessing structure members, nested structures , array of structures, structure and functions	
4	**Pointer:** Pointers Basics of pointers, pointer to pointer , pointer and array ,pointer to array, array of pointers , functions returning a pointer, structures and pointers	
5	**Memory:** Dynamic memory allocation Introduction to Dynamic memory allocation, malloac, Calloc, File management Introduction to file management and its functions	
Practical Content:		
• 10-15 practicals being taught from subject content		
Text Books/Reference Books:		
	1. Programming in ANSI C by Balaguruswamy 2. C Programming: Test Your Skills, 1/e by Ashok Kamthane 3. Programming With Ansi And Turbo C book : Ashok Kamthane 4. Programming in C Ansi standard, by Yashwant Kanetkar	

SEMESTER – II

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Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	II	**Version**	I
Subject Code	G2A05LDE	**Subject Name**	Linear Algebra & Differential Equations

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	01	01	05	Theory	20	50	70
Hours	03	02	02	07	Practical	10	20	30

Content:

Unit	Subject Content	135 Hrs
1	**Differential Equations:** Exact differential Equation, Existence and uniqueness of First order differential equation, Linear differential equation of nth order with constant coefficients, Simultaneous linear differential equations, second order linear differential equations with variable coefficients, Solution by changing independent variable, Reduction of order, Normal form, Method of variation of parameters (higher order also), Cauchy-Euler equation, Series solutions (Frobenius Method). Applications of LDE to engineering problems.	
2	**Laplace Transform (LT) and Applications:** Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse, and Error. Applications of LT for solving ordinary differential equations.	
3	**Fourier Series and Partial Differential Equations:** Definition of Fourier series, Dirichlet's conditions, Full range Fourier series, Half range Fourier series, Harmonic analysis, Parseval's identity and Applications to problems in Engineering. Introduction to Partial Differential Equations, Solutions of One	

	Dimensional Wave, Heat Equation & Laplace Equation.	
4	**Fourier Transform (FT) and Z – Transform (ZT):** Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms and their inverses, Discrete Fourier Transform. Z –Transform(ZT): Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.	
5	**Linear Transformation:** Definition, Properties of Linear transformation, Range and kernel, The rank and nullity of a linear transformation, Rank-Nullity Theorem and its consequences, The matrix representation of a linear transformation, Change of basis, Isomorphism theorems, Inevitability and isomorphism , change of coordinate matrix, Scalar product in an Inner product spaces, Orthogonality in inner product Spaces, Normed linear spaces, Inner product on complex vector spaces, Orthogonal Complements, orthogonal sets and projections, Gram-Schmidt Orthogonalization process, Bessel's inequality.	

Practical Content:

Introduction to Scilab and Basic syntax, Mathematical Operators, Predefined constants, Built in functions at SCILAB platform, CODE for addition, subtraction, multiplication & division of two matrices, transpose of a matrix and inverse of a non-singular matrix. CODE for basic find the value of function, use of 'If', 'If– else', 'for', 'while 'loop. Determination of LI of vectors and determining solution of system of linear equations. Kernel, range and verification of rank and nullity theorem. Compute the Eigen Values, Vectors, and check, whether a given matrix is symmetric, skew-symmetric, and orthogonal.

Initial value problem of II order and plotting the solution. Initial value problem of first and second order (domain specific) and plotting the solution of problem. One-dimensional wave equation under specified conditions and graphing the solution. Solve one dimensional heat equation under specified conditions and graphing the solution. Laplace equation to find the steady state temperature in the square plate satisfying specific boundary conditions and graphing the solution.

Text Books/Reference Books:

1. D. Poole, Linear Algebra: A Modern Introduction, 4th Edition, Brooks/Cole, 2015.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons.
3. Peter V. O'Neil, Advanced Engineering Mathematics, 7th Edition, Cengage Learning.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5th Edition, Narosa Publishers. 2. Robert T. Smith and Roland B. Minton, Calculus, 4th Edition, McGraw Hill Education.
5. David C Lay, Linear Algebra and its application, 3rd Edition,
6. KENNETH HOFFMAN, Linear Algebra, 2nd Edition, PRENTICE-HALL, INC., Englewood Cliffs, New Jerse
7. Urroz, G E., Numerical and Statistical Methods with SCILAB for Science and Engineering, Vol 1 Book Surge Publishing, 2001, ISBN-13: 978-1588983046
8. Software site: http://www.scilab.org, official scilab website

	9. Wikipedia article: http://en.wikipedia.org/wiki/Scilab

Subject Code	G2A06DGS		**Subject Name**	Digital Systems			
Teaching scheme				**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Binary System & Boolean Algebra:** Difference between Analog and Digital, Significance of Digital System, Computer System, Binary Number System, Conversion from one to other number systems such octal, hexadecimal, Complements, Binary Codes, Boolean Algebra, Basic Theorem and Properties of Boolean Algebra, Boolean functions.	
2	**Logic Gates:** Logical Operations and Logical Gates, Universal Gates, Simplification of Boolean functions, K – Map Method, Product of Sum Simplification, NAND and NOR gate Implementation, Don't care condition, Tabulation Method.	
3	**Combinational Logic Circuits:** Difference between combinational and sequential logic circuits, Design procedure, Adder, Subtractor, Code Conversion, Binary Parallel Adder, Decimal Adder, Magnitude Comparator, Decoder, Multiplexer, ROM, Programmable Logic Array	
4	**Sequential Logic Circuits:** Introduction, Flip-Flops, Triggering of Flip-Flops, Analysis of Clocked Sequential Circuits, Different Types of Flip-Flops and Excitation Table, Design of Counters, Different Types of Counters, Registers Transfer Logic and Micro Operation: Inter Register Transfer, Shift Operation, Fixed and Floating Point Data, TYPES: Registers, Shift Registers, Counters, Ripple Counters, Synchronous Counters, Timing Sequences, Memory Unit, RAM, ROM, EPROM,EEPROM, Flash Memory.	
5	**Logic Families, ADC and DAC:** Logic Families: Diode Transistor Logic, High Threshold Logic, Transistor- Transistor Logic, Resistor-Transistor Logic, Direct Coupled Transistor Logic, Emitter Coupled Logic, Comparison of Logic Families. ADC: Counter type, Flash Type, Dual Slope and Successive Approximation type ADC, DAC: R-2R Ladder type, Weighted Resistor type, Switched Current Source type, and Switched Capacitor type.	

Practical Content:

- 10-15 practicals being taught from subject content

Text Books/Reference Books:

1. M Morris Mano, "Digital Logic and Computer Design", Pearson, LPE
2. Malvino & Leach, "Principle of Digital Electronics", MCGraw-Hill
3. R. P. Jain, "Modern Digital Electronics", McGraw-Hill, 4th ed. 2010.
4. Boyce J. C., "Digital Logic: Operation and Analysis", Prentice Hall
5. Ronald J. Toccii, "Digital Systems: Principles and Applications", Pearson LPE

Subject Code	G2A07DCM	**Subject Name**	Data Communication

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	Introduction to Communication System, Communication System, Bandwidth Requirements, FDM, Channel, Noise: External Noise, Amplitude Modulation: Theory, Frequency Spectrum of AM wave, Representation of AM wave, Power Relation in the AM wave, Frequency and Phase Modulation: Theory, Representation of FM wave, Spectrum of FM wave, Phase Modulation: Intersystem comparison, Noise and FM: Effect of Noise on carrier, Pre-emphasis and De-emphasis, Other form of Interference, Comparison of wide band and narrow band FM.	
2	Sampling Theorem, Quantization, Pulse Code Modulation, Delta Modulation, Digital T Carriers, Companding, Digital Modulation: ASK, FSK and PSK: Introduction, modulation and demodulation circuits and waveforms, Pulse Modulation: Types, PWM.	
3	Random Variable and Processes, Probability Concept, Concept of Random Variable, Conditional statistics, Sequence of random variables, distribution	
4	Information and Entropy, Properties of entropy of a binary memory less source, Extension of a binary memory less source, Source coding: Huffman coding, Shanon-Fano code, Kraft's in-equality, Shannon's theorem and channel capacity.	
5	Channel Coding: Concept of Channel Coding, Types of Channel Coding, Linear Block Codes, generator matrices, parity check matrices, encoder, syndrome and error correction, minimum distance, error correction and error detection capabilities, Hamming codes, cyclic codes, BCH codes, Reed Solomon codes, Convolutional codes, encoder, distance properties,	

	maximum likelihood decoding, viterbi decoding, Trellis coding: coding and decoding.	

Practical Content:

- 10-15 practicals being taught from subject content

Text Books/Reference Books:

1. Communication Systems: Analog and Digital by R. P. Singh and B. D. Sapre, Tata-McGraw Hill
2. Modern Digital and Analog Communication Systems (4th Edition) by B. P. Lathi and Zhi Ding, Oxford University Press
3. Error Control Coding: Fundamentals and Applications – Shu Lin, Costello D. J. [Prentice Hall]
4. Digital Communications – Simon Haykin, [Wiley]

Subject Code	G2AD08OOP	**Subject Name**	Object Oriented Programming with C++

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Concepts of OOP:** Introduction OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP **Basics:** Overview, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures	
2	**C++ Functions:** Simple functions, Call and Return by reference, Inline functions, Macro Vs. Inline functions, Overloading of functions, default arguments, friend functions, virtual functions	
3	**Objects and Classes:** Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading, type conversion **Inheritance:** Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class	
4	**Polymorphism:** Pointers in C++, Pointes and Objects, this pointer, virtual and pure virtual functions, Implementing polymorphism	

5	**Templates, Exceptions and STL:** What is template? Function templates and class templates, introduction to exception, try-catch- throw, multiple catch, catch all, re throwing exception, implementing user defined exceptions, Overview and use of Standard Template Library	

Practical Content:

- 10-15 practicals being taught from subject content

Text Books/Reference Books:

1. Object Oriented Programming With C++, E Balagurusamy, TMH
2. C++ Programming, Black Book, Steven Holzner, dreamtech
3. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia
4. Object Oriented Programming with ANSI and Turbo C++, Ashok Kamthane, Pearson
5. The Compete Reference C++, Herbert Schlitz, TMH
6. C++ and Object Oriented Programming Paradigm, PHI
7. C++: How to Program, 9th Edition, Deitel and Deitel, PHI
8. Object Oriented Programming with C++, Saurav Sahay, Oxford

Subject Code	G2AD09DSA	**Subject Name**	Data Structures & Algorithms

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	**Introduction of data structure:** Data Management concepts, Data types – primitive and non-primitive, Performance Analysis and Measurement (Time and space analysis of algorithms-Average, best and worst-case analysis), Types of Data Structures- Linear & Non-Linear Data Structures.	
2	**Linear Data Structure:** Array: Representation of arrays, Applications of arrays, sparse matrix and its representation Stack: Stack-Definitions & Concepts, Operations On Stacks, Applications of Stacks, Polish Expression, Reverse Polish Expression and Their Compilation, Recursion, Tower of Hanoi Queue: Representation of Queue, Operations On Queue, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queue Linked List: Singly Linked List, Doubly Linked list, Circular linked list, Linked implementation of Stack, Linked implementation of Queue, Applications of linked list.	

3	**Non Linear Data Structure:** Tree-Definitions and Concepts, Representation of binary tree, Binary tree-traversal (in order, post order, preorder), Threaded binary tree, Binary search trees, Conversion of General Trees to Binary Trees, Applications of Trees Some balanced tree mechanism, eg. AVL trees, 2-3 trees, Height Balanced, Weight Balance, Graph-Matrix Representation Of Graphs, Elementary Graph operations,(Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree)	
4	**Hashing and File Structure:** Hashing: The symbol table, Hashing Functions, Collision Resolution Techniques, File Structure: Concepts of fields, records and files, Sequential, Indexed and Relative/Random File Organization, Indexing structure for index files, hashing for direct files, Multi-Key file organization and access methods.	
5	**Sorting & Searching;** Linear Search, Binary Search. Insertion Sort, Selection Sort, Bubble Sort, Quick Sort Graph Introduction to Graphs, Types of Graph, Representation of Graphs, Graph Traversals: DFS and BFS, Template of Graph using one Application, Applications of Graph.	
Practical Content:		
	• 10-15 practicals being taught from subject content.	
Text Books/Reference Books:		
	1. An Introduction to Data Structures with Applications. by Jean-Paul Tremblay & Paul G. Sorenson Publisher-Tata McGraw Hill. 2. Data Structures using C & C++ -By Ten Baum Publisher – Prenctice-Hall International. 3. Fundamentals of Computer Algorithms by Horowitz, Sahni,Galgotia Pub. 2001 ed. 4. Fundamentals of Data Structures in C++-By Sartaj Sahani. 5. Data Structures: A Pseudo-code approach with C -By Gilberg & Forouzan PublisherThomson Learning.	

SEMESTER – III

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICAL INTELLIGENCE AND CYBER SECURITY

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	III	**Version**	I
Effective from Academic Year	2020-21	**Effective for the batch Admitted in**	July 2021
Subject Code	G3A10OPS	**Subject Name**	Operating Systems

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Introduction** • Basics of Operating Systems: Definition – Generations of Operating systems • Types of Operating Systems: Network OS, Mobile OS, Server OS and Client OS. Real Time Operating System, OS Service, System Calls • OS structure: Layered, Monolithic, Microkernel Operating Systems – Concept of Virtual Machine	
2	**Process Management** • Inter Process Communication and Deadlocks • Processes: Definition, Process Relationship, Process states, Process State transitions, Process Control Block, Context switching – Threads – Concept of multithreads, Benefits of threads – Types of threads Process Scheduling, Scheduling criteria, Scheduling algorithms • Inter process Communication: Race Conditions, Critical Section, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing	

	• Classical IPC Problems Deadlocks: Definition, Deadlock characteristics, Deadlock Prevention, Deadlock Avoidance, Deadlock detection and Recovery	
3	**Memory Management** • Basic Memory Management: Definition, Logical and Physical address map • Memory allocation: Contiguous Memory allocation – Fixed and variable partition – Internal and External fragmentation and Compaction • Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing – Disadvantages of paging • Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging (Concepts only) – Page Replacement policies.	
4	**I/O Management** • Principles of I/O Hardware: I/O devices, Device controllers, Direct memory access • Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, • Secondary-Storage Structure: Disk structure, Disk scheduling algorithm	
5	**File Management** • File concept, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance, • Case study: UNIX and Windows file system **Security & Protection** • Security Environment, Design Principles of Security, User Authentication, • Protection Mechanism: Protection Domain, Access Control List	
6	**History of Linux** • (History, FOSS, current Linux Distributions-Distros examples), Linux Operating System Layers, The Linux Shell (different kinds of shell), • Process: (parent and child processes), Files and Directories (File Structure and directory structure), Interaction with System, Elementary Linux command, Shell Scripting.	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
	1. Operating System Concepts (8th Edition) by Silberschatz, Peter B. Galvin and Greg Gagne, WileyIndian Edition (2010).	

2. Modern Operating Systems (Third Edition) by Andrew S Tanenbaum, Prentice Hall India (2008).
3. Principles of Operating Systems by Naresh chauhan, Oxford Press (2014).
4. Operating Systems by D.M. Dhamdhere, Tata McGraw Hill 2nd edition.
5. Operating Systems (5th Ed) – Internals and Design Principles by William Stallings, Prentice Hall India, 2000
6. UNIX Concepts and Applications (4th Edition)– by Sumitabha Das, Tata McGraw Hill.
7. Unix Shell Programming – by Yashwant Kanetkar, BPB publications.

Subject Code	G3A11PSN		**Subject Name**	Probability, Statistics & Numerical Analysis			
Teaching scheme				**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	01	01	05	Theory	20	50	70
Hours	03	02	02	07	Practical	10	20	30

Content:

Unit	**Subject Content**	**135 Hrs**
1	**Probability and Random variables** Probability: Classical, relative, frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems. Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moment s, probability and moment generating function, median and quantiles, Markov in equality , Chebyshev' s in equality, problems	
2	**Special Probability Distributions:** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.	
3	**Joint Probability Distributions:** Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems. **Sampling Probability Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi - Square, t and F distributions, problems.	
4	**Estimation**	

	Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence interval s for proportions, problems.	
5	**Algebraic and Transcendental Equations** Bisection Method, The method of false position, The iteration method Newton Raphson method, Generalized Newton's method, Ramanujan's method, Graffe's root squaring method, Solutions of system of nonlinear Equations:-The method of iteration, Newton Raphson method	
6	**Numerical solution of Ordinary Differential Equation** Solution by Taylor's series Picard's method of successive approximations Euler's method Modified Euler's method Runge-Kutta method Predictor-Corrector methods Adam Bashforth method Adam Moulton method Milne's method Boundary value problems - Finite difference method.	

Practical Content:

- 10-15 tutorials being taught from subject content.

Reference Books:

1. An Introduction to Probability and Statistics by V. K. Rohatgi & A. K. Md. E. Sal eh.
2. Introduction to Probability and Statistics by J. S. Mi l ton & J. C. Arnold.
3. Introduction to Probability Theory and Statistical Inference by H. J . L arson.
4. Introduction to Probability and Statistics for Engineers and Scientist s by S. M. Ross
5. Introductory methods of Numerical Analysisby S.S.Sastry, fourth edition, Prentice-Hall of India (P) Ltd.
6. Numerical Methods for Scientific and Engineering students by M.K.Jain, S.R.K.Iyengar New age international (P) Ltd., Pune.

Subject Code	G3AD12JPM	**Subject Name**	Java Programming

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	02	05	Theory	20	50	70
Hours	03	00	04	07	Practical	10	20	30

Content:

Unit	**Subject Content**	**165 Hrs**
1	**Basics of Java** • Features of Java, Byte Code and Java Virtual Machine, JDK, Data types, Operator, Control Statements – If, else, nested if, if-else ladders, Switch, while, do-while, for, for-each, break, continue. • Array and String: Single and Multidimensional Array, String class, String Buffer class, Operations on string, Command line argument, Useof Wrapper Class. Classes, • Objects and Methods: Class, Object, Object reference, Constructor,	

	Constructor Overloading, Method Overloading, Recursion, Passing and Returning object form Method, new operator, this and static keyword, finalize() method, Access control, modifiers, Nested class, Inner class, Anonymous inner class, Abstract class.	
2	**Inheritance and Interfaces** • Use of Inheritance, Inheriting Data members and Methods, constructor in inheritance, Multilevel Inheritance – method overriding Handle multilevel constructors – super keyword, Stop Inheritance - Final keywords, Creation and Implementation of an interface, Interface reference, instance of operator, Interface inheritance, Dynamic method dispatch, Understanding of Java Object Class, Comparison between Abstract Class and interface, Understanding of System. out.println statement.	
3	**Package** • Use of Package, CLASSPATH, Import statement, Static import, Access control **Exception Handling** • Exception and Error, Use of try, catch, throw, throws and finally, Built in Exception, Custom exception, Throwable Class.	
4	**Multithreaded Programming** • Use of Multithread programming, Thread class and Runnable interface, Thread priority, Thread synchronization, Thread communication, Deadlock **IO Programming** • Introduction to Stream, Byte Stream, Character stream, Readers and Writers, File Class, File InputStream, File Output Stream, InputStreamReader, OutputStreamWriter, FileReader, FileWriter, Buffered Reader	
5	**Collection Classes** • List, AbstractList, ArrayList, LinkedList, Enumeration, Vector, Properties, Introuduction to Java.util package **Networking with java.net** • InetAddress class,Socket class, DatagramSocket class, DatagramPacket Class	
6	Introduction to Object orientation, Modelling as a Design Technique, Class Modelling, Advanced class Modelling, State modelling, Interaction Modelling	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
	1. Java Fundamentals A comprehensive introduction by Herbert Schildt, Dale Skrien, McGraw Hill Education. 2. Programming with Java A Primer – E.Balaguruswamy, Mc Grawhill 3. The Complete Reference, Java 2 (Fourth Edition), Herbert Schild, - TMH. 4. Core Java Volume-I Fundamentals Horstmann & Cornell, - Pearson Education. - Eight Edition	

	5. Object Oriented Modeling and Design with UML Michael Blaha and James Rambaugh – PEARSON second edition 6. UML Distilled: A Brief Guide to the Standard Object Modeling Language (3rd Edition) by Martin Fowler

Subject Code	G3A13DBM	**Subject Name**	Database Management System

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	**Introductory concepts of DBMS:** Introduction and applications of DBMS, Purpose of data base, Data, Independence, Database System architecture- levels, Mappings, Database, users and DBA	
2	**Relational Model:** Structure of relational databases, Domains, Relations, Relational algebra – fundamental operators and syntax, relational algebra queries, tuple relational calculus. Component of SQL: DDL, DQL, DML, DCL and TCL.	
3	**Entity-Relationship model:** Basic concepts, Design process, constraints, Keys, Design issues, E-R diagrams, weak entity sets, extended E-R features – generalization, specialization, aggregation, reduction to E-R database schema	
4	**Relational Database design:** Functional Dependency – definition, trivial and non-trivial FD, closure of FD set, closure of attributes, irreducible set of FD, Normalization – 1Nf, 2NF, 3NF, Decomposition using FD- dependency preservation, BCNF, Multi valued dependency, 4NF, Join dependency and 5NF	
5	**Query Processing & Query Optimization:** Overview, measures of query cost, selection operation, sorting, join, evaluation of expressions, transformation of relational expressions, estimating statistics of expression results, evaluation plans, materialized views	
6	**Transaction Management, Recovery and Security** Transaction concepts, properties of transactions, serializability of transactions, testing for serializability, System recovery, Two- Phase Commit protocol, Recovery and Atomicity, Log-based recovery, concurrent executions of transactions and related problems, locking	

	mechanism, solution to concurrency related problems, deadlock, two-phase locking protocol, Isolation, Intent locking, Security: Introduction, Discretionary access control, Mandatory Access Control, Data Encryption	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. An introduction to Database Systems, C J Date, Addition-Wesley.
2. Database System Concepts, Abraham Silberschatz, Henry F. Korth & S. Sudarshan, McGraw Hill.
3. Understanding SQL by Martin Gruber, BPB
4. SQL- PL/SQL by Ivan bayross
5. Oracle – The complete reference – TMH /oracle press

Subject Code	G3A14COM	**Subject Name**	Computer Organization & Microprocessor

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	Computer Data Representation Fixed point & Floating point representation, Introduction to Microprocessor 8085, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization, Microprocessor Architecture and Operations, design of Accumulator Unit, Memory, I/O devices, Memory and I/O operations, Basic Computer Organization and design	
2	Machine Language, Assembly Language, assembler, Classification of Instructions, Instruction codes: Register Transfer language, Arithmetic Micro-Operations, Logic Micro Operations, Shift Micro-Operations, Instruction cycle, Memory-Reference & Input output Instructions, Addressing Modes	
3	Programming The Basic Computer, Program loops, Programming Arithmetic and logic operations, subroutines, I-O Programming. Computer Arithmetic, Addition and subtraction, Multiplication Algorithms (Booth Multiplication Algorithm), Division Algorithms, Floating Point Arithmetic operations, Decimal Arithmetic Unit.	

4	Micro programmed Control: Control Memory, Address sequencing, Micro program Example, design of control Unit Central Processing Unit, General Register Organization, Stack Organization, Instruction format, Addressing Modes, data transfer and manipulation, Program Control, Reduced Instruction Set Computer (RISC)	
5	Pipeline And Vector Processing, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction, Pipeline, RISC Pipeline, Array Processors	
6	Input-Output Organization Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Input-Output Processor (IOP), CPUIOP Communication, Serial communication. Advanced Microprocessors : 8086 logical block diagram and segments	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. M. Morris Mano, Computer System Architecture, Pearson
2. Andrew S. Tanenbaum and Todd Austin, Structured Computer Organization, Sixth Edition, PHI
3. M. Murdocca & V. Heuring, Computer Architecture & Organization, WILEY
4. John Hayes, Computer Architecture and Organization, McGrawHill
5. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar Pub: Penram International.
6. 8086 Programming and Advance Processor Architecture, Savaliya M. T., WileyIndia

Subject Code	G3A15DMM	**Subject Name**	Discrete Mathematics

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	00	03	Theory	20	50	70
Hours	03	00	00	03	Practical	10	20	30

Content:

Unit	**Subject Content**	**45 Hrs**
1	**Set Theory:** Introduction, Combination of sets, Multisets, Ordered pairs. Proofs of some general identities on sets. Relations: Definition, Operations on relations, Properties of relations, Composite Relations, Equality of relations, Recursive definition of relation, Order of relations. Functions: Definition, Classification of functions, Operations on functions, recursively defined functions. Growth of Functions. Natural Numbers: Introduction, Mathematical Induction, Variants of Induction, Induction with Nonzero Base cases. Proof Methods, Proof by counter – example, Proof by contradiction.	

2	**Partial Order Sets:** Definition, Partial order sets, Combination of partial order sets, Hasse diagram. Lattices: Definition, Properties of lattices – Bounded, Complemented, Modular and Complete lattice. Counting Techniques, Inclusion and exclusion principal, Pigeon-hole principle, Permutation & Combination.	
3	**Propositional Logic:** Proposition, well-formed formula, Truth tables, Tautology, Satisfiability, Contradiction, Algebra of proposition, Theory of Inference Predicate Logic: First order predicate, well-formed formula of predicate, quantifiers, Inference theory of predicate logic.	
4	**Algebraic Structures:** Definition, Groups, Subgroups and order, Cyclic Groups, Cosets, Lagrange's theorem, Normal Subgroups, Permutation and Symmetric groups, Group Homomorphism, Definition and elementary properties of Rings and Fields.	
5	**Trees & Graphs:** Trees - Definition, Binary trees, Binary tree traversal, Binary search trees. Graphs - Definition and terminology, Representation of graphs, Bipartite graphs, Planar graphs, Isomorphism and Homeomorphism of graphs, Multigraphs, Euler and Hamiltonian paths, Graph colouring. Recurrence Relations: Introduction, Growth of functions, Recurrences from algorithms, Methods of solving recurrences.	
Practical Content:		
	• 10-15 tutorials being taught from subject content	
Text Books/Reference Books:		
	1. Liu and Mohapatra, "Elements of Distcrete Mathematics", McGraw Hill 2. Jean Paul Trembley, R Manohar, Discrete Mathematical Structures with Application to Computer Science, McGraw-Hill 3. Y. N. Singh, "Discrete Mathematical Structures", Wiley India, New Delhi, First Edition, August 2010. 4. R.P. Grimaldi, Discrete and Combinatorial Mathematics, Addison Wesley, 2004. 5. Discrete Mathematics and Its Applications, Kenneth H. Rosen, McGraw-Hill, 2006. 6. Discrete Mathematical Structures, B. Kolman, R. C. Busby, and S. C. Ross, Prentice Hall, 2004	

SEMESTER - IV

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICAL INTELLIGENCE AND CYBER SECURITY

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	IV	**Version**	I
Subject Code	G4A16SEN	**Subject Name**	Software Engineering

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	Software process Models and lifecycle: Software Product, Product, Software Processes, Evolving Role of Software, Software: A Crisis on the Horizon and Software Myths, Software Engineering: A Layered Technology, Study of different Software Process Models, The Linear Sequential Model, The Prototyping Model, The RAD Model, Evolutionary Process Models, Component-Based Development.	
2	Software Project Planning, Scheduling and Tracking: Project Planning Objectives, Software Engineering Project Management Concepts & Project Metrics: The Management Spectrum, People, Product, Process, Project, The W5HH Principle, Metrics in the Process and Project Domains (FP & LOC), Software Measurement, Metrics for Project and Software Quality Software Project Estimation using COCOMO Model, Software Scope and Resources , People and Effort, Software Engineering Tasks, Scheduling, Earned Value Analysis, Requirements Specification: Requirement Gathering and Analysis, Software Requirement Specification(SRS), Formal requirements specification and verification - axiomatic and algebraic specifications	

3	Analysis Modelling, Software Design Concepts and Principles: The Elements of the Analysis Model, Data Modelling, Functional Modelling and Information Flow, Behavioral Modelling and, Design Process, Design Principles, Design Concepts, Modular Design, Design Heuristics for Effective Modularity, Enterprise Architecture, Modelling using UML diagrams :Use case, Activity, DFD, Class, Sequence, User Interface Design	
4	Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks (Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation), Risks Monitoring and Management Coding, Software Testing Techniques & Software Testing Strategies: Software Testing Fundamentals and Test Case Design, White-Box Testing and Black-Box Testing, ISO/IEC/IEEE Software Testing standards, Testing for Specialized Environments, A Strategic Approach to Software Testing and Issues, Unit Testing, Integration and Validation Testing, System Testing.	
5	Software Quality Assurance and Configuration Management -Quality Concepts and Software Quality Assurance, Quality Planning and Control, Software Reviews (Formal Technical Reviews), Software Reliability and Fault Tolerance, ISO/ IEEE 12207, Six Sigma, Version Control and Change Control.	
6	Emerging and advanced topics in Software Engineering: Security Engineering, Agile Methods, SCRUM, Client Server Software Engineering, DevOps, Reverse Engineering, Re-engineering, Web Engineering, CASE.	

Practical Content

- 10-15 practicals being taught from subject content.

Reference Books:

1. Roger S. Pressman, Software Engineering: a practitioner's approach 8th Edition, McGraw Hill.
2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India.
3. Pankaj Jalote, An integrated approach to Software Engineering by Springer.
4. Ian Sommerville, Software Engineering, Addision and Wesley

Subject Code	G4AD17PPL	**Subject Name**	Python Programming Language

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	02	05	Theory	20	50	70
Hours	03	00	04	07	Practical	10	20	30

Content:

Unit	Subject Content	165 Hrs
1	Introduction to Python: Installation and Working with Python, Understanding Python variables, Python basic Operators, Understanding python blocks. Python Data Types: Declaring and using Numeric data types: int, float, complex, Using string data type and string operations, Defining list and list slicing, Use of Tuple data type	
2	Python Program Flow Control: Conditional blocks using if, else and elif, Simple for loops in python, for loop using ranges, string, list and dictionaries, Use of while loops in python, Loop manipulation using pass, continue, break and else. Python Functions, Modules And Packages: Organizing python codes using functions, Organizing python projects into modules, Importing own module as well as external modules, Understanding Packages, Powerful Lamda functions in python.	
3	Python String, List and Dictionary Manipulation: Building blocks of python programs, understanding string in build methods, List manipulation using in build methods, Dictionary manipulation, Programming using string, list and dictionary in build functions. Python File Operation: Reading and writing configuration files in python, Understanding read and write functions, Programming using file operations.	
4	Python Object Oriented Programming – Oops: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance, overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support	
5	Python Regular Expression, Python Exception Handling, Python Database Interaction	
6	Python Multithreading: Understanding threads, forking threads, Synchronizing the threads, Programming using multithreading. Python CGI Introduction.	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Python Programming: Using Problem Solving Approach by Reema Tharej, Oxford Publication.
2. Python Programming - Learn & Practice by, Swapnil Saurav
3. Python Programming: A Complete Guide for Beginners to Master, Python Programming Language by Brian Draper.

Subject Code	G4AD18DAA	**Subject Name**	Design & Analysis of Algorithms

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					

Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	The Role of Algorithm in Computing, analyzing algorithm, designing algorithm.	
2	Asymptotic analysis: Big O, little o, omega, and theta notation, worst case and average case analysis; recursive approach; iterative approach, recurrence relation, Strassen's Matrix Multiplication, Merge Sort, Quick Sort, Heap Sort.	
3	Algorithm Design Techniques: Divide-and-conquer, Greedy algorithms: knapsack problem, Job Sequencing with deadline, Optimal Merge Pattern, Huffman coding, prims & Kruskal algorithm, Dijkstra Algorithm.	
4	Dynamic programming: Floyd Warshall Algorithm, Matrix Chain Multiplication, Bellman Ford Algorithm, 0/1 knapsack, Optimal Binary Search Tree, Longest Common Subsequence, Traveling Salesmen problem.	
5	Branch and Bound: Job sequencing with deadline, 0/1 knapsack using Branch and Bound Travelling salesmen problem Branch and Bound, Backtracking and Heuristics.	
6	Introduction to P and NP class, String Matching algorithm.	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein [PHI].
2. Algorithm Design –Goodrich, Tamassia [John Wiley & Son]
3. The Design and Analysis of Computer Algorithms – Aho, Hopcroft, Ullman [Addison-Wesley]
4. The Art of Computer Programming -- Knuth [Pearson]

Subject Code	G4A19ITC	**Subject Name**	Introduction to Cryptography

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	Introduction to Cryptography: Classical Ciphers. Shannon's notion of perfect secrecy- example and proof.	
2	Computational secrecy: Definition of probabilistic polynomial time algorithm and negligible function. Discussion about- randomized algorithm, statistical distance, indistinguishability and security parameter. One-way function. Pseudorandom function. Pseudorandom generators. Pseudorandom permutation. Hash function- construction and security.	
3	Symmetric key Cryptography: Fiestel Network. Substitution and Permutation Network. Block ciphers- Data Encryption Standard, Advanced Encryption Standard. Stream cipher- RC4.	
4	Number Theory: Groups. Modular Arithmetic. Primality testing- Fermat's little theorem. Euler's phi function and Euler's theorem. Chinese remainder theorem. Polynomial rings, Field, Field extension, Primitive polynomial and primitive root. Generating random primes. Quadratic residues. Legendre symbol. Jacobi symbol. QR assumption.	
5	Public Key Cryptography: Mathematical assumptions- discrete logarithm problem and integer factorization problem. Diffie- Hellman key exchange protocol. Decisional and search version of Diffie-Hellman assumption. Elgamal encryption. RSA encryption. RSA assumption. Rabin cryptosystem. Paillier cryptosystem.	
Practical Content:		
1	Classical Ciphers	
2	DES, AES, RC4	
3	Diffie-Hellman key exchange and Elgamal encryption	
4	Square & multiply algorithm and RSA Encryption	
5	Rabin and Paillier Cryptosystem	
Reference Books:		
	1. Cryptography theory and practice, by D. R. Stinson. 2. Handbook of applied cryptography, by A. Menezes, P. V. Oorschot, and S. Vanstone. 3. Introduction to modern cryptography, by J. Katz and Y. Lindell. 4. The foundations of cryptography (Volume I), by O. Goldreich. 5. A graduate course in applied cryptography, by D. Boneh and V. Shoup. 6. Lecture notes on cryptography, by S. Goldwasser and M. Bellare. 7. Handout for basic probability by Luca Trevisa. 8. Handout for probability by Boaz Barak. 9. Handout for Algebra by Luca Trevisan.	
	Learning Objectives	
	Students will learn how to protect information in order to ensure its integrity, confidentiality, authenticity, and non-repudiation. ■ Students will have a clear understanding of cryptographic concepts. ■ Students will understand key management concepts and public key infrastructure. ■ Students will understand, analyze and implement symmetric key primitives.	

	■ Students will learn the basic number theory concepts. They will also learn mathematical assumptions and to build public key cryptography on these assumptions.

Subject Code	G4A20LSS	**Subject Name**	Linux & Shell Scripting

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	**General Overview of the System:** System structure, user perspective, O/S services assumption about Hardware: The Kernel and buffer cache architecture of Unix O/S, System concepts, Kernel data Structure, System administration, Buffer headers, Structure of the buffer pool, Scenarios for retrieval of the buffer, Reading and writing, disk block, Advantage and disadvantage of buffer cache.	
2	**Internal Representation of Files:** INODES, Structure of regular, Directories conversions of a path name to an inode, Super block, Inode assignment to a new file, Allocation of disk blocks, System Calls for the System: Open read write file and record close, File creation, Operation of special files change directory and change root, change owner and change mode, STAT and FSTAT, PIPES Mounting and unmounting files system, Link Unlink.	
3	**Structures of Processes and Process Control:** Process states and transitions layout of system memory, the context of a process, manipulation of process address space, Sleep process creation/termination. The user Id of a process, changing the size of a process, Inter process Communication and multiprocessor system: Process tracing system V IPO network communication sockets problem of multiprocessors systems, solution with master and hare process, and solution with semaphores.	
4	**Introduction to Shell Scripts:** Shell Bourne shell, C shell, Unix commands, permissions, editors, filters, sed, grep family, shell variables, scripts, metacharacters and environment, if and case statements, for while and until loops. Shell programming	
5	**Awk and Perl Programming:** Awk pattern scanning and processing language, BEGIN and END patterns, Awk arithmetic and variables, Awk built in variable names and operators, arrays, strings, functions, perl; the chop() function, variable and operators, $_ and $. , Lists, arrays, regular expression and substitution, file handling, subroutines, formatted printing.	
6	**Linux:**	

	History & Features of Linux, Linux structure, various flavours of Linux.	
Practical Content:		
	• 10-15 practicals being taught from subject content.	
Reference Books:		
	1. M.J. Bach "Design of UNIX O.S. ", Prentice Hall of India. 2. Y.Kanetkar "Unix shell programming", BPB Pub.	

SEMESTER – V

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICAL INTELLIGENCE AND CYBER SECURITY

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	V	**Version**	I
Effective from Academic Year	2021-22	**Effective for the batch Admitted in**	July 2021
Subject Code	G5AD21DAV	**Subject Name**	Data Analytics & Visualization

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	Introduction: Motivation and importance, different kinds of data, data miningfunctionalities, classification of data mining systems, major issues in data mining	
2	Data Pre-processing: Data summarization, data cleaning, data integration and transformation, data reduction, data discretization and concept hierarchygeneration	
3	Data Warehouse and OLAP Technology: Multidimensional data model, datawarehouse architecture, data warehouse implementation, Data Cube Computation and Data Generalization: Efficient methods for data cube computation, attribute oriented induction	
4	Mining Frequent Patterns, Associations and Correlations: Basic concept, efficient and scalable frequent item set mining methods, mining various kind of association rules, from association mining to correlation analysis, constraint- based association mining	

5	Classification and Prediction **:** Classification vs. prediction, Issues regarding classification and prediction, Classification by decision tree induction, Bayesian classification, rule-based classification, classification by backpropagation, support vector machines, associative classification, lazy learners, linear regression, nonlinear regression, accuracy and error measures, evaluation the accuracy of a classifier or predictor, ensemble methods	
6	Cluster Analysis: Types of data in cluster analysis, a categorization of major clustering methods, partitioning methods, hierarchical methods, density-based methods, grid-based methods, model-based clustering methods, clustering high dimensional data, outlier analysis. Current Problems in Machine Learning	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Jiawei Han and Micheline Kamber, Data mining: Concepts and Techniques, Morgan KaufmannPublishers.
2. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques,Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.
3. Hand, Mannila, and Smyth. Principles of Data Mining, MIT Press, 2001, ISBN: 026208290X.
4. Berry and Linoff, Mastering Data Mining, Wiley, 2000. ISBN: 0471331236.
5. Delmater and Hancock, Data Mining Explained, Digital Press, 2001. ISBN: 1555582311.

Subject Code	G5AD22CNW	**Subject Name**	Computer Networks

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	**Introduction:** Uses of computer network, Types of Computer Networks, Network technology, From Local to Global, Examples Of Networks, Network Protocols, Reference Models, Standardization, Policy, Legal, And Social Issues	

2	**The Physical layer:** Bandwidth, Maximum data rate of a signal, Guided and unguided transmission media, Cable Networks, Communication Satellites, Comparing Different Access Networks, RS232C Interface Standards **The Data Link Layer:** Design Issues: Framing, Error control, Flow control, Error detection and correction, Elementary data link protocols: Simplex, stop and wait, Sliding window protocol, HDLC.	
3	**The Medium Access Control Sublayer:** The channel allocation problem, Multiple Access protocols: ALOHA, CSMA, Collision Free Protocols, Limited Contention Protocols, Wireless LAN protocols, Ethernet: Traditional Ethernet, Classic Ethernet MAC Sublayer Protocol, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, 40- and 100-Gigabit Ethernet, IEEE 802.11, Data link layer switching: Bridges, Learning Bridges, Spanning tree bridges, Repeaters, Hub, Switches, Routers, Gateway, Virtual LANs.	
4	**The Network Layer:** Design Issues: Store and forward packet switching, Service provided to transport layer, Implementation of connection oriented and connection less service, Comparison of virtual circuit and datagram subnets, Routing algorithms: The Optimality principle, Shortest path routing, Flooding, Distance vector routing, Link state routing, Hierarchical routing, Broadcast routing, Multicast routing, Traffic management at the network layer, quality of service and application QOE, Internetworks: Connecting Heterogeneous Networks, Connecting Endpoints Across Heterogeneous Networks, Internetwork Routing: Routing Across Multiple Networks, Supporting Different Packet Sizes: Packet Fragmentation, The network layer in the internet: The IP protocol, IP addresses, Internet control protocol, Label Switching and MPLS, OSPF, BGP, Internet multicasting, Mobile IP, IPv6, Software-Defined Networking: Control and Data Plane	
5	**The Transport Layer:** The transport service: Services provided to the upper layers, Transport service primitives, Connection establishment, Connection release, congestion control, Flow control, The TCP, The UDP, Multiplexing, Performance issues	
6	**The Application layer:** The Domain Name System(DNS), Electronic Mail, The World Wide Web, FTP, Socket programming with TCP and UDP	
Practical Content:		
	• 10-15 practicals being taught from subject content.	
Reference Books:		
	1. Computer network, Andrew S. Tanenbaum, Nick Feamster, David Wetherall 6th Edition, Pearson. 2. Introduction to data communication and networking, Behrouz Forouzan, 6th Edition, TMH. **3.** Computer Networking, James F. Kurose, Keith Ross, 8th Edition, Pearson.	

	4. Data and computer communication, William Stallings, 10th Edition, Pearson.

Subject Code	G5A23DIP	**Subject Name**	Digital Image Processing

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	Introduction and Digital Image Fundamentals : Digital Image Fundamentals, Human visual system, Image as a 2D data, Image representation – Gray scale and Color images, image sampling and quantization	
2	Image enhancement in Spatial domain: Basic gray level Transformations, Histogram Processing Techniques, Spatial Filtering, Low pass filtering, High pass filtering. Filtering in the Frequency Domain: Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering	
3	Image Restoration and Reconstruction: Noise Models,Noise reduction,Inverse Filtering, MMSE (Wiener) Filtering. Color Image Processing: Color Fundamentals, Color Models, Pseudo color image processing	
4	Image Compression: Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard, Morphological Image Processing: Erosion, dilation, opening, closing, Basic Morphological Algorithms: hole filling, connected components, thinning,skeletons	
5	Image Segmentation: point, line and edge detection, Thresholding, Regions Based segmentation, Edge linking and boundary detection, Hough transform.	
6	Object Recognition and Case studies Object Recognition- patterns and pattern classes, recognition based on decision –theoretic methods, structural methods, case studies – image analysis Application of Image processing in process industries	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Gonzalez & Woods, —Digital Image Processing, 3rd ed., Pearson education, 2008
2. Jain Anil K., —Fundamentals Digital Image Processing, Prentice Hall India, 2010

Subject Code	G5AD24ARI	Subject Name	Artificial Intelligence

Teaching scheme					Examination scheme (Marks)			
(Per week)	Lecture		Practical (Lab.)	Total		INT	EXT	Total
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Introduction to AI** **Introduction:** What is AI, Applications of AI, characteristics, advantages and disadvantages **Problems, Problems Space and Search, Heuristic Search Techniques** Defining The Problems as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, Issues In The Design Of Search Programs, **Heuristic Search Techniques:** Hill Climbing, A*, AO*, Simulated Annealing, Branch and Bound, Nearest Neighbor, Blind Search Techniques: DFS, BFS, Best First Search, Control Strategies.	
2	**Logic and Programming Languages in AI** **Logic:** Propositional Logic, Predicate Logic and Fuzzy Logic, Monotonic and non-Monotonic **Programming Languages:** Introduction to Prolog: Syntax & Numeric Function, Basic List Manipulation Functions In Prolog, Functions, Predicates & Conditional, Input, Output & Local Variables, Iteration & Recursion, Property Lists & Arrays. GUI Version of Prolog. **Python Programming**: Syntax, Data Type, Libraries: NumPy, Numba, NumExpr, SciPy, AstroPy, Pandas, SymPy, MatplotLib, Jupyter, IPython	
3	**Knowledge Representation & Reasoning** **Knowledge Representation:** Knowledge Representations And Mappings, Approaches To Knowledge Representation. **Representing Knowledge using Rules** Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning. **Symbolic Reasoning Under Uncertainty and Statistical Reasoning:** Introduction To Non-monotonic Reasoning, Logics For Nonmonotonic Reasoning **Statistical Reasoning**	

	Probability And Bays' Theorem, Certainty Factors And Rule-Base Systems, Bayesian Networks, Dempster-Shafer Theory	
4	**Weak Slot-And-Filler Structure and Game Playing and Planning** **Weak Slot-And-Filler Structure:** Semantic Nets, Frames, Ontology, OWL, Reasoner **Game Playing and Planning:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person Games, Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance, State-of-the-Art Game Programs: Chess, Checkers or Draughts, Othello, Backgammon, Go The Blocks World, Components Of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems.	
5	**NLP and Text Analytics and Neural Networks** **NLP and Text Analytics:** Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse And Pragmatic Processing, Text Analytics, Text pre-processing, Bag of Words, Word Cloud, Machine Translation, sentiment analysis **Neural Networks:** Introduction: Simple Perceptron, Hopfield Network, Learning In Neural Network, Application Of Neural Networks, Recurrent Networks, Deep Neural Network, Convolution Network, Restricted Boltzmann machine, Transfer learning	
6	**Expert Systems and Optimization Techniques and AI & ML Tools** **Expert Systems:** An Introduction to Expert System, Explanation Facilities, Expert System Developments Process, Knowledge Acquisition. **Optimization Techniques and AI & ML Tools:** Genetic Algorithm (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization(PSO), Honey Bee AI , Machine Learning and Data Analytics Tools	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. "Artificial Intelligence" -By Elaine Rich and Kevin Knight (2nd Edition) Tata Mcgraw-Hill.
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence 3e: A Modern Approach, 3rd Edition. Person
3. Introduction to Prolog Programming By Carl Townsend
4. Artificial Intelligence - A New Synthesis by Nils J. Nilsson, Morgan Kaufmann Publishers.
5. Artificial Intelligence: Strategies and techniques for complex problems solving by George Luger, Addison-Wesley, 2003
6. Artificial Intelligence - A Modern Approach by Stuart Russell & Peter Norvig, Prentice Hall.

7. "Artificial Intelligence and Expert System, Development"-By D.W.Rolston, Mcgraw-Hill International Edition.
8. "Artificial Intelligence And Expert Systems "By D.W.Patterson
9. "PROLOG Programming For Artificial Intelligence" By Ivan Bratko, Addison-Wesley
10. "Programming with PROLOG" –By Klocksin and Mellish.

Subject Code	G5A25TOC	**Subject Name**	Theory of Computation

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	01	00	04	Theory	20	50	70
Hours	03	02	00	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**75 Hrs**
1	Review of Mathematical Theory: Sets, Functions, Logical statements, Proofs, relations, languages, Mathematical induction, strong principle, Recursive definitions	
2	Regular Languages and Finite Automata: Regular expressions, regular languages, applications, Automata with Output-Moore machine, Mealy machine, Finite automata, memory requirement in a recognizer, definition, union, intersection and complement of regular languages. Non Determinism Finite Automata, Conversion from NFA to FA, ^- Non Determinism Finite Automata Conversion of NFA- ^ to NFA and equivalence of three Kleene's Theorem, Minimization of Finite automata Regular And Non Regular Languages – pumping lemma.	
3	Context free grammar (CFG): Definition, Unions Concatenations And Kleen's of Context free language Regular grammar, Derivations and Languages, Relationship between derivation and derivation trees, Ambiguity Unambiguous CFG and Algebraic Expressions BacosNaur Form (BNF), Normal Form – CNF	
4	Pushdown Automata, CFL And NCFL:Definition, deterministic PDA,Equivalence of CFG and PDA, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL	
5	Turing Machine (TM): TM Definition, Model Of Computation And ChurchTurning Thesis, computing functions with TM, Combining TM, Variations Of TM, Non Deterministic TM, Universal TM, Recursively and Enumerable Languages, Context sensitive languages and Chomsky hierarchy.	
6	Computable Functions: Partial, total, constant functions, Primitive Recursive Functions, Bounded Mineralization, Regular function, Recursive Functions	

Practical Content:

	• 10-15 tutorials being taught from subject content.
Reference Books:	
	1. An introduction to automata theory and formal languages By Adesh K. Pandey, Publisher: S.K. Kataria& Sons 2. Introduction to computer theory By Deniel I. Cohen , Joh Wiley & Sons, Inc 3. Computation: Finite and Infinite By Marvin L. Minsky Prentice-Hall 4. Compiler Design By Alfred V Aho, Addison Weslley 5. Introduction to the Theory of Computation By Michael Sipser 6. Automata Theory, Languages, and Computation By John Hopcroft, Rajeev Motowani and Jeffrey Ullman

SEMESTER – VI

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICAL INTELLIGENCE AND CYBER SECURITY

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	VI	**Version**	I
Subject Code	G6AD27IOT	**Subject Name**	Internet of Things

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	Introduction to Embedded Systems: Introduction, Classification of Embedded system, Major Application Areas of Embedded System, Purpose of Embedded System, Typical Embedded System: Core of the embedded system, memory, sensors and actuators, communication interface, embedded firmware, other system components.	
2	Operating System for Embedded Application: Inferno, Pebble component Based Operating System, Introduction to Edge Computing, Cloud Computing & Fog Computing. Modern Wireless Technologies: LpWAN, Cellular (3G, 4G, 5G), RFID, Introduction to SDR.	
3	Internet of Things (IoT) Introduction, IoT Protocols (Infrastructure, Communication, Data), Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT.	
4	Networked Embedded Systems: Introduction, Object-Oriented Design, Design Integration & Optimization, and Co-design, Reconfiguration & Prototyping (include Hardware & Software), Multiple Application Support with FPGA.	

	Wireless Sensor Networks: Smart Sensor Network; Power-Aware Wireless Sensor Network; Routing in Wireless Sensor Network; Distributed Sensor Network; Clustering Techniques; Security Protocols and Network support for Embedded Systems	
5	Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Raspberry Pi, Implementation of IoT with RaspberryPi	
6	Internet of Things Privacy, Security and Governance, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT Case Study: Agriculture, Healthcare, Activity Monitoring	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. K.V. Shibu, Mc Graw Hill, "Introduction to Embedded System"
2. Anna Hac' (Wiley), Wireless Sensor Network Design
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014
4. Brian Russell and Drew Van Duren "Practical Internet of Things Security"
5. Amita Kapoor (Packt), "Hands-On Artificial Intelligence for IoT"

Subject Code	G6A28LNT	**Subject Name**	Language Translators

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	**Subject Content**	**105 Hrs**
1	Overview of the Translation Process, A Simple Compiler, Difference between interpreter, assembler and compiler. Debugger, macro-processor, pre-processor. Overview and use of linker and loader, types of Compilers, Analysis of the Source Program, The Phases of a Compiler, Cousins of the Compiler, The Grouping of Phases, Lexical Analysis, Hard Coding and Automatic Generation Lexical Analyzers, Front-end and Back-end of compiler, pass structure.	
2	Lexical Analyzer: Introduction to Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, A Language for Specifying Lexical Analyzers, Finite Automata from a Regular Expression, Design of a Lexical Analyzer Generator, Optimization of DFA.	

3	Parsing Theory: Top Down and Bottom-up Parsing Algorithms, Top-Down Parsing, Bottom-Up Parsing, Operator-Precedence Parsing, LR Parsers, Using Ambiguous Grammars, Parser Generators, and Automatic Generation of Parsers. Syntax-Directed Definitions, Construction of Syntax Trees, Bottom-Up Evaluation of S-Attributed Definitions, L-Attributed Definitions, syntax directed definitions and translation schemes.	
4	Error Recovery: Error Detection & Recovery, Ad-Hoc and Systematic Methods, Intermediate Code Generation: Different Intermediate Forms, Syntax Directed Translation Mechanisms and Attributed Mechanisms and Attributed Definition. Run Time Memory Management: Source Language Issues, Storage Organization, Storage-Allocation Strategies, and Access to Non local Names, Parameter Passing, Symbol Tables, and Language Facilities for Dynamic Storage Allocation, Dynamic Storage Allocation Techniques.	
5	Code Optimization: Global Data Flow Analysis, A Few Selected Optimizations like Command Sub Expression Removal, Loop Invariant Code Motion, Strength Reduction etc.	
6	Code Generation: Issues in the Design of a Code Generator, The Target Machine, Run-Time Storage Management, Basic Blocks and Flow Graphs, Next-Use Information, A Simple Code Generator, Register Allocation and Assignment, The DAG Representation of Basic Blocks, Peephole Optimization, Generating Code from DAGs, Dynamic Programming Code-Generation Algorithm, Code Generator Generators.	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Compilers: Principles, Techniques and Tools By Aho, Lam, Sethi, and Ullman, Pearson.
2. Compilers: Principles, Techniques and Tools By Aho, Sethi, and Ullman, Addison-Wesley.
3. Compiler Design in C By Allen I. Holub, Prentice-Hall/Pearson.
4. Advanced Compiler Design and Implementation By Muchnick, Morgan and Kaufmann.

Subject Code	G6A29SCS	**Subject Name**	Selected Topics from CS

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					

Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

To be studied online.

Subject Code	6B30WSV / 6B31SWS	**Subject Name**	**Elective I** • Web Security & Vulnerability Assessment • Software Security

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content: Web Security & Vulnerability Assessment

Unit	**Subject Content**	**75 Hrs**
1	Working of Hackers: Invading PCs, Script Kiddies, Working of Personal Hacker Protection, Working of Spyware and Antispyware, Attack Surface: Analysis, Defining, Identifying, Measuring, Assessing, and Managing Introduction to MITRE Framework, Matrix, Techniques, Benefits	
2	Vulnerability assessment: Nessus, OpenVAS, Nexpose, Tenable.io, web application scanning tools, Frameworks: Metasploit, Recon-ng	
3	Web Application Security, Burp suit, SQL injection, XSS Attack, The Defence mechanism of SQL Injection and XSS attack, Broken authentication and session hijacking, Security misconfiguration	
4	Malicious file inclusion, Insecure direct object reference, Information leakage and improper error handling, Failure to restrict URL access, Request forgery attack and countermeasures, Remote code execution, RFI, LFI, Report writing	
5	OWASP and Bug bounty Methodologies	
6	Static and Dynamic Analysis for Mobile Applications, Requirements for: Architecture, Design and Threat Modelling, Data Storage and Privacy, Cryptography, Authentication and Session Management, API Testing Tools: adb, MobSF, AndroBug, drozer usage and documentation	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Preston Galla, How Personal and Internet Security Work,Que Publications
2. Alfred Basta and Wolf Halton, Computer Security Concepts, Issues and Implementation,Cengage Learning
3. Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, Gray Hat Hacking: The Ethical Hackers' Handbook, TMH Edition
4. Jon Erickson, Hacking: The Art of Exploitation, SPD
5. Peltier, T. R., Peltier, J., & Blackley, J. A. (2003). Managing a Network Vulnerability Assessment. CRC Press.
6. Caswell, B., Beale, J., Ramirez, G., & Rathaus, N. (2005). Nessus, Snort, and Ethereal Power Tools: Customizing Open Source Security Applications. Elsevier.

Content: Software Security

Unit	Subject Content	75 Hrs
1	Software design principles; how software breaks; secure programming; securing stack and heap; Compile-time and run-time exception handling; address space randomization;debugging;	
2	Cross-site request forgeries; cross-site scripting attacks and prevention; browser-enforced defence mechanism	
3	Security vs. efficiency of software; reliability of software; control flow integrity; failure analysis of software; patching;	
4	Software Vulnerabilities- state transition, immunology, attack trees, worms and botnets;malware detection, obfuscation, polymorphism;	
5	Apps security; virtual machines security; XML security; security in the cloud; trusted platform computing.	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Analyzing Computer Security -- Pfleeger and Pfleeger [Prentice Hall]
2. Security in Computing – Pfleeger, Pfleeger, Shah {Pearson]
3. Introduction to Computer Security -- Matt Bishop [Addison-Wesley

Subject Code	G6B32DBS/ G6B33ISM	Subject Name	**Elective II** • Database Security • Information Security Management Systems

Teaching scheme					Examination scheme (Marks)			
(Per week)	Lecture		Practical (Lab.)	Total		INT	EXT	Total
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content: Database Security

Unit	Subject Content	75 Hrs
1	Introduction to databases; ACID properties; database security lifecycle; data classification; data risk assessment; database security architecture; feedback mechanisms.	
2	Database installation and configuration: profiles, passwords, privileges, and roles; databases security controls, security models, user administration.	
3	Database application security models: Take-Grant Model; PN model; Bell and LaPadula Model, Biba Model, Clack-Wilson model; Lattice Model, Roll-based accesscontrol, XML databases.	
4	Database Vulnerabilities & Threats: External and internal database threats; flaws in perimeter security; database security hierarchy.	
5	Security in distributed databases: evaluate database security; evaluate organization's asset; system eventtriggers; flaws fixes and security patches; managing USB ports and USB enabled devices; database obscurity; virtual private database; SQL injection; backup mechanisms.	
6	Data security policy: database security risks; database security testing; database auditing models and tools; user management strategies; maintenance policy,assessment and (counter) measures.	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
1. Database Security – A. Basta andM. Zgola [Cengage Learning] 2. Database Security -- Castano, Fugini, Martella [Pearson] 3. Database Security and Auditing-- Hassan Afyouni [Cengage Learning] 4. Effective Oracle Database 10g Security by Design -- David C. Knox [McGraw-Hill]		
Content: Information Security Management Systems		
Unit	**Subject Content**	**75 Hrs**
1	Security Risk Assessment and Management: introduction to security risk management, risk management approach (3 Phase Approach) , risk assessment, quantitative and qualitative measures; information classification; asset classification	
2	Security assurance approaches and standards: ISO17799, ISO27000, ISO27001, COBIT.	
3	Management of IT security infrastructure; system log analysis malware handling, vulnerability analysis, enforcing security policies.	
4	Business continuity planning and disaster recovery; backup and recovery techniques.	
5	Data protection bill, Data privacy bills, Compliance aspects of Bill; Indian IT Act, IT Audit; Audit Planning, Certificates, NIST, SANS & CIS.	
6	SNORT, NESSUS and NMAP.	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		

	1. Information Security Management Principles-- David Alexander, Amanda Finch, David Sutton, Andy Taylor [BCS Learning] 2. IT Security and Risk Management – J. Slay and A. Koronios[Wiley] 3. Information Security Management Handbook-- Harold F. Tipton and Micki Krause [Auerbach Publications]

SEMESTER - VII

RASHTRIYA RAKSHA UNIVERSITY

(An Institution of National Importance)
Lavad, Dehgam, Gandhinagar-382305, Gujarat, India

SCHOOL OF INFORMATION TECHNOLOGY, ARTIFICAL INTELLIGENCE AND CYBER SECURITY

Name of the Programme: (*Approved as per Academic Council*)

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)

Programme	B.TECH	**Branch/Spec.**	COMPUTER SCIENCE & ENGINEERING (WITH SPECIALIZATION IN CYBER SECURITY)
Semester	VII	**Version**	I
Effective from Academic Year	2021-22	**Effective for the batch Admitted in**	July 2021
Subject Code	G7AD34MLR	**Subject Name**	Machine Learning

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Fundamental concepts and Statistical Learning Techniques** **Fundamental concepts:** Introduction to Data science, Theory and practices in machine learning, Designing a Learning System, Issues in Machine Learning, Applications of ML, Global Developments of ML, Key challenges to adoption of ML in India. **Statistical Learning Techniques:** Descriptive statistics, Simple Linear Regression, ANOVA, Logistic Regression, Multi Linear regression, Correlation, Moving Average, Random Number Generation, Histogram Smoothing, Sampling, Rank Percentile.	

2	**Neural Networks** Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training, Perceptron learning rule, Hebbian learning rule, Delta Learning rule, Loss Functions (L1 loss, L2 loss, Cross-Entropy), Multilayer networks and Backpropagation Learning Algorithm, Feed Forward, Activation Functions, Types of Neural Network Architecture, Bias-Variance trade-off. Regularization and model/feature selection, Sampling Methods, Optimizers (Gradient Descent, Adagrad, RMSProp, Adam), Learning Rate	
3	**Bayesian Learning** Bayes Theorem, Maximum Likelihood and Least Squared Error Hypothesis, Maximum likelihood hypothesis for Predicting probabilities, Bayesian Belief Network.	
4	**Supervised and Unsupervised Learning** **Supervised Learning:** Classification, Decision Trees, Random Forest Classifier, Bayes Optimal Classifier, Naïve Bayes Classifier, Support Vector Machine, K - Nearest Neighbors, Ensemble Methods – Bagging and Boosting **Unsupervised Learning:** Clustering, K-means, K-medoids, Hierarchical clustering, Density based clustering, Association Rules, Dimensionality Reduction - Principal Component Analysis **Evaluation:** Cross-Validation, Measures of Performance for Classification (Accuracy, Confusion Matrix, Precision, Recall, F1-Score), Measures of Performance for Clustering (Homogeneity, Completeness, V-Measure)	
5	**Reinforcement learning** Q Learning, Non deterministic rewards and Actions	
6	**Deep Neural Networks** Introduction to Deep Learning, Deep Neural Network, Restricted Boltzmann machine, Convolution Neural Network, Auto Encoders, Deep Belief Network, Recurrent Neural Network, Transfer learning. Applications and case studies for ML & DL	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
	1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008. 2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e. 3. Tom Mitchell, Machine Learning, TMH 4. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification and Scene Analysis, Wiley	

5. Kishan Mehrotra, Chilukuri Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, Penram International
6. Rajjan Shinghal, Pattern Recognition, Techniques and Applications, OXFORD
7. Athem Ealpaydin, Introduction to Machine Learning, PHI
8. Andries P. Engelbrecht, Computational Intelligence - An Introduction, Wiley Publication
9. Prince , Computer Vision: Models, Learning, and Inference, Cambridge University Press, Theodoridis and Koutroumbas
10. Theodoridis, Pikrakis, Koutroumbas, and Cavouras, "Pattern Recognition", 4th ed., Academic Press.

Subject Code	7A35NWS		**Subject Name**	Network Security			
Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Introduction:** Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security **LAN security mechanisms and attacks:** VLAN hopping, Tag stack attack, Broadcast floods, ARP spoofing, DHCP DoS, DHCP and DNS hijacking, Spanning tree attacks, Control Plane Policing, Link Layer Security, Port/BPDU guard, 802.1AE/encryption, NetFlow, RMON	
2	**IP Security:** IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange (IKE), Transport and Tunnel mode, Virtual Private Networks	
3	**Transport-Level Security:** Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS standard, Secure Shell (SSH) application. **Electronic Mail Security:** Pretty Good Privacy, S/MIME, DomainKeys Identified Mail	
4	**Network Defence Tools:** Intrusion Detection ,Password Management, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations, ACLs	

5	**Mobile & Wireless Networks:** Mobile communication security: 3G, 4G, 5G; Kasumi, platform security, apps security; phone hardware security. Cellular Jamming, Attacks, Mitigation, Secure Mobile VoIP Services, Mobile App Security, 802.11 attacks	
6	**Cloud Infrastructure:** Introduction to Cloud Computing, Datacenter networks and relevant Standards: Topologies, Network Expansion, Traffic, Routing and Addressing, Cloud Security: Existing solutions, FlowIPS	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Cryptography and Network Security, Atul Kahate, 4th Edition, McGraw Hill.
2. Network Security, Private Communication in a public world, Mike Speciner, Radia Perlman, Charlie Kaufman, 2nd Edition, Prentice Hall PTR.
3. Cryptography and Network Security: Principles and Practice, William Stallings,8th Edition, Pearson
4. Cryptography and Network Security, Behrouz A Forouzan, 3rd Edition, McGraw Hill.
5. Network Security, Firewalls And VPNs, J. Michael Stewart, Jones & Bartlett Learning,
6. How to Cheat at Securing a Wireless Network, Chris Hurley, EDN.
7. Internetworking with TCP/IP Volume One, Douglas E Comer, 6th Edition, Pearson Education India
8. Cloud Services, Networking, and Management, Nelson L. S. da Fonseca, Raouf Boutaba, Wiley-IEEE Press

Subject Code	G7AD36BDA	**Subject Name**	Big Data Analytics

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content:

Unit	Subject Content	105 Hrs
1	**Big Data and Analytics** Introduction to Big Data, Big Data Characteristics, Types of Big Data, Traditional Versus Big Data Approach, Technologies Available for Big Data, Infrastructure for Big Data, Use of Data Analytics, Big Data Challenges.	
2	**Introduction to Hadoop and Hadoop Architecture** Big Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization	

3	**HDFS, HIVE AND HIVEQL, HBASE** HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper , how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper	
4	**Apache Spark, No SQL** Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDD, Spark SQL, Spark Streaming. Types of NoSQL databases, Advantages of NoSQL, Use of NoSQL in Industry, SQL vs NoSQL	
5	**MongoDB and Neo4j** Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents , MongoDB Query Language	
6	**Graph Analytics and Data Visualization** Apache Spark GraphX: Property Graph, Graph Operator, SubGraph, Triplet Neo4j: Modeling data with Neo4j, Cypher Query Language: General clauses, Read and Write clauses. Big Data Visualization with D3.js, Kibana and Grafana	

Practical Content:

- 10-15 practicals being taught from subject content.

Reference Books:

1. Tom White "Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
3. Bart Baesens , Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, ,Wiley, 2014
4. Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.
5. Chuck Lam, Hadoop in Action, December, 2010.
6. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press.

Subject Code	G7B37REM/ G7B38XWS/ G7B39ACR	**Subject Name**	**Elective III** • Reverse Engineering & Malware Analysis • XML & Web Services • Advanced Cryptology

Teaching scheme					**Examination scheme (Marks)**			
(Per week)	**Lecture**		**Practical (Lab.)**	**Total**		**INT**	**EXT**	**Total**
	L	TU	P					
Credit	03	00	01	04	Theory	20	50	70
Hours	03	00	02	05	Practical	10	20	30

Content: Reverse Engineering & Malware Analysis		
Unit	**Subject Content**	**75 Hrs**
1	**Introduction to Malware:** • Basics of Malware • Types of Malware • Basic of Static Analysis • Basic of Dynamic Analysis • Basic Analysis Methodology • Automated Malware Analysis **Introduction to Reverse Engineering:** • Basic of Reverse Engineering • Machine Code • Assembly Language: Assembly Basics, Registers, Operands, Instruction, Arithmetic Instructions • System and Code Level Reversing, Legality of Reverse Engineering, Reversing Tools – IDA • Debugging Concepts, Stepping, Breakpoints and Exceptions, Modifying Execution, Ollydbg	
2	**Fundamentals of Malware Analysis:** • Assembling a toolkit for effective malware analysis • Examining static properties of suspicious programs • Performing behavioral analysis and dynamic code analysis of malicious Windows executables	
3	**Reversing Malicious Code:** • Understanding core x86 assembly concepts to perform malicious code analysis • Identifying key assembly logic structures with a disassembler • Following program control flow to understand decision points during execution • Recognizing common malware characteristics at the Windows API level (registry manipulation, keylogging, HTTP communications, droppers) • Extending assembly knowledge to include x64 code analysis	
4	**Malicious Web and Document Files:** • Study malicious websites to assess the nature of their threats • De-obfuscating malicious JavaScript • Analysing suspicious: PDF files, RTF document files and Microsoft Office documents	
5	**In-Depth Malware Analysis:** • Identifying packed malware • Getting started with unpacking • Using debuggers for dumping packed malware from memory • Examing obfuscated PowerShell scripts • Analysing multi-technology and file less malware • Code injection and API hooking • Using memory forensics for malware analysis	

	• Malware sandbox, advanced dynamic malware analysis (Covert Malware Launching and Malware-Focused Network Signatures)	
6	**Examining Self-Defending Malware:** • How malware detects debuggers and protects embeddeddata • Unpacking malicious software • Bypassing the attempts by malware to detect and evadethe analysis toolkit • Handling code misdirection techniques • Unpacking malicious executable by anticipating thepacker's actions	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
	1. Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware by Monnappa K A 2. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski 3. Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code by Michael Hale Ligh, Matthew Richard, Blake Hartstein, Steven Adair 4. Reversing: Secrets of Reverse Engineering by Eldad Eilam 5. Reverse Engineering for Beginners by Dennis Yurichev	
Content: XML & Web Services		
Unit	**Subject Content**	**75 Hrs**
1	Introduction: Role of XML - XML and The Web - XML Language Basics - SOAP - Web Services - Revolutions of XML - Service Oriented Architecture (SOA).	
2	XML Technology : XML Technology, XML - Name Spaces - Structuring With Schemas and DTD - Presentation Techniques - Transformation – XML Infrastructure	
3	SOAP: Overview of SOAP - HTTP - XML-RPC - SOAP: Protocol – Message Structure - Intermediaries - Actors - Design Patterns And Faults - SOAP With Attachments.	
4	WEB Services: Overview - Architecture - Key Technologies - UDDI - WSDL - ebXML - SOAP And Web Services In E-Com - Overview Of .NET And J2EE.	
5	XML Security: Security Overview - Canonicalization - XML Security Framework - XML Encryption - XML Digital Signature - XKMS Structure	
6	Guidelines For Signing XML Documents - XML In Practice	
Practical Content:		
• 10-15 practicals being taught from subject content.		
Reference Books:		
	1. Frank. P. Coyle, XML, Web Services And The Data Revolution, Pearson Education, 2002. 2. Ramesh Nagappan , Robert Skoczylas and Rima PatelSriganesh, Developing Java	

	WebServices, Wiley Publishing Inc. 3. Sandeep Chatterjee, James Webber, Developing EnterpriseWebServices, Pearson Education. 4. McGovern, et al., Java Web Services Architecture, Morgan Kaufmann Publishers. 5. Gustavo A, Fabio C, Harumi K, Vijay M. Web Services: Concepts, Architectures and Applications. Springer (Universities Press).	
Content: Advanced Cryptology		
Unit	**Subject Content**	**75 Hrs**
1	Data encryption standard. Double encryption. Triple encryption. Linear feedback shift register. Non-linear feedback shift register. Modern stream ciphers- Grain V1. Security in mobile telephony. Design specification of ZUC cipher (4G standard).	
2	Pilling up lemma. Discussion on CPA & CCA security. Cryptanalysis on block ciphers- linear and differential. Cryptanalysis on stream ciphers- correlation and algebraic.	
3	Number Theory: Elliptic curve group. Square and multiply algorithm. Baby step giant step algorithm.	
4	Public key encryption: Discussion about formulating security model, semantic security, indistinguishability and decisional & search version of Diffie-Hellman assumption. RSA encryption and its security proof. Elgamal encryption and its security proof. Bilinear pairing. Digital Signature- security model, RSA digital signature and its security proof, elliptic curve digital signature algorithm (ECDSA). Identity based encryption. Attribute based encryption. Fully homomorphic encryption. Predicate encryption. Functional encryption.	
5	Signal protocol. Commitment schemes. Zero knowledge proofs. Introduction to post quantum cryptography: Mathematical assumptions- SVP, CVP, SIS, LWE. Regev's encryption. GPV signature scheme and its security proof. Gentry-Sahai-Waters(GSW) fully homomorphic encryption scheme.	
LAB	**Title**	**HOURS**
1	Triple DES, Linear cryptanalysis, Differential cryptanalysis, Correlation attack, Algebraic attack	
2	RSA Digital signature, ECDSA	
3	Signal Protocol	
4	Zero knowledge proofs	
5	Regev's encryption and GPV signature	
Pre-requisites		
This course requires mathematical maturity and you must have completed the first course "Introduction to Cryptography". The course will be self-complete but you should be comfortable with the following mentioned courses- Elementary Number Theory, Linear Algebra, Probability & Statistics, Abstract Algebra, Discrete Mathematics and Algorithms.		
Study Materials		
1. Cryptography theory and practice, by D. R. Stinson. 2. Handbook of applied cryptography, by A. Menezes, P. V. Oorschot, and S. Vanstone. 3. Introduction to modern cryptography, by J. Katz and Y. Lindell. 4. The foundations of cryptography (Volume I), by O. Goldreich.		

5. A graduate course in applied cryptography, by D. Boneh and V. Shoup.
6. Lecture notes on cryptography, by S. Goldwasser and M. Bellare.
7. Algorithmic cryptanalysis, A. Joux.
8. https://signal.org/en/.
9. http://www.is.cas.cn/ztzl2016/zouchongzhi/201801/W020180126529970733243.pdf.
10. https://www.gsma.com/aboutus/wp-content/uploads/2014/12/eea3eia3zucv16.pdf.
11. A Decade of Lattice cryptography by Chris Peikert.
https://eprint.iacr.org/2015/939.pdf.

Learning Outcomes

On successful completion of this course, students should be able to understand
■ security definition and its types, and be familiar with cryptanalysis on stream and block ciphers. They should also be able to implement the cryptanalysis on stream and block ciphers
■ security in mobile communication (4G) and end to end encryption
■ security reduction in public key encryption. They will also learn an algorithm (exponential time) to solve discrete logarithm problem
■ computation in elliptic curve group and bilinear pairing
■ digital signature and its security model & security proof
■ commitment schemes and zero knowledge

Examination Evaluation Scheme as per Choice Based Credit System (CBCS)

RRU is gearing up for several initiatives towards academic excellence, quality improvement and administrative reforms. In view of this priority and in-keeping with RRU Vision and Mission; process was already initiated towards introduction of semester system, grading system and credit system. The above initiatives acquired further strength with UGC Circular D. O. No. F.1-2/2008(XI Plan) dated March 2009 informing all the Universities regarding UGC's new initiatives under the 11th Five Year plan, on speedy and substantive academic and administrative reforms regarding higher education. Given this background RRU has framed this "RRU CBCS REGULATION- 2021". As the RRU has adopted this regulation, the same will have to be implemented by all the Faculties of RRU for their academic Programmes. The Evaluation scheme shall be follows as per

1. Examination Evaluation:

1.1 Continuous Internal Assessment (CIA)

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by a continuous internal assessment (CIA) by the concerned course teacher as well as by an end semester examination and will be consolidated at the end of the course. The components for continuous internal assessment are as follows.

BACHELOR LEVEL PROGRAMME (B.TECH)								
CONTINUOUS ASSESSMENT								
No	**Credit**	**Internal Part**				**External Part**		
		Written Tests/ MCQ based Quiz	Seminar/ Group Discussion/ Presentation Classroom Activity	Assignment /Project/ FieldVisit & Report Writing	**Total Marks**	University Practical/ Viva Examination	**External Exam**	**Total Marks**
1	**5 Credits**	**10**	**10**	**10**	**30**	**20**	**50**	**70**
2	**4 Credits**	**10**	**10**	**10**	**30**	**20**	**50**	**70**
3	**3 Credits**	**30**				**70**		
4	**Mini Project 4 Credits**	**30**				**70**		

5	**Major Project 8 Credits**	**30**	**70**

1.2 Question Paper Pattern:

Each Question Paper will have total four questions as per the following table. Each Student shall have to secure minimum 50% marks from External Examination for passing the subject. (i.e., 35 marks out of 70 marks).

BACHELOR LEVEL PROGRAMME B.TECH			
EXTERNAL EXAMINATION QUESTION PAPER PATTERN			
Question No.	**Marks**	**Pattern**	**Extra Question**
1	10	Simple Answer (10*1 Marks=10)	No
2	10	Short Answer (5*2 Marks =10)	1
3	15	Answer in detail (5*3 Marks=15)	1
4	15	Long Answer (3*5 Marks=15)	1
Total	**50**		

1.3 Passing Minimum:

The students shall be required cumulatively 50 % passing marks of the total marks of the individual subject including both Internal Assessment and End Semester Examination. However, a student must appear in End Semester Examination otherwise the student's result will be declared as absent for a particular subject(s)."For the award of grade, calculation of CGPA and award of degree the candidate must score a minimum SGPA of 5.0 in each semester separately.

1.4 Grading:

- The RRU adopts absolute grading system wherein the marks are converted to grades, and every semester result will be declared with semester grade point average (SGPA) and Cumulative Grade Point Average (CGPA). The CGPA will be calculated every semester, except the first semester.
- The grading system is with the following letter grades as given below:

Marks Out of 100	**Division/ Class**	**Grade Point**	**Letter Grade**	**Description**
90 to 100	Distinction	10	O	Outstanding
80 to <90		9	A+	Excellent

70 to <80		8	A	Very Good
60 to <70	First	7	B+	Good
55 to <60	Second	6	B	Above Average
50 to <55	Pass	5	C	Pass
Less than 50	Fail	0	F	Fail
Absent	Ab	0	Ab	Absent

- A student obtaining Grade "F" shall be considered failed and will be required to reappear in the examination.
- Number of attempts taken to clear a subject/s shall be shown in the transcripts and grade cards.

2. Declaration of Semester Results:

For Students, who have appeared both in the current Semester Examination and for their backlog courses of the Previous Semesters and having result status as Fail-Detained in the previous Semesters, the result of such students shall be declared as Fail-Detained instead of Withheld in the current semester and the student shall be allowed to appear in the Remedial.

Students failing in the end semester examinations shall be given the option of either to appear in remedial examination arranged by the University in which the marks obtained in the internal examination shall be carried forward or opportunity shall be given to repeat the course in line with the policy of detention due to lack of attendance in which student shall improve the internal marks.

2.1 Grade Point: Grade point is an integer indicating the numerical equivalent of the letter grade.

2.2 Credit Point (P): Credit point is the value obtained by multiplying the grade point (G) by the credit (C): P = G x C.

2.3 Semester Grade Point Average (SGPA): Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

2.4 Cumulative Grade Point Average (CGPA): 'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicates the comprehensive academic performance of a student in a programme.

An overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his/her CGPA.

2.5 Calculation of semester grade point average (SGPA) and cumulative grade point average

(CGPA):

- Performance in a semester will be expressed as Semester Grade Point Average (SGPA).
- Cumulative performance of all the semesters together will reflect performance in the whole programme and will be known as Cumulative Grade Point Average (CGPA). Thus, CGPA is the real indicator of a student's performance.
- The formula for calculation of SGPA and CGPA is given below:

  SGPA = (Σ Ci Mi) / (Σ Ci) CGPA = (Σ Σ Cni Gni) / (Σ Σ Cni) Where

  Ci - number of credits for the ith course, Gi - grade point obtained in the ith course, Cni - number of credits of the ith course of the nth semester, Gni - grade points of the ith course of the nth semester
- Refer the following examples for better understanding of CGPA/SGPA.

Example:

SGPA Total credit points earned by a student in a Semester Total Credit

For Example: Semester - I					
Course	**Credit**	**Marks Obtained by Students**	**Grade Letter**	**Grade Point**	**Credit Grade**
Core Comp.	4	59	B	6	6×4 = 24
Core Allied	4	52	C	5	5×4 = 20
Elective Generic	4	82	A+	9	9×4 = 36
Elective Option	4	70	B+	7	7×4 = 28
Foundation Generic	2	51	C	5	5×2 = 10
Total	**18**				**118**

SGPA = 118/18 = 6.55

Thus, SGPA for Semester – I is 6.55

Percentage for Semester I is 6.55 × 10 = 65.5

Cumulative grade point average (CGPA) is Obtained by dividing the total no. points earned in all the Semester by the total number of credits in all Semester.

For Example: Semester - II					
Course	**Credit**	**Marks Obtained by Students**	**Grade Letter**	**Grade Point**	**Credit Grade**
Core Comp.	4	51	C	5	5×4 = 20
Core Comp.	3	95	O	10	10×4 = 40

Core Allied	4	82	A+	9	9×4 = 36
Elective Generic	4	52	C	5	5×4 = 20
Elective Option	3	40	F	0	0×3 = 00
Foundation Generic	2	59	B	6	6×2 = 12
Total	**20**				**128**

Thus, SGPA= 128/20=6.4

Illustration No.2(a)

For Example: Semester – II (Repeat Exam)					
Course	**Credit**	**Marks Obtained by Students**	**Grade Letter**	**Grade Point**	**Credit Grade**
Elective Option	3	60	B+	7	7×3 = 21
Result	20				Ci (First Attempt)128 + Ci (subsequent attempt) 21= 149

Thus, SGPA= 149/20=7.45

CGPA= $\frac{6.55x18 + 7.45x20}{38}$ =117.9 +149/38 = 7.02 CGPA

Sample calculation for SGPA

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit X Grade)**	**SGPA(Credit Point/Credit)**
Semester I					
1A01ENM	06	B	6	36	
1A02FOE	06	B+	7	42	
1A03CFC	06	C	5	30	
1A04COP	02	**B**	6	12	
Total	**20**			**120**	**6.0 (120/20)**
Semester II					
2A01DMM	06	B	6	36	
2A02DGS	06	B	6	36	
2A03DCM	06	C	5	30	
2A04OOP	02	A+	9	18	
Total	**20**			**120**	**6.0 (120/20)**
Semester III					
3A01OPS	06	A	8	48	
3A02PSN	06	A+	9	54	
3A03JPM	06	A	8	48	
3A04DBM	02	A	8	16	
Total	**20**			**166**	**8.3 (166/20)**
Semester IV					

4A01SEN	06	C	5	30	
4A02PPL	06	B	6	36	
4A03DAA	06	B+	7	42	
4A04ITC	02	A+	9	18	
Total	**20**			**126**	**6.3 (126/20)**
Semester V					
5A01DAV	06	B	6	36	
5A02CNW	06	A+	9	54	
5A03DIP	06	A	8	48	
5A04ARI	02	B	6	12	
Total	**20**			**150**	**7.5 (150/20)**
Semester VI					
6A01IOT	06	B+	7	42	
6A02LNT	06	B	6	36	
6A03SCS	06	C	5	30	
6B04FOS	02	C	5	10	
Total	**20**			**118**	**5.9 (118/20)**
CGPA					
Grand Total	**120**			**800**	**6.67 (800/120)**

Sample calculation for CGPA

Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI
Credit:20; SGPA: 6.0	**Credit:20; SGPA: 6.0**	**Credit:20; SGPA: 8.3**	**Credit:20; SGPA: 6.3**	**Credit:20; SGPA: 7.5**	**Credit:20; SGPA: 5.9**

Thus CGPA= (20x6.0+20x6.0+20x8.3+20x6.3+20x7.5+20x5.9)/120
=6.67