B TECH in COMPUTER AND COMMUNICATION ENGINEERING

THIRD SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	MAT 2155	Engineering Mathematics - III	2	1	0	3
	ICT 2153	Data Structures	3	1	0	4
	ICT 2171	Digital Systems and Computer Organization	3	1	0	4
II	ICT 2155	Object Oriented Programming	3	1	0	4
	ICT 2156	Principles of Data Communication	3	1	0	4
	ICT 2162	Data Structures Lab	0	1	3	2
	ICT 2165	Digital System Design Lab	0	1	3	2
	ICT 2164	Object Oriented Programming Lab	0	0	3	1
			14	7	9	24
	Total Contact Hours (L + T + P)		(14+7+9) = 30			

FOURTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
MAT 2256	Engineering Mathematics - IV	2	1	0	3
ICT 2255	Computer Network Protocols	4	0	0	4
ICT 2271	Database Systems	3	0	0	3
ICT 2257	Design and Analysis of Algorithms	3	0	0	3
ICT 2258	Operating Systems	3	1	0	4
****	Open Elective - I				3
ICT 2263	Algorithms Lab	0	0	3	1
ICT 2266	Database Systems Lab	0	1	3	2
ICT 2265	Operating Systems Lab	0	0	3	1
		15	3	9	24
Total Contact Hours (L + T + P) + OE		(15+3+9)+3=30			

FIFTH SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	HUM 3152	Essentials of Management	2	1	0	3
	ICT 3171	Data Mining and Predictive Analysis	3	0	0	3
	ICT 3172	Information Security	3	0	0	3
III	ICT 3173	Network Programming and Advanced Communication Networks	3	0	0	3
	ICT 3174	Software Design Technology	3	1	0	4
	****	Open Elective - II				3
	ICT 3166	Advanced Programming Lab	0	1	3	2
	ICT 3167	Data Mining and Predictive Analysis Lab	0	1	3	2
	ICT 3168	Network Design and Programming Lab	0	0	3	1
			14	4	9	24
	Total Contact Hours (L + T + P) + OE		(14+4+9)+3=30			

SIXTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
HUM 3151	Engg. Economics and Financial Management	2	1	0	3
ICT 3271	Embedded Systems Design	3	0	0	3
ICT 3272	Wireless Communication and Computing	3	1	0	4
ICT ****	Program Elective - I	3	0	0	3
ICT ****	Program Elective –II	3	0	0	3
****	Open Elective - III				3
ICT 3267	Embedded Systems and Iot Lab	0	1	3	2
ICT 3268	Mobile Application Development Lab	0	0	3	1
ICT 3269	Network Simulation Lab	0	0	3	1
		14	3	9	23
Total Contact Hours (L + T + P) + OE		(14+3+9)+3 =29			

SEVENTH SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	ICT ****	Program Elective - III	3	0	0	3
	ICT ****	Program Elective - IV	3	0	0	3
IV	ICT ****	Program Elective- V	3	0	0	3
	ICT ****	Program Elective- VI	3	0	0	3
	ICT ****	Program Elective- VII	3	0	0	3
	****	Open Elective - IV				3
			15	0	0	18
	Total Contact Hours (L + T + P) + OE		(15+0) + 3 = 18			

EIGHTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
ICT 4298	Industrial Training	0	0	0	1
ICT 4299	Project Work / Practice School	0	0	0	12
ICT 4296	Project Work (Only for B. Tech honour Students)				20
		0	0	0	13
Total Contact Hours (L + T + P) + OE					

Minor Specializations

I. Advanced Network Systems
ICT 4041: Mobile Computing
ICT 4042: Multimedia Communication
ICT 4043: Next Generation Telecom Networks
ICT 4044: Software Defined Networking

II. Computational Intelligence
CSE 4053: Artificial Intelligence
ICT 4031: Computer Vision
ICT 4032: Machine Learning
CSE 4054: Soft Computing Paradigms

III. Computer Graphics & Visualization
CSE 4051: Augmented and Virtual Reality
ICT 4033: Computer Graphics
ICT 4031: Computer Vision
CSE 4052: Digital Image Processing

IV. Data Analytics
ICT 4034: Big Data Analytics
ICT 4035: Information Retrieval
ICT 4032: Machine Learning
ICT 4036: Semantic Web

V. Material Science
PHY 4051: Physics of Low Dimensional Materials
PHY 4052: Physics of Photonic & Energy Storage Devices
CHM 4051: Chemical Bonding
CHM 4052: Chemistry of Carbon Compound

VI. Business Management
HUM 4051: Financial Management
HUM 4052: Human Resource Management
HUM 4053: Marketing Management
HUM 4054: Operation Management

VII. Computational Mathematics
MAT 4051: Applied Statistics and Time Series Analysis
MAT 4052: Computational Linear Algebra
MAT 4053: Computational Probability and Design of Experiments
MAT 4054: Graphs and Matrices

Programme Electives
ICT 4045: Cloud Computing
ICT 4046: Deep Learning
ICT 4047: Game Theory with Computer Applications

ICT 4048: High Performance Computing
ICT 4049: Human Computer Interaction
ICT 4050: Internet of Things
ICT 4051: Natural Computing
ICT 4052: Neural Networks and Fuzzy Logic
ICT 4053: Pattern Recognition
ICT 4054: Social Network Analysis
ICT 4055: Software Reliability

Open Electives
ICT 4301: Computer Graphics and Animation
ICT 4302: Design and Development of Web Applications
ICT 4303: Fundamentals of Data Structures and Algorithms
ICT 4304: Machine Learning Tools and Technologies
ICT 4305: Networking with TCP/IP

MAT 2155: ENGINEERING MATHEMATICS-III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Well-formed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path. Group theory: Semi groups, Monoids, Groups- subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. LiuC.L., Elements of Discrete Mathematics (2e), McGraw Hill, New Delhi, 2007.
2. Trembaly J.P. and Manohar R., Discrete Mathematics Structures with application to computer Science, Tata McGraw Hill, 2012.
3. Page E.S. and Wilson L. B., An Introduction to Computational Combinatorics, Cambridge Univ. Press, 1979.
4. Narasingh Deo, Graph theory with Applications to Computer Science, PHI, 2012.

ICT 2153: DATA STRUCTURES [3 1 0 4]

Introduction, Programming fundamentals, Stacks, Queues and their applications, Sparse Matrix, Pointers and dynamic memory allocation, Linked Lists: Singly linked lists, Dynamically Linked Stacks and Queues, Polynomial representation and polynomial operations using singly linked list, Singly Circular Linked List, Doubly Linked Lists, Trees: Binary trees, Heaps, Binary Search Trees, Threaded binary trees, Graphs: Depth First Search, Breadth First Search, Connected components, Spanning trees, Sorting and searching Techniques.

References:

1. Horowitz E., Sahni S., Mehta D., Fundamentals of Data Structures in C++ (2e), Golgotha Publications, 2008.
2. Weiss M. A., Data Structures and Algorithm Analysis in C++ (3e), Pearson Education, 2009.
3. Michael T. Goodrich, Tamassia R., Mount D., Data Structures and Algorithms in C++ (2e), John Wiley & Sons, 2011.
4. Horowitz E., Sahni S., Anderson-Freed S., Fundamentals of Data structures in C (2e), Silicon Press, 2008.

ICT 2171: DIGITAL SYSTEMS AND COMPUTER ORGANIZATION [3 1 0 4]

Introduction, Simplification of Boolean functions – K-map method, NAND and NOR implementation, Combinational logic, Design of Adders/Subtractors, code converters, Application of typical TTL integrated circuit components like Binary Parallel adder[74283], multiplier using 74283, Magnitude Comparator [7485], Decoders [74138,7442], Encoders [74148], Multiplexers [74157], combinational shifter design, De Multiplexers, Sequential logic - counters and shift registers, Computer organization- Introduction, ALU unit, Control unit, Hardwired and Micro – programming approach, Memory unit, Input and Output unit.

References:

1. Mano M.R.,Kime C.R.,Martin T.,Logic & Computer Design Fundamentals (5e), Prentice Hall India, 2015.
2. Tocci R.J., Widmer N.S., Greegory L.M., Digital Systems: principles and Applications(12e), Pearson Education India, 2017.
3. Rafiquzzaman M., Chandra R., Modern computer Architecture (3e), Galgotia publications Pvt Ltd, 2010.

ICT2155: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

Introduction to the java programming language, Importance of Java in the internet, Data types, Variable and arrays, Type conversion and casting, Operators and control statements, Classes and inheritance, Packages and interfaces, Collections Framework - array list, vector and dictionary, String handling, Exception handling, Thread concepts – synchronization, inter thread communication, Input/output – File:file input stream, File output stream, Random access files, Reader, Writer, Serialization, Serializable, Object input stream, Object output stream, Swings - swing fundamentals, Introduction to event handling.

References:

1. Schildt H., Java-The Complete Reference (9e), Tata McGraw-Hill 2014.
2. Horstmann C. S. & Cornell G.,Core Java Volume I – Fundamentals (9e), Prentice Hall 2013.
3. Horstmann C. S. & Cornell G., Core Java Volume II– Advanced Features (9e), Prentice Hall 2013.

ICT 2156: PRINCIPLES OF DATA COMMUNICATION [3 1 0 4]

Introduction to Data Communication, Signals, Basic properties of data communication system, NY Quist rate, Shannon Capacity, Signal encoding and TX and RX models, Modulation schemes. Properties of Media and digital transmission systems, wired and wireless medium, Error detection and correction, Block codes, CRC, Hamming code, Stop and wait flow control, Sliding window flow control, ARQs, HDLC, Multiplexing, Media Access Sub layer and LAN, Approaches to sharing transmission medium, Random access protocols, Token passing protocols, IEEE LAN standards, Bridges, MAN, FDDI.

References:

1. Stallings W., Data & Computer Communications (9e), Pearson Education Inc., Noida, 2017.
2. Frozen B., Introduction to data communication & networking (4e), Tata McGraw Hill, New Delhi-2014.
3. Garcia A. L., Widjaja I., Communication Networks (2e), Tata McGraw Hill, 2011.

ICT 2162: DATA STRUCTURES LAB [0 1 3 2]

Application using arrays, String operations, Class concepts: Creation, Initialization using constructors, Applications of stacks, Arithmetic expression conversion and evaluation using stack, queues, Sparse matrix representation, Transpose of a sparse matrix, Singly linked lists and applications, Circular linked lists, Doubly linked lists, polynomial addition and multiplications using circular linked lists, Binary Tree: creation, deletion and traversal techniques, Binary search tree operations, sorting and searching techniques.

References:

1. Horowitz E, Sahni S., Mehta D., Fundamentals of Data Structures in C++ (2e), Golgotha Publications, 2008.
2. Weiss M. A.,Data Structures and Algorithm Analysis in C++ (3e), Pearson Education, 2009.
3. Horowitz E., Sahni S., Anderson-Freed S., Fundamentals of Data structures in C (2e), Silicon Press, 2008.

ICT 2165: DIGITAL SYSTEM DESIGN LAB [0 1 3 2]

Verification of Boolean algebra and De Morgan theorems, Simplification of Boolean expressions using K-maps, combinational logic circuit implementation like BCD adder, multiplier, code converter, comparator, comparator with cascading inputs using 4 bit binary adder [7483], 3 to 8 decoder [74138], magnitude comparator [7485], Multiplexers [74151, 74153, 74157] ICs, Sequential logic circuits that include conversion of flip-flops, analyzing timing diagram using output waveform, Asynchronous and Synchronous counters [7490, 9495, 74193 ICs], Shift registers, sequence generators, sequence detector.

References:

1. Mano M.R.,Kime C.R.,Martin T.,Logic & Computer Design Fundamentals (5e), Prentice Hall India, 2015.
2. Tocci R.J., Widmer N.S., Greegory L.M., Digital Systems: principles and Applications (12e), Pearson Education India,2017.
3. Wakerly J.F.,Digital Design Principles and Practices (4e), Pearson Education, 2014.

ICT 2164:OBJECT ORIENTED PROGRAMMING LAB [0 0 3 1]

Programs based on the following concepts: Data types, Type conversions, Operators, Control statements, Classes, Inheritance, Polymorphism, Threads, Interfaces and abstract classes, Collections: array list and vector, String handling, file handling, Swings.

References:

1. Schildt H., Java-The Complete Reference (9e), Tata McGraw-Hill 2014.
2. Horstmann C. S. & Cornell G.,Core Java Volume I – Fundamentals (9e), Prentice Hall 2013.
3. Horstmann C. S. & Cornell G., Core Java Volume II– Advanced Features (9e), Prentice Hall 2013.

FOURTH SEMSTER

MAT 2256: ENGINEERING MATHEMATICS-IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and two dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two Dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit Theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis: significance level, certain best tests; Chi square test.

References:

1. P.L.Meyer, Introduction to probability and Statistical Applications (2e), Oxford and IBH Publishing, 1980.
2. Miller, Freund and Johnson, Probability and Statistics for Engineers (8e), PHI, 2011.
3. Hogg and Craig, Introduction to mathematical statistics (6e), Pearson education, 2012.
4. Ross Sheldon M, Introduction to Probability and Statistics for Engineers and Scientists, Elseveir, 2010.

ICT 2255: COMPUTER NETWORK PROTOCOLS [4 0 0 4]

Introduction to Computer Networks: Definition, Network Layer, Network Layer services, Interfacing - Bridges, IP addressing, Subnetting and Supernetting, IPv6 addressing, Delivery Forwarding, and Routing of IP Packets, Internet Protocol - Datagram, Fragmentation, Options, Checksum, Introduction to Routing Protocols, Interior and Exterior routing, Dynamic IP Routing Protocols - RIP, RIP Version 2, OSPF, Routing between peers – BGP, ARP and RARP, Internet Control Message Protocol, User Datagram Protocol, Transmission Control Protocol and Introduction to application layer, Domain Name System (DNS), DHCP, FTP, SNMP.

References:

1. Behrouz A. F., TCP/IP Protocol Suite (4e), Tata McGraw-Hill 2017.
2. Andrew S. T., Computer Network (5e), Prentice Hall of India Pvt Ltd 2013.
3. Behrouz A. F., Data Communications and Networking (5e), Tata McGraw Hill 2013.
4. Garcia L.,Widjala, Communication Networks (2e), Tata McGraw Hill 2004.

ICT 2271: DATABASE SYSTEMS [3 0 0 3]

Introduction to database system, Database users, Database architecture, Relational database, Keys, Schema, Formal relational query language, SQL basics, Constraints, Intermediate SQL, Joins, Nested queries, Advanced SQL, Functions, Procedures, Triggers, High level data modelling using entity relationship model, Relational database design, Notion of functional dependencies, Normalization, Transaction management, ACID properties, Serializability, Concurrency control, Locking, Deadlock handling, Unstructured database, Introduction to NoSQL, Basics of document-oriented database, MongoDB.

References:

1. Silberschatz A., Korth H. F., Sudarshan S., Database system concepts (6e), McGraw-Hill, 2013.
2. Elmasri, Ramez, Navathe S., Fundamentals of database systems (7e), Pearson, 2016.
3. Molina, Hector, Ullman J. D., Widom J., Database systems, The Complete Book (2e),Pearson Prentice Hall, 2013.
4. Chodorow K., MongoDB: The definitive guide (2e), O'Reilly, 2013.

ICT 2257: DESIGN AND ANALYSIS OF ALGORITHMS [3 0 0 3]

Introduction, Graphs: Representation of graphs & Digraphs, Graph Search Methods: Breadth First Search, Depth First Search, Shortest path algorithms, Algorithm Design Techniques: The Greedy Method, Divide and Conquer, Dynamic Programming, Tree-Binary search trees, Heap Trees, Height Balanced Tree, B Trees, B+ trees. Hashing: hash functions, collision resolution techniques. Heaps and priority Queues, P, NP, NP-Complete and NP hard problems, Approximation Algorithms.

References:

1. Cormen T H., Leiserson C. E., Rivest R. L., Stein C., Introduction to Algorithms(3e), Prentice-Hall India, 2009.
2. Sahni S., Data Structures, Algorithms and Applications in C++(2e), Silicon Press, 2005.
3. Weiss M., Data Structures and Algorithm Analysis in C(3e), Pearson Education, 2009.

ICT 2258: OPERATING SYSTEMS [3 1 0 4]

Introduction to Operating systems - Operating System Services, Operating system Structure, System calls, Process management - Process concept, Threads, Inter-process communication, CPU Scheduling, Process synchronization, Handling deadlocks – Deadlock Characterization, Deadlock Detection, Prevention, Avoidance and Recovery, Memory management - Main memory, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Virtual memory – Demand Paging, Page Replacement, Thrashing, Allocating Kernel Memory, Storage Management- File management, Disk scheduling, Case study on Unix based Operating system – Design Principles, Kernel Modules, Basic concepts of Real time operating systems – Classification of Real Time Systems, Microkernels, Scheduling.

References:

1. Silberschatz A., Galvin P.B. & Gagne G., Operating System Concepts (9e), Wiley, 2012.
2. Stallings W.,Operating Systems: Internals and Design Principles (9e), Pearson, 2017.
3. Laplante P.A. &Ovaska S.J., Real time systems design and analysis (4e), Wiley, 2013.
4. Mall R.,Real time systems: Theory and Practice (2e), Pearson, 2009.

ICT 2263: ALGORITHMS LAB [0 0 3 1]

Graphs: Finding a Path, cycle. Greedy Method: 0/1 Knapsack Problem, Dijkstra's Algorithm, Minimum spanning tree using Prim's/Kruskal's Algorithm. Divide and Conquer Method: Merge Sort, Quick Sort, Strassen's Matrix multiplication method, Binary Search, Closest Pair of points. Dynamic Programming: Matrix Multiplication Chain Problem, 0/1 Knapsack problem, All pairs shortest path. Backtracking/Branch and Bound: Travelling sales person problem, 0/1 Knapsack Problem. Approximation Algorithm: Travelling sales person problem, Vertex cover problem.

References:

1. Cormen T. H., Leiserson C. E., Rivest R. L., Stein C, Introduction to Algorithms(3e), Prentice- Hall India, 2009.
2. Sahni S., Data Structures, Algorithms and Applications in C++ (2e), Silicon Press, 2005.

ICT 2266: DATABASE SYSTEMS LAB [0 1 3 2]

Basics of Visual C# for GUI design and control, Data Definition Language, Basic database query operations, Nested sub queries, Join Operations, Views, Stored procedures, Functions, Trigger, Cursors, Transaction control queries, Data Access from Visual C#, Introducing NoSQL-MongoDB, Design and development of application based on database concepts.

References:

1. Ivan B., SQL, PL/SQL: The Programming Language of Oracle(4e), BPB Publications, 2010.
2. Ken C., Csharp, Available :https://www.homeandlearn.co.uk/csharp/csharp.html [Online]

3. JavaTPoint, Oracle-tutorial, Available : https://www.javatpoint.com/oracle-tutorial [Online]
4. W3Schools, SQL Tutorial, Available : https://www.w3schools.com/sql/ [Online]
5. MongoDB, MongoDB Tutorials, Available: https://docs.mongodb.com/manual/tutorial/ [Online]

ICT 2265: OPERATING SYSTEMS LAB [0 0 3 1]

UNIX based operating system commands, executing shell scripts, inter process communication using system calls, implementing CPU scheduling algorithms, memory and deadlock management.

References:

1. Blurn R. & Bresnahan C., Linux Command Line Shell Scripting Bible, Wiley (3e), 2015.
2. Silberschatz A., Galvin P.B. & Gagne G., Operating System Concepts (9e), Wiley, 2012.

FIFTH SEMSTER

HUM 3152: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & Staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

References:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, McGraw Hill, New Delhi, 2012.
2. Peter Drucker, Management: Tasks, Responsibilities and Practices, Harper and Row, New York, 1993.
3. Peter Drucker, The Practice of Management, Harper and Row, New York, 2004.

ICT 3171: DATA MINING AND PREDICTIVE ANALYSIS [3 0 0 3]

Introduction to Data mining, Importance of data mining, Kinds of data to be mined, Major issues in Data Mining, Data objects and Attribute types, Data visualization, Data cleaning, Data integration, Data reduction, Data transformation strategies, Association rule mining: Apriori algorithm, Dynamic item set counting algorithm, Pincer – Search Algorithm, FP-tree growth algorithm, PC Tree, Cluster analysis, Partitioning methods: K-means, K-Medoid, Hierarchical methods, Density-Based methods: DBSCAN, Classification techniques: Decision tree induction, Bayes classification method, Model evaluation and selection, Regression techniques: Simple linear regression, Multivariable linear regression with gradient descent, support vector machine for regression, Introduction to web mining, temporal, spatial data mining

References:

1. Han J., Kamber M., Jian P.,Data Mining Concepts and Techniques (3e), Morgan Kauffmann Publishers 2011.
2. Pujari A. K.,Data Mining Techniques (4e), Orient BlackSwan/ Universities Press 2016.
3. Pang-N. T., Steinbach M., Anuj K, Vipin K., Introduction to Data Mining, Pearson Education (2e), Pearson 2016.
4. Kelleher J D., Brian M N, D' Arcy A., Fundamentals of Machine Learning for predictive Data Analytics: Algorithms, Worked Examples and Case Studies (1e), MIT Press, 2015.

ICT 3172: INFORMATION SECURITY [3 0 0 3]

Introduction to Information and Network Security, Symmetric-Key Ciphers: Classical and Modern encryption techniques, Block ciphers, Advanced Encryption Standard, Uses block ciphers, Asymmetric-Key Cryptographic Ciphers, Principles of public key cryptosystems, Number theory concepts, Uses of primes, Message Integrity and Message Authentication, Cryptographic hash functions, Application of cryptographic hash functions, Digital Signature, Key Management, Entity Authentication, Transport Level Security, System Security concepts, Firewalls, Network Intrusion detection and prevention systems.

References:

1. Stallings W., Cryptography and Network Security: Principles and Practice (7e), Pearson Publications, 2016. Pfleeger
2. C. P., Pfleeger S.L., Margulies J., Security in Computing (5e), Prentice Hall, 2015.
3. Michael E., Whitman and Mattord H.J., Principles of Information Security (5e), Cengage Learning, 2015.
4. Stamp M., Information Security: Principles and Practice (2e), John Wiley & Sons, 2011.
5. Forouzan B.A., Mukhopadhyay D., Cryptography and Network Security (2e), (Revised), Tata McGraw-Hill Education India, 2010.

ICT 3173:NETWORK PROGRAMMING AND ADVANCED COMMUNICATION NETWORKS [3 0 0 3]

High Speed Communication Networks: Queuing Models, Optical Networks, High Speed Network, Components, Integrated and Differentiated Services, Multiprotocol Label Switching, Virtual Private Networks, Signaling, Applications. UNIX Programming: Elementary Sockets, Elementary TCP, IPv4 and IPv6 Interoperability, Daemon Process, Multicasting, Multicast Routing, Multicast Socket Options, Advanced UDP Sockets, Datagram Truncation.

References:

1. Stevens R. W., Fenner B., Rudoff A. M., UNIX Network Programming Volume 1 (3e), Addison Wesley 2011.
2. Stallings W., High Speed Networks and Internet (2e), Pearson Education New Delhi 2002.
3. James P.G. Sterbenz, Touch J. D., High Speed Networking: A systematic approach to High Bandwidth Low Latency Communication (1e), John Wiley and Sons 2001.
4. Garcia L., Indra Widjaja, Communication Networks (2e), Tata Mc. Graw Hill publication 2002.
5. Yuan R. and Strayer T. W., VPN technologies and solutions (1e), Addison wesley publishing company incorporated 2001.

ICT 3174: SOFTWARE DESIGN TECHNOLOGY [3 1 0 4]

Introduction to Software Engineering, Process Models, Agile Process Model, Requirement Engineering, Analysis Modeling- Data Modeling, Scenario-based Modeling, Class based Modeling, Design Engineering-Design Models and Patterns, Architectural Design, Software Testing-Strategies and Techniques, Testing Object Oriented Applications, Software Project Management, Software Quality Assurance, Project Planning, Scheduling and Estimation Techniques.

References:

1. Pressman R.S., Software engineering - A practitioner's approach (8e), McGraw Hill, 2014.
2. Booch G., Rumbaugh J., Jacobson I., The Unified Modelling Language User Guide (1e), Pearson, 2015.
3. Jalote P., Software Project Management in Practice (1e), Addison Wesley Professional, 2009.
4. Hughes, Software Project Management (5e), McGraw Hill, 2017.
5. Kelkar S. A., Software Project Management: a concise study (3e), PHI learning-New Delhi, 2013.

ICT 3166: ADVANCED PROGRAMMING LAB [0 1 3 2]

List, Tuples, Sets, Strings , Dictionaries, Dictionary Operations, Boolean Expression, Control Flow, Functions, Parameter Options, Local, Nonlocal, Global Variables, Modules, Programs, Classes and Object Oriented Programming Static and Class Methods, Inheritance, Private Variables, Destructors and Memory Management, Exception Handling, File System, Regular Expressions, Packages, Graphical User Interface, Database Connectivity, Web Designing, Networking using Python Programming.

Students are expected to develop a mini project using the concepts practiced in the lab.

References:

1. Eric M.,Python Crash Course: A Hands-On, Project-Based Introduction to Programming (1e), William Pollock Publication, 2016.
2. Mark L., Learning Python(5e), O'REILLY publication, 2013.
3. Daryl H., Kenneth M. M. and Vernon C.,The Quick Python Book (2e), Manning Publications, 2011.
4. Allen B. D.,Think Python: How to think like a Computer Scientist (2e), O'REILLY publication, 2015.

ICT 3167: DATA MINING AND PREDICTIVE ANALYSIS LAB [0 1 3 2]

Pre-processing the raw-datasets using data mining software, Applying data mining techniques such as association rule mining, clustering, classification and Regression on the pre-processed data using software tools, Construction of physical data model, Populating data into tables using data flows, serial and parallel execution of data flows in control flow using data warehousing software, Implementation of Apriori algorithm, K-means, Decision tree, Simple linear regression, Design and development of Mini Project.

References:

1. Han J., KamberM., Jian P.,Data Mining Concepts and Techniques (3e),Morgan Kauffmann Publishers 2011.
2. PujariA. K.,Data Mining Techniques (4e), Orient BlackSwan/ Universities Press 2016.
3. Kelleher J. D., Brian M. N., D' ArcyA., Fundamentals of Machine Learning for predictive Data Analytics: Algorithms, Worked Examples and Case Studies (1e), MIT Press, 2015.
4. Silberschatz A., Sudarshan S., Database System Concepts (6e), McGraw Hill Education 2013.

ICT 3168: NETWORK DESIGN AND PROGRAMMING LAB [0 0 3 1]

Simulation of Ethernet LAN protocol, token bus and token ring protocols, implementation of distance vector algorithm, link state routing algorithm and finding shortest path using packet tracer; Socket programming; Python APIs for Socket programming.

Reference:

1. Stevens R., Stephen R. A., Advanced Programming in the UNIX Environment (2e), Pearson Education 2013.
2. Jesin A, Packet Tracer Network Simulator (1e), Packt Publishing 2014.
3. Faruque S M. O., Washington S.,Learning Python Network Programming (1e), Packt Publishing 2015.

SIXTH SEMESTER

HUM 3151: ENGG. ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

1. Prasanna Chandra, Fundamentals of Financial Management, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa, Engineering Economics, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran, Accounting and Financial Management, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H, Fundamentals of Financial Management (12e),Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain, Financial Management (5e),Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J, Engineering Economics, Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J, Engineering Economy, McGraw Hill, Delhi, 2002.
8. Chan S. Park, Fundamentals of Engineering Economics (3e), Pearson Publication, 2013.

ICT 3271: EMBEDDED SYSTEMS DESIGN [3 0 0 3]

An overview of ARM-Cortex- M Architecture, CISC versus RISC, The RISC and ARM design philosophy, ARM addressing modes, data transfer instructions, arithmetic and logical instructions, shift and rotate instructions, branch and conditional branch instructions, function call and return, stack, recursive functions, conditional execution, assembly language programming, Input/output (I/O) programming, timer/counter programming, I/O interfacing : LED, LCD, keyboard, stepper motor, ADC, and DAC, PWM, UART, Hardware and software synchronization, multithreading, Nested Vectored Interrupt Controller (NVIC), external hardware interrupts, IO interrupts, SysTick interrupts, implement architectural design for IoT.

References:

1. Jonathan W.V., Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers (4e), Createspace Independent Publishing Platform, June 2014.
2. Wilmshurst T.,Fast and Effective Embedded System Design applying the ARM mbed, Elsevier, 2017.
3. Jonathan W.V., Embedded systems: Introduction to Arm(r) Cortex-M Microcontrollers, Createspace Independent publishing platform (5e), June 2017.
4. UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 3.1, 2014.
5. Joseph V., A definitive Guide to ARM Cortex-M3 and Cortex-M4 processors (3e), Elsevier, 2014.

ICT 3272: WIRELESS COMMUNICATION AND COMPUTING [3 1 0 4]

Introduction to Wireless Systems, Advanced Modulation / Acess Techniques (MFSK, Spread Spectrum, OFDM), Convolutional Coding, Antenna and Propagation: Line of Sight and Non Line of Sight, Fading, Link Budget Analysis, Wireless networks Cellular Concepts, channel assignments, Handoff strategies, GoS, Improving Coverage & Capacity. Physical modelling for wireless channels, Statistical channel models. Point to point communication: diversity, Cellular Systems: multiple access and interference management, GSM systems, GPRS, CDMA, WCDMA, OFDM, Multiuser capacity and opportunistic communication. Modeling of MIMO fading channels, cooperative wireless communication.

References:

1. Dalal U., Wireless communication (1e), Oxford 2014.
2. Molisch A., Wireless Communications (2e), John Wiley & Sons Ltd. 2011.
3. Pahlavan K., Krishnamurthy P., Principles of Wireless Networks (1e), Prentice Hall 2009.
4. Goldsmith A., Wireless Communications (2e), John Wiley & Sons Ltd. 2011.

ICT 3267: EMBEDDED SYSTEMS AND IOT LAB [0 1 3 2]

Familiarization of data transfer from code segment to data segment and from data segment to data segment, arithmetic operations, logical instructions, branch instructions, code conversion from hexadecimal to decimal and decimal to hexadecimal, packing and unpacking of ASCII digits, sorting using selection sort and bubble sort techniques, searching using linear and binary search techniques, recursion, I/O interfacing of LEDs, LCD, keyboard, 7 segment display, stepper motor, DAC and ADC, PWM, implement architectural design for IoT. In addition to the above list of experiments, students are required to develop a mini project.

References:

1. Jonathan W.V., Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers (4e), Create space Independent Publishing Platform, June 2014.
2. Wilmshurst T.,Fast and Effective Embedded System Design applying the ARM mbed, Elsevier, 2017.

3. Jonathan W.V., Embedded systems: Introduction to Arm(r) Cortex-M Microcontrollers, Create space Independent publishing platform (5e), June 2017.
4. UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 3.1, 2014.
5. Joseph V.,A definitive Guide to ARM Cortex-M3 and Cortex-M4 processors (3e), Elsevier, 2014.

ICT 3268:MOBILE APPLICATION DEVELOPMENT LAB [0 0 3 1]

Introduction to Android Basics of Android Mobile Application Development Tool, Introduction to Activity and Layouts in Android and Event Handler, Input Controls in Android, Input Controls-Spinners, Pickers ,Menu, Creating Contextual and Pop-up Menus, Android Sqlite and Shared Preferences ,Security and Permissions, Services, Broadcast Receiver and Intent Filters, Camera, Bluetooth and Wi-Fi. Mini Project based on above concepts.

References:
1. Zheng P. and Ni L.M., Smart Phone and Next Generation Mobile Computing (1e), Morgan Kaufmann, 2006.
2. Horton J.,Android Programming For Beginners, Packt Publishing Ltd, 2015.
3. Griffiths D., Head First Android Development (2e), O'Reilly Media, Inc., 2015.

ICT 3269: NETWORK SIMULATION LAB [0 0 3 1]

Building wired topologies, wireless network topologies, tracing using NS3, NetAnim and supporting tools like SUMO/MOVE, Trace Route, 5G Network simulation using NS3-mmwave.

Reference:
1. Forouzan B. A.,TCP/IP Protocol Suite (4e), Tata McGraw – Hill 2017.

SEVENTH SEMESTER

There are five program electives and one open elective with total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

ICT 4298: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

ICT 4299: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

PROGRAM ELECTIVES

ICT 4041: MOBILE COMPUTING [3 0 0 3]

Introduction to Mobile Wireless Communication, Mobile IP and WAP, Internet mobility, Agent discovery and registration, Tunneling, mobile computing models, Client-Server models, location management for mobile networks, VANET: IEEE802.11p, Vehicular Mobility Modeling for VANET, Introduction to GPS, GPRS, Wireless LAN – IEEE802.15: Bluetooth, Zigbee, performance evaluation of technologies involved in mobile environment.

References:
1. RappaportT.S., Wireless Communications: Principles and Practices (2e), McGraw Hill Education Private Ltd. 2017.
2. Stallings W., Wireless Communications and Networks (2e), Pearson Education 2012.
3. Schiller J., Mobile Communication (2e), Pearson Education Pvt ltd. 2011.
4. Adelstein F., Gupta S. K. S., Richard G., Schwiebert L., Fundamental of Mobile and Pervasive Computing (1e), TMH 2008.
5. Hartenstein H., VANET: Vehicular Applications and Inter-Networking Technologies (1e), John Wiley and Sons 2010.

ICT 4042: MULTIMEDIA COMMUNICATION [3 0 0 3]

Introduction to Media and Data Streams, Overview of Multimedia processes and Coding, Multimedia Coding/ Compression Standards, Huffman Coding, Runlength Coding, JPEG, GIF, TIFF, MPEG, DVI, H.261, Text compression, Compression principles, Audio Video compression, Media Coding, Media processing, Synchronization issues, synchronization specification, Multimedia Operating system and database management, MDBMS, Multimedia Communications, Delay compensation, Prototype Multimedia systems, Video-on-Demand, Video conferencing, Media Data Modeling.

References:
1. Li N., Drew M. S., Fundamentals of Mutlimedia (2e), Pearson Education, 2014.
2. Steinmetz R., Nahrstedt K., Multimedia Computing, Communications and Applications(1e), Pearson Education, 2012.
3. Woods J. W., Multi-Dimensional Signal, Image and Video Processing and Coding (2e), Academic Press, 2011.
4. RaoK.R., Bojkovic Z., Milovanovic D. A., Multimedia Communication Systems (2e), Prentice Hall, 2012.

ICT 4043: NEXT GENERATION TELECOM NETWORKS [3 0 0 3]

Introduction to Next Generation Technologies, Next Generation Services, Telecommunication Optical Networks, Active and Passive Optical Network, HSPA Technology, HSDPA Channels, Resource management in HSDPA, 3GPP LTE, LTE System Architecture, WiMax overview, Design Principles of the WiMax Network Architecture, Application, Unlicensed Mobile Access (UMA), Convergence and IP Multimedia Sub Systems, Cognitive Radio, Principles of Interweaving, Spectrum sensing, Spectrum management, Spectrum sharing, Overview of New Technologies for 5G system.

References:
1. Cox C., An Introduction to LTE: LTE, LTE Advanced, SAE and 4G Mobile Communication (1e), John Wiley & Sons 2012.
2. Mishra A.R.., Cellular Technologies for Emerging Markets: 2G, 3G and Beyond (1e), John Wiley & Sons 2010.

3. Plevyak T., Sahin V., Next Generation Telecommunication Networks, Services and Management (1e), John Wiley & Sons 2010.
4. Molisch A.F., Wireless Communications (2e), Wiley 2013.
5. Saunders S., Carlaw S., Giustina A., Bhat R. R., Rao S. V., Siegberg R., Femtocells Opportunities and Challenges for Business and Technology (1e), John Wiley & Sons 2009.

ICT 4044: SOFTWARE DEFINED NETWORKING [3 0 0 3]

History and Evolution of SDN, Control and Data Plane Separation, Moving information between planes, Distributed control planes, Open Flow Architecture, Configuration and extension ability, Virtual Networking, SDN Controllers, Mininet, Network Programmability, Network Function Virtualization, OpenStack, CloudStack, Traffic Engineering, Use Cases of SDNs, Use Cases for Data Center Overlays.

References:

1. Hu F., Network Innovation through Open Flow and SDN: Principles and Design (1e), CRC Press 2014.
2. Nadeau T. D., Gray K., SDN: Software Defined Networks (3e), O'Reilly Media 2016.
3. Azodolmolky S.,Software Defined Networking with Open Flow (1e),Packt Publishing 2013.

CSE 4053: ARTIFICIAL INTELLIGENCE [3 0 0 3]

Foundations of Artificial Intelligence, History of Artificial Intelligence, The state of the Art. Agents and Environments, The concept of Rationality, The Nature of Environments, The structure of Agents. Problem Solving agents, Example Problems, Searching for Solutions, Uninformed search strategies, informed (Heuristic) search strategies, Heuristic functions. Games, Optimal decision in games, Alpha Beta Pruning Knowledge based agents, The Wumpus World, Logic, Propositional logic, Propositional Theorem Proving. Representation revisited, Syntax and semantics of First order logic, Using First order logic, Knowledge engineering in First order. Ontological Engineering, Categories and objects, Reasoning systems for categories, The internet shopping world. Acting under uncertainty, Basic probability notation, Baye's rule, representing knowledge in uncertainties, semantics of Bayesian networks.

References:

1. Russell S., and Norvig P., Artificial Intelligence A Modern Approach (3e), Pearson 2010.
2. Rich E., Knight K., Nair S.B., Artificial Intelligence (3e), Tata McGraw Hill, 2008.

ICT 4031:COMPUTER VISION [3 0 0 3]

Introduction to computer vision and its applications, Image formation, Liner Filtering, Image transformations and Colour models, Edge Detection methods (Laplacian detectors and canny edge detector), Points and patches, Harris corner detector, Histogram of Gradients, Difference of Gaussian detector, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC, Camera models, Camera calibration, Stereo vision, Stereo correspondence, Epipolargeometry, Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense Motion estimation, Support Vector Machines, Face detection and recognition, Bag of words, deep Learning.

References:

1. Szeliski R., Computer Vision: Algorithms and Applications, Springer 2011.

2. David A. F. and Ponce J., Computer Vision: A Modern Approach, PHI learning 2009.
3. Solem J. E., Programming Computer Vision with Python, O'Reilly, 2012.

ICT 4032: MACHINE LEARNING [3 0 0 3]

Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning-LMS, logistic regression, GDA, Naive Bayes, SVM, model selection, Learning theory-bias/variance tradeoff, union and Chernoff bounds, VC dimensions, Unsupervised learning-clustering, k-means, Gaussian mixture, factor analysis, PCA, ICA, Reinforcement learning-MDPs, Bellman equations, value and policy iteration, LQR, LQG, Q-learning, policy search, POMDPs.

References:

1. Murphy K.P, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Mohri M., Rostamizadeh A., and Talwalkar A., Foundations of Machine Learning, MIT Press, 2012.
3. Koller D., and Friedman N, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
4. Bishop C.M., Pattern Recognition and Machine Learning (2e), Springer, 2013.

CSE 4054: SOFT COMPUTING PARADIGMS [3 0 0 3]

Soft Computing, Artificial Intelligence, Soft-Computing Techniques, Expert Systems Types of Problems, Modeling the Problem, Machine Learning, Handling Impreciseness, Clustering, Hazards of Soft Computing, Road Map for the Future . Artificial Neural Networks, The Biological Neuron, The Artificial Neuron, Multilayer Perceptron, Modeling the Problem, Types of Data Involved, Training, Issues in ANN, Example of Time Series Forecasting. Types of Artificial Neural Networks, Radial Basis Function Network, Learning Vector Quantization, Self-Organizing Maps, Recurrent Neural Network, Hopfield Neural Network, Adaptive Resonance Theory, Character Recognition by Commonly Used ANNs. Fuzzy Systems, Fuzzy Logic, Membership Functions, Fuzzy Logical Operators, More Operations, Fuzzy Inference Systems, Type-2 Fuzzy systems, Other Sets, Sugeno Fuzzy Systems, Example: Fuzzy Controller Evolutionary Algorithms: Evolutionary Algorithms, Biological Inspiration. Evolutionary Algorithms Genetic Algorithms, Fitness Scaling, Selection, Mutation, Crossover, Other Genetic Operators, Algorithm Working, Diversity, Grammatical Evolution, Other Optimization Techniques, Metaheuristic Search, Traveling Salesman Problem. Introduction, Key Takeaways from Individual Systems, Adaptive Neuro-Fuzzy Inference Systems, Evolutionary Neural Networks, Evolving Fuzzy Logic, Fuzzy Artificial Neural Networks with Fuzzy Inputs, Rule Extraction from ANN, Modular Neural Network.

References:

1. Shukla A., Tiwari R., Kala R., Real Life Applications of Soft Computing, CRC Press, Taylor and Francis Group, London 2010.
2. Ross T.J., Fuzzy Logic with Engineering Applications, Wiley publication, 2010.
3. Sivanandam S.N., Deepa S.N., Principles of Soft Computing, (2e), Wiley Publication, 2010.
4. Rajasekaran S., and Pai G. A. V., Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI Learning, 2010.
5. Jang J. S .R., Neuro-Fuzzy and Soft Computing, PHI 2003.

CSE 4051: AUGMENTED AND VIRTUAL REALITY [3 0 0 3]

Introduction of Virtual and Augmented reality, Definition and scope, A Brief History 3 I's of Virtual Reality A Short History of Early Virtual Reality, Early Commercial VR Technology, VR Becomes an Industry, Components of a VR System, Displays In augmented reality Multimodal Displays, Audio Displays Haptic, Tactile, and Tangible Displays, Displays, Visual Perception, Requirements and Characteristics, Multiple Models of I/O Gesture Interfaces Three-Dimensional Position Trackers, Navigation and Manipulation Interfaces, Gesture Interfaces. Output Devices, Haptic Display, Graphics Displays, Sound Displays. Computer Vision for Augmented Reality, Natural Feature Tracking by Detection, Incremental Tracking, Simultaneous Localization and Mapping, Outdoor Tracking, Computing Architectures for VR, The Rendering Pipeline, Workstation-Based Architectures, Distributed VR Architectures, Geometric Modeling, Kinematics Modeling, Physical Modeling, Behavior Modeling.

References:
1. Burdea, G. C. and P. Coffet. Virtual Reality Technology (2e), Wiley-IEEE Press, 2006.
2. Dieter Schmalstieg, Tobias Hollerer, Augmented Reality: Principles &Practice (1e), Addison-Wesley, 2016.
3. Tony parisi, Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile (1e),O'Reilly Media, 2015.
4. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability) (1e), Addison-Wesley Professional, 2016.
5. Jonathan Linowes, Unity Virtual Reality Projects Paperback, Packt Publishing eBooks Account, September 2015.

ICT 4033: COMPUTER GRAPHICS [3 0 0 3]

Introduction: History of computer graphics and applications, Introduction to OpenGL, Geometric Transformations: Homogeneous coordinates, affine transformations (translation, rotation, scaling, Shear, reflection), concatenation, matrix stacks and use of model view matrix in OpenGL for these operations Examples, Viewing (3D), Visibility- z-Buffer, BSP trees, Open-GL culling, hidden surface algorithms, Shading, Rasterization- Line segment and polygon clipping, 3D clipping, scan conversion, polygonal fill, Bresenham's algorithm, Discrete Techniques: Texture mapping, compositing, textures in OpenGL; Ray Tracing, Representation and Visualization: Bezier curves and surfaces, B-splines, visualization, interpolation, marching squares algorithm.

References:
1. Hearn D and Baker P., Computer Graphics with OpenGL (4e), Pearson, 2014.
2. Edward Angel, Interactive Computer Graphics A Top-Down Approach Using OpenGL (6e), Pearson Education, 2011.
3. F. S. Hill Jr. and S. M. Kelley, Computer Graphics using OpenGL (3e), Prentice Hall, 2006.
4. Peter Shirley and Steve Marschner, Computer Graphics (1e), A. K. Peters, 2010.

ICT 4031: COMPUTER VISION [3 0 0 3]

Introduction to computer vision and its applications, Image formation, Liner Filtering, Image transformations and Colour models, Edge Detection methods (Laplacian detectors and canny edge detector), Points and patches, Harris corner detector, Histogram of Gradients, Difference of Gaussian detector, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC, Camera models, Camera calibration, Stereo vision, Stereo correspondence, Epipolargeometry, Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense Motion estimation, Support Vector Machines, Face detection and recognition, Bag of words, Deep Learning.

References:
1. Szeliski R., Computer Vision: Algorithms and Applications, Springer 2011.
2. David A. F. and Ponce J., Computer Vision: A Modern Approach, PHI learning 2009.
3. Solem J. E., Programming Computer Vision with Python, O'Reilly, 2012.

CSE 4052: DIGITAL IMAGE PROCESSING [3 0 0 3]

Introduction, components of image processing system, Spatial domain transformations, histogram processing, smoothing, sharpening spatial filters, Filtering in the frequency domain- Introduction to Fourier transform, image smoothing, image sharpening using frequency domain filters. Image restoration- Noise models, restoration using spatial filtering, periodic noise reduction by frequency domain filtering, Morphological image processing- Preliminaries, dilation and erosion, opening and closing, hit-or-miss transformation, basic algorithms, extension to gray-scale images, Image segmentation- Point, line, and edge detection, Thresholding, Region Segmentation Using Clustering and Superpixels, Graph Cuts, morphological watersheds, motion in segmentation.

References:
1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (4e), Pearson, 2017.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing, Analysis and Machine Vision (4e), CENGAGE Learning, 2014.
3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,Digital Image Processing Using MATLAB (2e),Mc Graw Hill India, 2010.
4. Gloria Bueno García, Oscar Deniz Suarez, José Luis Espinosa Aranda, Jesus Salido Tercero, Ismael Serrano Gracia, Noelia Vállez Enano, Learning Image Processing with OpenCV (1e), Packt Publishing, 2015.

ICT 4034: BIG DATA ANALYTICS [3 0 0 3]

Understanding Big Data: Concepts and Terminology, Big Data Characteristics, Different Types of Data, Case Study Background. Big data and Hadoop: Understanding Hadoop features, Learning the HDFS and MapReduce architecture, Understanding Hadoop subprojects, Understanding the basics of MapReduce, Introducing Hadoop MapReduce, Understanding the Hadoop MapReduce fundamentals, writing a Hadoop MapReduce example. Spark and Big Data: Theoretical concepts in Spark, Core components of Spark, The Spark architecture, Spark SQL, Spark Streaming. NoSQL databases: Need for NoSQL, NoSQL databases, In-memory databases, columnar databases, Document-oriented databases, Key-value databases, Graph databases, Other NoSQL types and summary, working on NoSQL systems using MongoDB. Applications:Implementation of machine learning algorithms using MapReduce and Spark.

References:
1. Erl T., Khattak W., and Buhler P., Big Data Fundamentals, Concepts, Drivers & Techniques(1e), The Prentice Hall Service Technology Series, 2016.
2. Prajapati V., Big Data Analytics with R and Hadoop, Packt Publishing Ltd., 2013.

3. Dasgupta N., Practical Big Data Analytics, Packt Publishing Ltd, 2018.
4. Rajaraman A., and Ullman J. D., Mining of Massive Datasets, Cambridge University Press, 2011.
5. ZahariaM., Wendell P., Konwinski A.,Karau H., Learning Spark, O'Reilly Media, Inc., 2015.

ICT 4035: INFORMATION RETRIEVAL [3 0 0 3]

Boolean Retrieval Model, Index Construction, Index Compression, Vector Space Model, Evaluation in IR, Relevance Feedback and Query Expansion, Latent Semantic Indexing, Web Search Basics, Web Crawling and Indexes, Link Analysis

References:

1. Manning C. D.,RaghavanP., and Schütze H., Introduction to Information Retrieval, Cambridge University Press, 2008.
2. Buettcher S., Charles L. A., Clarke, and Cormack G. V., Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2010.
1. Grossman D. A. and Frieder O., Information Retrieval: Algorithms and Heuristics, Springer, 2004.

ICT 4032: MACHINE LEARNING [3 0 0 3]

Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning-LMS, logistic regression, GDA, Naive Bayes, SVM, model selection, Learning theory-bias/variance tradeoff, union and Chernoff bounds, VC dimensions, Unsupervised learning-clustering, k-means, Gaussian mixture, factor analysis, PCA, ICA, Reinforcement learning-MDPs, Bellman equations, value and policy iteration, LQR, LQG, Q-learning, policy search, POMDPs.

References:

1. Murphy K.P., Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Mohri M., Rostamizadeh A., and Talwalkar A., Foundations of Machine Learning, MIT Press, 2012.
3. Koller D., and Friedman N, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
4. Bishop C.M., Pattern Recognition and Machine Learning(2e), Springer, 2013.

ICT 4036: SEMANTIC WEB[3003]

Semantic Web Vision, Layered approach, Describing Web Resource : RDF data models, syntax, semantics, schema, RDFS, Direct inference system, RDF Data structures, Containers and colletcions, Querying Semantic Web: SPARQL matching patterns, filters, querying schemas Ontology and Information Systems L use of ontologies, types, design principles, methodologies, Ontology Languanges : OWL2, OWL2 profiles, Ontology Reasoning: Monotonic rules, Rule interchange format, Semantic web rules languages, RuleML, Ontology Design and Management: Types, purposes, creating ontology manually, reusing existing, mapping, Ontology Programming: Programming in Go

References:

1. Grigoris Antoniou, Paul Groth, Frank van vanHarmelen and Rinke Hoekstra, A Semantic Web Primer, MIT Press, 2012.
2. Bob DuCharme, Learning SPARQL (2e), O'REILLY, 2013.
3. Brain McBride, Dan Brickley, R.V. Guha, 'RDF Schema 1.1', 2014, [Online], Available: https://www.w3.org/TR/rdf-schema
4. Lex Sheehan, Learning Functional Programming in Go, Packt Publishing, 2017.

5. Frank Manola, Eric Miller, David Veckett, Ivan Herman, 'RDF Primer Turtle Version', 2007. [Online]. Available: https://www.w3.org/2007/02/turtle/primer/.
6. Vandana Kabilan, Ontology for Information Systems (O4IS) Design Methodology (Doctoral dissertation), 2007.

ICT 4045: CLOUD COMPUTING [3 0 0 3]

Introduction, Cloud infrastructure, Cloud computing delivery models and services, Cloud computing at Amazon, The Google perspective, Microsoft Windows Azure, Application paradigms, Architectural styles of cloud computing, Cloud resource management and scheduling, Cloud resource virtualization, Types of virtualization, Understanding hypervisors, Virtual machine and its components, Resource management, Memory ballooning, Thin virtual provisioning, Storage tiering, Virtual LAN, VLAN trunking, VLAN tagging, Business continuity and cloud management, Virtual machine fault tolerance, Virtual machine replication methods, Cloud security, Virtual machine security, Access control and identity management, Cloud tools: Eucalyptus, Open Nebula/OpenStack, CloudSim.

References:

1. Dan Marinescu C., Cloud Computing Theory and Practice, Elsevier, 2013.
2. Rajkumar Buyya, Christian Vecchiola, Thamarai SelviS., Mastering Cloud Computing, McGraw Hill, 2017.
3. Anthony VelteT., Toby VelteJ., Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw Hill, 2017.

ICT 4046: DEEP LEARNING [3 0 0 3]

Introduction, Mathematical Preliminaries, Machine Learning Basics, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Recurrent and Recursive Networks, Practical Methodology

References:

1. Goodfellow I., Bengio Y., and Courville A.,Deep Learning, MIT Press 2017.
2. Haykin S., Neural Networks and Learning Machines, PHI, 2016.
3. Patterson J., and Gibson A., Deep Learning: A Practitioner's Approach, O'Reilly, 2017.

ICT 4047: GAME THEORY WITH COMPUTER APPLICATIONS [3 0 0 3]

Introduction to Game Theory and Mechanism Design, Mathematical Preliminaries, Non-Cooperative Game Theory, Cooperative Game Theory, Mechanism Design

References:

1. Narahari Y., Game Theory and Mechanism Design, World Scientific, Chennai, 2015.
2. Fudenberg D, and Tirole J., Game Theory, ANE Books, New Delhi, 2015.
3. Bauso D., Game Theoy with Engineering Applications, SIAM, Philadelphia, 2016.
4. Roughgarden T., Twenty Lectures on Algorithmic Game Theory, Cambridge University Press, 2016.

ICT 4048: HIGH PERFORMANCE COMPUTING [3 0 0 3]

Introduction to CPU & GPU micro-architecture, Flynn's taxonomy, Amdahl's law, Challenges in parallel programming, Parallel programming languages, Introduction to CUDA C programming, Data parallelism, Mapping threads to multidimensional data, Synchronization, Querying device properties, Data Parallel Algorithm Primitives, Reduction, Parallel histogram computation, Convolution, Parallel prefix sum, Introduction to CUDA Library, Basic thrust features, Interoperability, Thrust algorithm, Optimization Techniques, Memory optimizations, Common compiler optimizations, Profiling, Application Case Study.

References:

1. Kirk D. B. and Hwu W., Programming Massively Parallel Processors: A Hands-on Approach(3e), Morgan Kaufmann Publishers Inc., 2016.
2. Barlas G., Multicore and GPU Programming: An Integrated Approach. Morgan Kaufmann Publishers Inc., 2015.
3. Gaster B., Howes L., Kaeli D. R., Mistry P., and Schaa D., Heterogeneous Computing with OpenCL(2e), Morgan Kaufmann Publishers Inc., 2012.

ICT 4049: HUMAN COMPUTER INTERACTION [3 0 0 3]

Contexts for HCI, Processes for user-centered development, Different measures for evaluation, Usability heuristics and the principles of usability testing, Physical capabilities that inform interaction design, Cognitive models that inform interaction design, Social models that inform interaction design, Principles of good design and good designers, Accessibility, Interfaces for differently-aged population groups.

References:

1. Dix A., Finlay J.E., Abowd G.D. and Beale R., Human-Computer Interaction (3e), Prentice Hall, 2003.
2. Shneiderman B., Plaisant C., Cohen M. and Jacobs S., Designing the User Interface: Strategies for Effective Human-Computer Interaction (5e), Addison-Wesely, 2009.
3. Rubin J. and Chisnell D.,Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests (2e), New York: Wiley, 2008.
4. Rogers Y., Sharp H. and Preece J., Interaction Design: Beyond Human - Computer Interaction (3e), Wiley, 2011.

ICT 4050: INTERNET OF THINGS [3 0 0 3]

Introduction to M2M communication and IoT, An emerging industrial structure for IoT, IoT system architecture, IoT reference model, IoT deployment and operational view, IoT physical devices and endpoints, Communication and networking protocols-MQTT and AMQP protocols, IoT enabling technologies-RFID, WSN,SCADA etc., Analytics for the IoT, Applying the geospatial analytics to IoT data, Real world design constraint, Technical design constraint, Future internet design for various IoT use cases such as smart cities, smart environments, smart homes, smart health etc.

References:

1. Holler J., Tsiatsis V., Mulligan C., Karnouskos ., Boyle D., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence (1e), Elsevier 2014.
2. Bahga A., Madisetti V., Internet of Things-A Hands on Approach (1e),Orient Blackswan Private Limited, 2015.
3. Roderick O., Marko N., Sanchez D. and Aryasomajula A., Internet of Things and Data Analytics Handbook (1e), Wiley-Blackwell, 2017.
4. Patil Y., Azure IoT Development Cookbook (1e), Packt publishing Ltd,2017.

5. Minteer A., Analytics for the Internet of Things (1e), Packt publishing Ltd, 2017.

ICT 4051: NATURAL COMPUTING [3 0 0 3]

Basic Notations of Biochemistry and Molecular Biology, DNA Computing, Basic Computing Models: Finite Automata (FA), Push Down Automata (PDA), Linear Bounded Automata (LBA) and Turing Machine (TM), Quantum Turing Machine (QTM) and Quantum Languages, Computation by circuits, Thermodynamics of Computation, Algorithmic Botany, Cellular Automata, DNA Computation Models:Lipton Model, Sticker model, DNA Splicing model, DNA Self Assembly, Hairpin Model, Algorithms for Natural Security and Cryptography, Experiments in Self-Assembly, DNA Origami (2D and 3D), Error-Correction in Self-Assembly, Bacterial Computers and Data Storage, Peptide Computing, Membrane Computing, Chemical Computing.

References:

1. Leandro Nunes de Castro, Fundamentals of Natural Computing: Basic Concepts, Algorithms and Applications, CRC Press, USA, 2006.
2. Ignatova Z., Martnez-Prezl., and Karl-Heinz Zimmermann, DNA Computing Models, Springer, 2008.
3. Amos M., Theoretical and Experimental DNA Computation, Springer, 2005.
4. Hopcroft J.E., Motwani R., and Ullman J.D., Introduction to Automata Theory, Languages and Computation, Pearson Asia, 2001.

ICT 4052: NEURAL NETWORKS AND FUZZY LOGIC [3 0 0 3]

Introduction to Neural Networks and Fuzzy Logic, Learning Processes, Single-Layer Perceptron, Multi-Layer Perceptron, Radial Basis Function Networks, Support Vector Machine, Fuzzy Sets and Crisp Sets, Fuzzy Relations, Membership Functions, Fuzzy Logic and Inference, Membership Development.

References:

1. Haykin S., Neural Networks and Learning Machine(3e), Pearson Education, New Delhi, 2016.
2. Hagan M.T., Demuth H B., and Beale M.H., Neural Network Design(2e), Pearson Education, New Delhi, 2014.
3. Ross T.J., Fuzzy Logic with Engineering Applications(3e), Wiley, USA, 2011.

ICT 4053: PATTERN RECOGNITION [3 0 0 3]

Machine perceptron, Pattern recognition, design cycle, Minimum error rate classification, Discriminant features, Normal desnsity, Bayesian belief network, Missing and noisy features, Maximum-likelihood estimation, Gaussian case, Computational complexity, Fisher linear discriminant, Nearest neighbor, Fuzzy classification, Linear discriminant function, Minimizing Perceptron criterion function, Relaxation MSE, Ho-Kashyap procedures, Hidden Markov models, Evaluation, Decoding, Learning, Unsupervised bayesian learning, Criterion functions for clustering, Iterative optimization, Hierarchical clustering.

References:

1. Duda R. O., Peter E.H. and David G. S., Pattern Classification(2e), Wiley-Interscience, 2000.
2. Fukunaga K., Introduction to Statistical Pattern Recognition(2e), Academic ress, 2013.
3. Bishop C. M., Pattern Recognition and Machine Learning(1e), Springer, 2011.

4. Hastie T., Tibshirani R.and Friedman J.,The Elements of Statistical Learning: Data Mining, Inference, and Prediction(2e), Springer, 2017.

ICT 4054: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to social networks: matrices used to analyze the network, types of network mode, Graph Concepts: connectivity, DFS and BFS in network, Datasets, Strong and Weak Ties: Strength of weak ties, Network structure in Large scale data, Graph Partitioning, Networks in their surrounding contexts: Homophily, Spatial model of Segregation, Positive and negative relations: Structural balance, characteristics, applications Information cascades: Baye's rule, Simple cascade model, Network effects: Economy with and without network effects, Power laws and Rich Get Richer Phenomena: Effect of search tools and recommendation system, analysis of Rich-Get-Richer Processes, Cascading behavior in the network: Diffusion, cascades and clusters, Small world phenomena: Six Degrees of Separation, Decentralized Search, Visualization using Gephi: Graph layout algorithm

References:
1. Easley D. and Kleinberg J., Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010.
2. Prell C., Social Network Analysis, SAGE Publications, 2012.
3. Yang S., Keller F. B., Lu Zheng, Social Network Analysis, SAGE Publications, 2017.
4. Khokhar D.,Gephi Cookbook, Packt Publishing, 2015.

ICT 4055: SOFTWARE RELIABILITY [3 0 0 3]

Need and concepts of software reliability; Software reliability models-classification, limitations and issues; model disagreement and inaccuracy, predictive accuracy, recalibration; The operational profile –concepts and development procedures, test selection; Testing for reliability measurement; Software testing; operational profiles – difficulties, estimating reliability, time/structure based software reliability; Fundamentals of measurement product metrics –measurement of internet product attributes, size and structure , measurement of quality; Reliability growth model.

References:
1. Lyu M., Handbook of Software Reliability Engineering, IEEE Computer Society Press, ISBN: 0-07-039400-8, 1996.
2. Connor P. D., Practical Reliability Engineering(5e), John Wesley & sons, 2012.
3. Fenton N. E., Beiman J., Software metrics-A rigorous and practical approach(3e), Chapman & Hall/CRC Innovations in Software Engineering and Software Development Series, 2014.
4. Musa J. D., Software Reliability Engineering(2e), Tata McGraw Hill, 2005.
5. Yamada S., Software Reliability Modeling: Fundamentals and Applications (SpringerBriefs in Statistics), 2014 Edition, Springer, 2014.

OPEN ELECTIVES

ICT 4301: COMPUTER GRAPHICS AND ANIMATION [3 0 0 3]

Introduction to Computer Graphics, Video Display Devices, Raster Scan Systems, Graphics Output Primitives, Line Drawing Algorithms, Circles and Ellipses Generating Algorithms, Geometrical Transformation, Two Dimensional and Three Dimensional Transformations, Inverse Transformations, Three Dimensional Translation, Rotation and Scaling, , Transformation, Two Dimensional and Three Dimensional Viewing , Animation, Raster Methods for Computer Animation, Design of Animation sequences, Articulated Figure Animation, Periodic Motion, Graphics Programming using OpenGL,

References:
1. Donald D. H., Warren C., M. Pauline B.,Computer Graphics with OpenGL(4e), Pearson, Education, 2014.
2. Zhigang X., Computer Graphics: Theory and Practice with OpenGL (3e), Pearson Education, 2016.
3. Edward A., Interactive Computer Graphics- A top down approach using OpenGL (5e), Pearson Education, 2012.
4. Foley J. D., VanDam A., Feiner S. K., Hughes J. F., Computer Graphics, Principles and Practice (3e), Addision-Wesley, 2014.

ICT 4302:DESIGN AND DEVELOPMENT OF WEB APPLICATIONS [3 0 0 3]

Introduction to Internet and Web. Basic components of web page and fundamental concepts of languages required for Client side scripting and Server side scripting: HTML markup for structure of the simple page, text, creating links, adding images, table markup and forms. CSS for presentation: Orientation, formatting text, different selectors, colors background plus even more selectors, box model, padding, border, positioning, layouts, transitions, transformation and animation. Java script data types, control structure, DOM, arrays, objects, event handling. PHP introduction, control statements, arrays, objects, functions, connecting to mysql data base.

References:
1. Robbins J.N., Learning Web Design (4e), O'reilly Media, 2017.
2. Harris A., HTML 5 and CSS 3: All in One for Dummies (3e), Wiley Brand, 2017.
3. Nixon R., Learning PHP, MySQL, JavaScript with Jquery CSS and HTML5 (4e), O'reilly Media, 2017.

ICT 4303: FUNDAMENTALS OF DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Introduction to algorithms, Arrays: Elementary operations, Applications, Performance Analysis, Sparse matrix representation, Transpose of sparse matrix, Stacks operations, Arithmetic expression conversion and evaluation using stack, Queue Operations, Singly linked Lists, Circular lists, Doubly linked lists, Trees, Binary Tree traversals and different operations, Binary search Tree, Heaps, Graph Abstract type: Representations and elementary operations, Sorting and searching techniques, Analysis of algorithm.

References:
1. Horowitz E., Sani S., Dinesh Mehta, Fundamentals of Data Structures in C++ (2e), Golgotha Publications, 2008.
2. Weiss M. A.,Data Structures and Algorithm Analysis in C++ (3e), Pearson Education, 2009.
3. Horowitz E., Sahni S., Anderson-Freed S., Fundamentals of Data structures in C (2e), Silicon Press, 2008.

ICT 4304: MACHINE LEARNING TOOLS AND TECHNOLOGIES [3 0 0 3]

Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning-LMS, logistic regression, GDA, Naive Bayes, SVM, model selection, Learning theory-bias/variance tradeoff, union and Chernoff bounds, VC dimensions, Unsupervised learning-clustering, k-means, Gaussian mixture, factor analysis, PCA, ICA, Machine Learning with Python.

References:

1. Murphy K.P., Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Mohri M., Rostamizadeh A., and Talwalkar A., Foundations of Machine Learning, MIT Press, 2012.
3. Koller D., and Friedman N, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
4. Bishop C.M., Pattern Recognition and Machine Learning (2e), Springer, 2013.

ICT 4305: NETWORKING WITH TCP/IP [3 0 0 3]

Introduction to Networking and brief History of Internet, OSI and TCP/IP Reference Models, Network Layer, IP Addresses, Internet Protocol (IP) Datagram, Fragmentation, Options, Address Translation, ICMP and IGMP, Intra and Inter domain Routing, Distance Vector Routing, RIP, Link State Routing, OSPF, Path Vector Routing, BGP, User Datagram and Transmission Control Protocol, SCTP, Application Layer Protocols, The Web and HTTP, DNS: Services Provided by the DNS.

References:

1. Beerhouse A. F., TCP/IP Protocol Suite (4e), Tata McGraw Hill 2017.
2. Andrew S. T., Computer Network (5e), Prentice Hall of India Pvt Ltd 2013.
3. James F. K., Computer Networking A top-Down Approach Featuring the Internet (6e), Pearson Education Inc 2013.
4. Beerhouse A. F., Data Communications and Networking (5e), Tata McGraw Hill, 2013.

MCA 4301: INTRODUCTION TO DATABASE SYSTEMS WITH MYSQL [3 0 0 3]

Modeling and Designing Databases, Database Design Process, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model, Super, candidate, primary ,foreign key, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Creating a MySQL Database, Table, Modifying table, constraints, indexes, Basic SQL, Inserting Data, Selecting Data, Updating Data, Deleting Data, MySQL Functions, Numeric, String, Date /Time, Advanced Queries, Sorting, Multiple tables, Inner Join, Left Join, Right Join, Natural Join, Nested queries, Generating summaries, COUNT(), MIN(), MAX(), SUM(), AVG(), Group By, Statistical techniques, Calculating Descriptive statistics, Per-Group Descriptive Statistics, Generating frequency distribution, Calculating correlation coefficients, assigning ranks, Stored routines, stored procedure, stored function, Triggers, Events to schedule Database actions, Managing users and privileges, Importing and Exporting data, importing data with LOAD data and mysql import, importing csv files, exporting query results, tables, importing XML.

References:
1. Paul Dubois, MySQL Cookbook, O'REILLY, First Edition, 2007.
2. Larry Ullman, Visual Quick Start guide MySQL, Pearson Education, 2nd Edition, 2007.
3. Seyed M. M, Saied Tahaghoghi and Hugh Williams, Learning MySQL, O'Reilly, 2006.
4. Russell J.T. Dyer, MySQL in a Nutshell, O'REILLY, 2nd Edition, 2008.

MCA 4302: INTRODUCTION TO VR AND AR TECHNOLOGIES [3 0 0 3]

Introduction: Input Devices, Output Devices, Displays, Computing Architectures for VR, The Rendering Pipeline, PC Graphics Architecture, Workstation-Based Architectures, Distributed VR Architectures, Modeling, Geometric Modeling, Physical Modeling, Behavior Modeling, Model Management, VR Programming and other Toolkits. Introduction to Unity 3D Engine, 2D Game concepts and basic scripting, 3D Game concepts and environment creation, Advanced game concepts. Introduction to Unity AR: Foundation and Vuforia, working with Vuforia in Unity, ARCore in unity, Mini project on AR. Introduction to VR, Unity for Google cardboard, Basic VR app development for Cardboard, Develop for a specific VR platform.

References:
1. Jonathan Linowers, Krystian Banbilinski, Augmented Reality for Developers,Packt Publishers, 2017.
2. Edward Lavieri, Getting started with Unity 5, Packt publishing, 2015.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley-IEEE Press, 2003.
4. Sherman, W.R. & A. Craig, Understanding, Virtual Reality: Interface, Application and Design, Morgan Kaufmann, San Francisco, CA, 2003.
5. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC, Taylor and Francis, 2011.

MCA 4303: INTRODUCTION TO LINUX AND SHELL SCRIPTING [3 0 0 3]

Introduction to UNIX/LINUX Operating System: OS concepts, Linux overview, key features of Linux, pros and cons of Linux. Processes: Processes and Files, I/O redirection and pipes, process creation, process attributes standard process file descriptors. File and Process commands. File systems: Files and directories, file naming and wildcards, file attributes, file permissions. Regular Expressions & filters: find, grep, cut, sort, grep patterns. AWK and SED. Shell and Shell Scripting: The need for shell, types of shells, interactive uses of shell, using shell for creating user commands, functions. Bash shell features: Statements, data structure, built-in commands, environment customization primitives. Linux Editors.

References:
1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting BIBLE, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. Stephen G. Kochan. Unix Shell Programming, 3rd Edition, SAMS Publications, 2003.
4. Bash Reference Manual Download able from GNU Project.
5. Brian W Kerningham and Rob Pike. The Unix Programming Environment, PHI Learning Pvt. Ltd., 2009.

MCA 4304: INTRODUCTION TO DATA ANALYTICS [3 0 0 3]

Introduction - data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population. Data summarization and visualization – tables and graphs. Data Preprocessing- cleaning, transformation, dimensionality reduction. Data Analysis and Visualization – descriptive, inferential statistics, uni-variate and multi-variate analysis. Grouping – Cluster Analysis- distance measures, partitioning, hierarchical, density based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis. Classifiers-Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees. Prediction- Regression models, Evaluating Classification and Predictive performance, ensemble methods. Anomaly Detection. Forecasting models.

References:
1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

Minor Specialization: Computational Mathematics

MAT 4051: APPLIED STATISTICS AND TIME SERIES ANALYSIS [2 1 0 3]

Stochastic and deterministic dynamic mathematical models – forecasting and control, transfer function models, models for discrete control systems. Basic ideas in model building- linear and multiple linear regression. Basic concepts in stochastic processes and Markov chains, Mean square distance, mean square error prediction, prediction of covariance stationary process, ergodic theory and stationary process, applications of ergodic theory, spectral analysis of covariance stationary processes, Gaussian systems, stationary point processes, level crossing problems. ARIMA models, Autoregressive models, moving average models, duality, model properties, parameter estimates, forecasts.Volatility models: ARCH and GARCH modelling, testing strategy for heteroscedastic models, volatility forecasts, Black Scholes model.

References:

1. G.E.P. Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, (5e), Wiley Series, 2016.
2. Anderson T W, *The Statistical Analysis of Time Series*, John Wiley, New York, 1994
3. Samuel Karlin, Howard M Taylor, *First Course in Stochastic process*, Academic Press, New York,
4. C. Chatfield, *The Analysis of Time Series – An Introduction*, Chapman and Hall / CRC, (4e), 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

MAT 4052: COMPUTATIONAL LINEAR ALGEBRA [2 1 0 3]

Matrix Analysis: Basic Ideas from Linear algebra, vector norms, matrix norms, orthogonality and SVD, Projections and CS decomposition, the sensitivity of square linear systems. General Linear Systems: Triangular systems, The LU factorization, Round off analysis of Gausian elimination, Pivoting, Improving and estimating accuracy. Orthogonalization and least squares: Householder and Givens matrices, The QR factorization, The full rank LS problem, Other orthogonal factorizations, The rank deficient LS problem, Weighing and iterative improvement, square and underdetermined systems.The symmetric Eigen value problem: Eigen values properties and decompositions, Power iterations, the symmetric QR algorithm, Jacobi methods, Tridiagonal Methods, Computing the SVD, some generalized eigen value problems.

References:

1. Gene H. Golub and Charles F. Van Loan, *Matrix Computations*, (4e), Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, (4e), Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*,(3e), Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, (2e), Cambridge University Press, 2013.

MAT 4053: COMPUTATIONAL PROBABILITY AND DESIGN OF EXPERIMENTS [2 1 0 3]

Sampling and sampling distributions, Most powerful tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test, Randomized Designs, Inferences about the differences in Means, Paired Comparison Designs, Inferences about the variance of normal distributions, Monte Carlo estimation methods.The analysis of variance, RCBD, LSD and Related Designs, The Graeco - Latin square Design, Balanced Incomplete Block Designs, PBIBD   Introduction to Factorial Designs, The Two Factor factorial design, Blocking in a factorial design, 2^k Factorial Design, Blocking and Confounding in the 2^k Factorial Design, Partial Confounding. Two level fractional factorial designs, three level and mixed level factorial and fractional factorial designs, 3^k Factorial Design, Confounding in the 3^k Factorial Design, Fractional replication of the 3^k Factorial Design, Factorials with mixed levels.

References:

1. Robert V Hogg and Allen Craig, *Introduction to Mathematical Statistics*, (4e), Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statitical Inference and its applications*, (2e), Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, (8e), Wiley Series, 2012,
5. D D Joshi, Linear Estimation and Design of Experiments, New Age International Publishers, 2009

MAT 4054: GRAPHS AND MATRICES [2 1 0 3]

Graphs and subgraphs, walks, paths and connectedness, distance as a metric, degrees, regular graphs, cubic graphs, bipartite graphs, self-complementary graphs, operations on graphs, extremal graphs, cut points, bridges and blocks, block graphs and cut point graphs.Trees and their characterizations, centres and centroids, block-cut point trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, graphical variations of Menger's theorem. Traversability: Eulerian graphs and Hamiltonian graphs. Line graphs and total graphs. Line graphs and traversability, coverings and independence, critical points and lines. Planarity: Plane and planar graphs, outer planar graphs, Kuratowski's theorem, vertex colouring.Incidence Matrix: Rank, minors, path matrix, 0-1 incidence matrix. Adjacency Matrix: Eigen values of some graphs, determinant, bounds, energy of a graph, antiadjacency matrix of a directed graph, non-singular trees. Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorems, bounds for Laplacian spectral radius, edge-Laplacian of a tree.

References:

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, (5e), Elsevier Publishing Co., 1982.
3. D.B. West, *Introduction to Graph Theory*, Pearson Education, Inc., 2001.
4. R.B Bapat, *Graphs and Matrices*, Hindustan Book Agency, 2010.
5. Lowell W Beineke and Robin J Wilson, *Topics in Algebraic Graph Theory*, Cambridge University Press, 2005.

OPEN ELECTIVES
MAT 5301: APPLIED GRAPH THEORY [2 1 0 3]

Graphs and applications of the theorems by Havel and Hakimi, Erdos and Gallai. Cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centre and centroids, block-cut points trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, Whitney's theorem. Traversability-Eulerian, Hamiltonian, line graphs and total graphs. Traversability, coverings and independence, theorem of Gallai, critical points and lines. Planarity, genus, thickness, crossing number. Colorability, chromatic number and its bounds, Nordhaus Gaddum theorems, the four and five colour theorems, chromatic polynomial. Matrix Representation -Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs, Matrix - tree theorem on number of spanning trees. Tournament. Graph theoretic Algorithms: Computer representation of graphs-Input and output, Algorithms for connectedness, Spanning Tree, Fundamental Circuits, Directed Circuits and Shortest paths.

References:

1. F. Harary, *Graph theory*, Narosa Publishers
2. Narsingh Deo, *Graph theory with applications to Engineering and Computer Science*, Prentice Hall.
3. Robin J.Wilson, *Introduction to Graph theory*, Logman

MAT 5302: APPLIED LINEAR ALGEBRA [2 1 0 3]

Finite dimensional vector spaces, subspaces, linear independence, basis and dimension. Sum and intersection of subspaces. Algebra of linear transformations, range and null space of a linear transformation, Inner-product spaces, metric spaces and banach spaces, Gram Schmidt orthogonalization, linear operators and their adjoint, self adjoint, unitary and normal transformations, polar decomposition. Matrix algebra, simultaneous equations, Eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Application of eigen values to solve simultaneous difference and differential equations. Quadratic forms and their classification, constrained optimization. Somecomputational methods of linear algebra.

References:

1. Gantmocher F.R., *The Theory of Matrices*, Cheisea.
2. Gilbert Strang , *Linear Algebra and its applications*,Thomson learning
3. David C. Lay, *Linear Algebra and its applications*, Pearson Education

MAT 5303:APPLIED NUMERICAL METHODS [2 1 0 3]

Matrix Algebra : Solution for linear system of equations – Direct methods: Gauss elimination method, Gauss Jordon method, Crouts (LU decomposition) method. Iterative methods, Jacobi Gauss Seidal and successive over relaxation methods. Computation of inverse of a matrix: Jordan method, Triangularization method, Choleski's method, partition method. Eigen value & Eigen vectors: Given's method for real symmetric matrices, Jocobi's method for real symmetric matrices, Power method. Numerical Solution of Ordinary Differential Equations: Single step methods, Runge- Kutta method, Adam Bashforth's predictor corrector method, Milne's predictor and corrector method. Numerical Solution of Partial Differential Equations: Finite difference approximation to derivatives of Parabolic, Elliptic. Explicit finite difference method, implicit method.

References:

1. Jain, Iyengar and Jain: *Numerical methods for Scientific and Engineering Computations*, New Age Publishers
2. Carnahan, Luther and Wikes: *Applied Numerical Methods*, John Willey
3. Conte S.D and Be Door, *Introduction to Numerical analysis*, McGraw Hill.

MAT 5304:MATHEMATICAL MODELLING [2 1 0 3]

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey- Predator model Mathematical modeling through systems of ordinary differential equations, modeling in medicine A model for diabetic mellitus. Modelling on population dynamics Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

References:

1. J N Kapur, *Mathematical Modelling*, New age international publishers,(2e), 2015.
2. J N Kapur *Mathematical Models in biology and medicine*, East- West press.
3. J N Kapur *Mathematical models of environment*, INS Academy, New Delhi

MAT 5305:OPTIMIZATION TECHNIQUES [2 1 0 3]

Formulation, Linear programming-simplex method, Penalty coase methods, 2-phase method. Dual Simplex method. Duality theory .Transportation problem-Volgel's approximation method, MODI method, Assignment problem-Hungarian method.Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using Linear programming.

References:

1. Bronson Richard - *Theory and Problems of Operations Research*-Schaum series- MGH
2. P.K.Gupta& Man Mohan - *Operations Research* - Sultan Chand & Sons
3. HamdyA.Taha - *Operations Research* PHI

MAT 5306: STOCHASTIC PROCESSES AND RELIABILITY [2 1 0 3]

Static probabilities: Review and prerequisites generating functions, difference equations.Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes : assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behaviour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a wiener process, Kolmogrov equations, Ornstein – Unlenbeck Process. White note. Reliability Theory : Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Paralled - series system & related problems.

References:

1. Medhi. J., *Stochastic Processes*, Wiley Eastern.
2. Bhat U R, *Elements of Applied Stochastic Processes*, John Wiley.
3. A Papoulis, *Probability, Random Variables and Stochastic Procesess*, McGraw Hill.

HUM 4051: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction and objectives of financial management, Evolution of corporate finance, responsibilities. Types of accounts, Golden rules of accounting, Preparation of Journal, Ledger, Trial balance and final accounts. Sources of long term finance, Characteristics of equity capital, Preference capital, Debenture capital & Term loans. Valuation of securities, Concepts, Bond valuation and related models, Bond value theorems, Yield to maturity. Equity valuation; Dividend capitalization approach, Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management, Capital budgeting: appraisal criteria, pay-back period, Average rate of return, Net present value, Benefit cost ratio and Internal rate of return. Risk analysis in capital budgeting, Cost of capital: introduction, cost of debt capital, Preference capital and Equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2006.
2. I M Pandey, Financial Management, Vikas Publishing House Pvt Ltd.,, New Delhi, 2015.
3. N Ramachandran & Ram Kumar Kakani, Financial Accounting for Management, 3/e, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E, Financial Management: Theory and Practice. 12e, Cengage Learning, India, 2008.
5. Maheshwari S.N., Financial Management, Sultan Chand & Co., New Delhi, 2002.

HUM 4052: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health.

References:

1. Michael Armstrong ., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India,2006
2. Gary Dessler& BijuVarkey .,Human Resource Management:12th Edition Dorling Kindersley(India),Noida,2011
3. T.V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
4. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999.
5. Aswathappa K,Human ResourceManagement,Text&Cases McGrawHill 7th Edition,2006
6. N G Nair and Latha Nair., Personnel Management and Industrial Relations, S. Chand Company, 1995.

HUM 4053: MARKETING MANAGEMENT [2 1 0 3]

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing

References:

1. Philip Kotler, Kevil Keller, Abraham Koshy & Mithileshwar Jha, Marketing Management – A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
2. Arun Kumar & N Meenakshi, Marketing Management, Vikas Publishing House Pvt Ltd, New Delhi, 2011.
3. Varshney R L and Gupta S L., Marketing Management, Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer., Principles of Marketing, Oxford University Press, New York, 2000.

HUM 4054: OPERATIONS MANAGEMENT [2 1 0 3]

Introductions to operations management – process view and supply chain view, types of production activities, competitive priorities and capabilities. Break-even analysis, evaluating services or products, evaluating processes - make or buy decision, decision making under risk, and decision trees. Introduction to forecasting, importance and uses of forecasting, demand patterns, demand management options, judgement methods, causal methods - linear regression, time series method – naïve method, moving average, weightage moving average, and exponential smoothing curve. Planning long-term capacity, measures of capacity and utilization, economies of scale, diseconomies of scale, capacity timing and sizing strategies, sizing capacity cushions, timing and sizing expansion – expansionist strategy, wait and see strategy, and a systematic approach to long term capacity decision. Levels inoperations planning and scheduling across the organization, sales and operation planning strategies- chase strategy, level strategy, operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, identifying bottle necks, relieving bottle necks, drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, supply chains for services and manufacturing, measures of supply chain performance - inventory measures, financial measures, inventory and supply chains - pressures for small inventories, pressures for large inventories, types of inventory, inventory reduction tactics, and inventory placement. Costs of quality, total quality management, acceptance sampling, statistical process control - control charts, and process capability. Continuous improvement using lean systems, different types of wastes, strategic characteristics of a lean system, designing lean system layout, and Kanban system.

References:

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., *Operations Management*, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B., *Operations Management*, 11th edition. Pearson Education India, 2016.
3. Khanna R. B., *Production and Operations Management*, 2nd edition, PHI Learning Private Limited, 2015.

OPEN ELECTIVES

HUM 4301: COMMUNICATIVE ENGLISH [3 0 0 3]
(Offered for Lateral Entry Students only)

Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/ Expository/Narrative Essays; Reading Comprehension; Dynamic text; Critical Evaluation; Group Discussions; Presentation Skills; Essay writing.; Audio texts/speeches -Practice listening skills- summary, commentary, listening exercises. Video Speeches - T h e m e b a s e d s p e e c h e s - motivational, informative, technical, and persuasive, discussions. Speech - Elements of a good speech, types of speeches, model speech, Speech exercises, individual presentations, peer and facilitator feedback. Formal/Informal communication. Communication Styles- formal and informal, standard English and variations in usages, examples and analysis of faulty usages; Correspondence: formal/informal letters and emails .

References:

1. Green David., *Contemporary English Grammar, Structures and Composition* Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB., *A Practical English Grammar*, OUP.
3. Turton N D , Heaton J B., *Longman Dictionary of Common Errors*, 1998.
4. Meenakshi Raman & Sangita Sharma., *Technical Communication; Principles and Practice*, Oxford University Press, 2011.

HUM 4302: FILM STUDIES [2 1 0 3]

History of invention of motion pictures - Daguerre, Muybridge, Edison, SkaldanowskyBrothers,Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbakf, Majid Majidi, Keislowski, Zhang Yimou, Kim Ki Duk, "New Wave" Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr.Caligari, The kid, Children of heaven, Hero, Ghatashraddha, PatherPanchali, Mathilukal.

References:

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction, 7th ed*. New York: McGraw-Hill Co., 2004.
2. Kawin, Bruce., *How Movies Work*. Berkeley and Los Angeles: University of California Press, 1992.
3. Cook, David A., *A History of Narrative Film*, 4th ed. New York: W.W. Norton & Co., 2004.

HUM 4303:GERMAN FOR BEGINNERS [3 0 0 3]

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany.Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation, basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

References:

1. Sally Johnson, Natalie Braber., *Exploring the German Language*, (2E), Cambridge University Press. 2008.
2. Charles Russ., *The German Language Today: A Linguistic Introduction*, Routledge. 1994.

HUM 4304: BUILDING BRIDGES: INDO-EUROPEAN INTERCULTURAL DYNAMICS [3 0 0 3]

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication , Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.

References:

1. Dodd, Carley H. *Dynamics of Intercultural Communication*, McGraw-Hill, Boston. 1998.
2. Gannon M J and Pillai R. *Understanding Global Cultures*, Sage Publications, California. 2010.
3. Hall, E. T. *The dance of life: The other dimension of time*, Random House, New York. 1983.
4. Hofstede, Geert., *Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, CA. 2001.
5. Martin, J.N. & Nakayama, T.K., *Intercultural communication in contexts*. 4th Edition. Mountain View, CA: Mayfield. 2007.
6. Samovar, L A and Porter, R., *Communication between Cultures*, Cengage Learning, Wadsworth, CA. 2007.

HUM 4305: INTERPRETATION OF LITERARY TEXTS [3 0 0 3]

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and texuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech ; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and   discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting,   characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

References:

1. Austin, J.L., *How to do Things with Words*, Longman, London, 1992.
2. Barthes. R., *Introduction to the Structural Analysis of Narratives*, Fontana, London, 1977.
3. Blake.N.F, *An Introduction to the Language of Literature*, Macmillan, London. .1990.
4. Carter, R. (ed.)., *Language and Literature: An introductory Reader in Stylistics*, Allen and Unwin, London, 1982.
5. Cook, G., *Discourse and Literature*, Oxford University Press, London, 1994.
6. Harold, C.M.(ed.)., *Style in Prose Fiction*, Columbia University Press, New York.
7. Leech, G.N., *A Linguistic Guide to English Poetry*, Longman, London, 1969.

HUM 4306: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accent (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery-Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy., *Resonate: Present Visual Stories that Transform Audiences*, John John Wiley and Sons, 2010.
2. Minto Barbara., *The Pyramid Principle: Logic in writing, thinking and Problem Solving*, Financial Times Prentice Hall, 2002.
3. Berkun Scott., *Confessions of a Public Speaker*, O'Reily Media, 2009.
4. Goodale Malcolm., *Professional Presentations*, Cambridge University Press, 2005.
5. Carnegie Dale., *The Art of Public Speaking*, 1905.

HUM 4307: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments.

References:

1. Boring, E.G., Langfield,H.S. &Weld,H.P., *Foundations of Psychology, Asia* Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C., *Abnormal Psychology & Modern Life*, (8th ed) Scoff, Foresman&Co. 1988.
3. Lahey, B.B.,Psychology: *An Introduction*, 6th Ed., Tata McGraw Hill, New York, 1965.
4. Olson, M.; Hergenhahn, B.R., *Introduction to the Theories of Learning*, Prentice-Hall India, 2009.

HUM 4308: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

References:

1. Aquinas, Thomas., *On Being and Essence. Trans. Armand Maurer*. Canada: Pontifical Institute of Mediaeval Studies, 1968.
2. John-Terry, Chris., *For the Love of Wisdom: An Explanation of the meaning and Purpose of Philosophy*. New York: Alba House, 1994.
3. Maritain, Jacques., *An Introduction to Philosophy*, London: Sheed and Ward. 1979.
4. Radhakrishnan, S. (Ed)., *History of Philosophy Eastern and Western Vol.II* George Allen and Unwin Ltd., London, 1953.
5. Wallace, William., *The Elements of Philosophy*. New York: Alba House, 1990.

HUM 4309: CREATIVE WRITING [3 0 0 3]

Various literary/prose forms and their characteristics; techniques and strategies for reading; nuances of language and meaning in reading and writing; Writing Exercises - techniques and strategies of writing creatively; Critical Concepts and Terms in Literary Writing; Writing Exercises; creative writing output.

References:

1. Milan Kundera ., *The Art of the Novel*.
2. The Art of Fiction: Illustrated from Classic and Modern Texts, David Lodge

HUM 4310: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]

Part I:The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics -   About diegetic images that show the world of the story-About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the   meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities.

References:

1. Roger Sabin., *Comics, Comix and Graphic Novels*.
2. Robert Petersen, Allan Moore., *Comics, Manga and Graphic Novels: A History of Graphic Narrative3. Comics as Performance*, Fiction as Scalpel.
3. JeetHeer, Kent Worcester., *Arguing Comics: Studies in Popular culture*.

HUM 4311: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Management information system: Introduction to management, information and system. System concepts, general model of a system and types of systems. Evolution of MIS , models and resources used in the MIS model. Structure of MIS, operating elements of an information system, synthesis of the structure. Information systems for different applications: Transaction processing systems, Human resource management systems and Marketing-application areas. Production planning and Office automation systems. Role of management information in decision making: Concepts of decision making, Decision making process and information needs at different levels of management. Herbert. A. Simon model. Phases in the decision making process, Programmed vs non-programmed decisions, General model of human as an information processor, Allen Newell Simon model. Decision support systems -structure, elements and working. Information as a strategic resource. MIS as a technique for making programmed decisions: Behavioral models of the decision maker and methods. MIS support for decision making. Role of MIS in Organizations -recent trends and e-commerce applications. Development of customized management information system approaches: SDLC -phases in SDLC, Strategic and project planning for MIS, conceptual design and detailed design phases: general business planning and MIS response. MIS Planning and planning cycle. Conceptual system design and Detailed System design. MIS System Implementation, and Pit falls: Pit Falls in MIS development, Fundamental weaknesses, soft spots in planning, design problems and review.

References:

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.
5. Mudrick; Ross (1997) "Information Systems for Modern Management " Prentice Hall of India.
6. James A. O.Brien (1995)"Management Information Systems, Galgotia Publications.

HUM 4312: ENTREPRENEURSHIP [3 0 0 3]

Entrepreneur: Meaning of entrepreneur, evolution of the concept, functions of an entrepreneur, types of entrepreneur, and intrapreneur. Concept of entrepreneurship - evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers for entrepreneurship. Small scale industry: Definition, characteristics, need and rationale. Objectives, scope, role of Small Scale Industries (SSI) in economic development, advantages of SSI, steps to start an SSI - government policy towards SSI, different policies of SSI, impact of liberalization, privatization, and Globalization. Effect of WTO/GATT and supporting agencies of government for SSI. Institutional support: Different Schemes: TECKSOK, KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI, NSIC, SIDBI, and KSFC, New schemes and support for start-ups and new venture under Govt. of India. Preparation of Business plan and project report: components of a successful plan. Meaning of project, project identification, project selection, project report, need and significance of report, contents, formulation, guidelines by planning commission for project report. Network analysis, errors in project report, project appraisal. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study and documentation and evaluation.

References:

1. Vasant Desai., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House, 2007.
2. David H. Holt Entrepreneurship: New Venture Creation, Published by prentice Hall,1991.
3. Poornima. M. Charantimath., Entrepreneurship Development, Pearson Education, 2006.
4. S.S. Khanka., Entrepreneurship Development, S.Chand& Co, 2007.

Minor Specialization: Material Science

PHY 4051: PHYSICS OF LOW DIMENSIONAL MATERIALS [3 0 0 3]

Thin films: Thick and Thin Film Materials, preparation by physical and chemical methods. Thickness measurement techniques. Theories of nucleation - Capillarity and atomistic theory, effect of deposition parameters on nucleation and growth of thin films. Epitaxial growth. Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmittance in thin films. Antireflection coatings. Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal and semiconducting films. Thermoelectric power in metal films. thin film resistors, thermopiles. Quantum well devices.

Nanomaterials: Chemical Synthesis of Nanoparticles: Bottom up approach. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanoastructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclustures. Nanostructured films. Physical Methods of Nanostructure Fabrication: Top down approach. Nanopatterning- Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography.

References:
1. Chopra K. L., *Thin Film Phenomena*, Mc Graw Hill, 1969
2. Milton Ohring, *Materials Science of Thin Films*, Elsevier, 2001
3. Heavens O. S., *Optical Properties of Thin Solid Films*, Dover, 1955
4. Liz-Marzan L. M. and Kamat P. V. (Eds), *Nanoscale Materials*, Kluwer, 2003
5. Nalwa H. S. (Ed), *Nanostructured Materials and Nanotechnology*, Academic, 2002

PHY 4052: PHYSICS OF PHOTONIC AND ENERGY STORAGE DEVICES [3 0 0 3]

Semiconductors: Direct and indirect band gaps. Carrier concentrations at thermal equilibrium. Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth techniques Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices. IC technology, elements of lithography.

Photonic Devices: LED and semiconductor lasers: Radiative and non-radiative transitions, diode laser, population inversion, laser operating characteristics, efficiency, photoconductor, photodiode, avalanche photodiode, phototransistor, material requirement for solar cells, theory and types of solar cells.

Fuel cells: Hydrogen energy – merits as a fuel – production of hydrogen, Hydrogen Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells. Application of fuel cells – commercially available fuel cells.

References:
1. Neamen Donald A., *Semiconductor Physics and Devices, basic principles*, Tata McGraw-Hill, 2002
2. Sze S. M., *Physics of Semiconductor Devices*, John Wiley & Sons, 2007
3. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, Wiley, 2003
4. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2005
5. S. Srinivasan, *Fuel Cells*: From Fundamentals to Applications, Springer, 2006

OPEN ELECTIVES

PHY 4301: FUNDAMENTALS OF ASTRONOMY AND ASTROPHYSICS [3 0 0 3]

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

References:
1. Marc L Kutner, *Astronomy: A physical Perspective (2e)* Cambridge University Press, 2003
2. BaidyanathBasu, *An Introduction to Astrophysics (2e)*, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, *Introductory Astronomy and Astrophysics (4e)*, Saunders College Pub. 1992.

PHY 4302: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]

Types of magnetism, ferromagnetic domains, soft and hard magnetic materials, ferrites, magnetic storage, Superconducting materials, Applications of superconductors, Nano-materials, bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Composite materials, micromechanics of composites - Density, Mechanical and Thermal properties, Semiconductors, Metals, semiconductors and insulators, Direct and indirect band-gap semiconductors, Intrinsic and extrinsic semiconductors, Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices.

References:
1. William F. Smith, *Principles of Materials Science and Engineering (2e)*, McGraw-Hill International Edition, 1990.
2. Nalwa H.S., *Nanostructured Materials and Nanotechnology (2e)*, Academic, 2002.
3. Chawla K. K. *Composite Materials- Science & Engineering (3e)*, Springer-Verlag, 2012.
4. Streetman Ben G. and Banerjee Sanjay Kumar, *Solid State Electronic Devices (6e)* PHI learning Private Limited, 2012.

PHY 4303: RADIATION PHYSICS [3 0 0 3]

Radiation Sources: Fast electron sources-Heavy charged particle sources-Sources of electromagnetic radiation-Neutron sources. Radiation Interaction: Photoelectric and Compton process -pair production. Interaction of heavy charged particles-stopping power-Energy loss characteristics- Bragg curve-Particle range-range straggling- stopping time-energy loss in thin absorbers-Interaction of fast electrons-absorption of beta particles-interaction of gamma rays-gamma ray attenuation-Interaction of neutrons-neutron cross section-neutron induced nuclear reactions. Radiation Detectors and Instrumentation: Semiconductors diodes-JFET-MOSFET-Integrated Circuits-OPAMP and their characteristics-Differential Amplifier-Operational amplifier systems-Pulse Amplifiers. Principles of radiation detection and measurements-Gas filled detectors-Ionisation chambers-Proportional counters-GM counters-Scintillation detectors-Semiconductor detectors-Thermo luminescent Dosimeters-Radiation spectroscopy with scintillators-Gamma spectroscopy-Multichannel pulse analyzer-Slow neutron detection methods-Reactor instrumentation. Industrial uses of nuclear measurements: Radiation detection in industrial environments-Measuring systems for industrial problems-Determination of physical material characteristics by nuclear measurements-Level height determination-Density measurements-Quantity measurements-Thickness measurement-coating thickness measurement.

References:

1. Knoll G. F., *Radiation Detection and Measurement (3e)*, Wiley 2010
2. Boylestad R. L., *Electronic Devices and Circuit theory (11e)*, Pearson Education 2016
3. Malvino A. P., *Electronic Principles (7e)*, TMH 2010
4. Foldiak G., *Industrial Applications of Radioisotopes*, Elsevier Science Ltd 1986

PHY 4304: SOLID STATE PHYSICS [3 0 0 3]

Review of Crystal structure: Lattice, basis and unit cell, crystal system, symmetry, crystal planes and miller indices, reciprocal lattice, Bragg's law, experimental methods of x-raydiffraction, types of crystal binding, analysis of stress and strain in crysals. Electrical conduction: Free electron gas model, Sommerfield quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfield theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductorsDielectrics: Static dielectric constant, polarization and polarizability, local field, ferro electricity, piezo electricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materialsMagnetism: Classification of magnetic materials, classical theory of diamagnetism and paramagnetism, Weiss theory of ferromagnetism, ferrites, hard and soft magnetic materials, garnets, magnetic bubbles, ceramic magnets, applications of magnetic materials

References:

1. Kittel C., *Introduction to Solid State Physics (7e)*, Wiley 1996.
2. Rao A., *A first course Solid State Physics*, Asiatech publications 2000.
3. Pillai S.O., *Solid State Physics (6e)*, New age international publications 2006.
4. Wahab M. A., *Numerical problems in Solid State Physics*, Alpha science international publications 2011.
5. Gupta H. C., *Solid State Physics*, Vikas publishing house Pvt. Ltd. 1996.

PHY 4305: MODERN OPTICS [3 0 0 3]

Optics: Review of geometrical and physical optics, Dual nature of light, Electromagnetic spectrum, Optical devices, mirrors, lenses, prisms, grating, beam splitters, zone plate, polaroids. Light sources, emission profile. Elements of lasers: Basic requirements in a laser, characteristic properties of lasers. Q-switched and mode locked lasers. CO2, Nd: YAG lasers. Applications. Introduction to Non-linear optics. Optoelectronic devices and its application: Photo diodes, solar cells, LED, and diode lasers. DBR and DFB lasers, CCD. Optical Communication: Conceptual picture of the optical communication system, Modulation and Detection Schemes, properties of optical fibers, discussion on device requirements, OEICS. Optical storage devices: Data recording and read out from optical discs. Holographic data storage systems.

References:

1. Ghatak A., *OPTICS (4e)*, Tata McGraw Hill Publishing Company Ltd. 2009.
2. Singh J., *Optoelectronics: An Introduction to Materials and Devices*, TATA McGraw- Hill Companies, Inc. 2014.
3. Wilson & Hawkes, *LASERS*, Prentice-Hall of India Pvt. Ltd. 1987.
4. Hugh Bennett, *Understanding Recordable & Rewritable DVD*, OSTA.org.
5. Hugh Bennett, *Understanding CD-R & CD-RW*, OSTA.org.

PHY 4306: INTRODUCTORY QUANTUM MECHANICS [3 0 0 3]

Review of certain basics : Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wavepacket, Heisenberg's uncertainty principle, Mathematical Formalism : operators; commutation relation; orthonormal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics.The Schrödinger Equation : Introduction, wavefunctions , time dependent Schrödinger equation, conservation of probability, expectation values, Ehrenfest's theorem, time independent Schroedinger equation, stationary states, Schroedinger equation in one dimension : the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator.Quantum mechanics in three dimensions: Schrödinger equation in spherical coordinates, separation of variables, the angular equation, the radial equation, Applications (energy eigenvalues and eigenfunctions): the rigid rotator; the hydrogen atom; angular momentum. Identical Particles.Some applications of quantum mechanics in nuclear physics, condensed matter physics, and spectroscopy: alpha decay, nanostructures, STM, vibrational and rotational spectra of molecules etc.

References:

1. Verma H.C., *Quantum Physics (2e)*, Surya Publications. 2016.
2. Gasiorowicz S., *Quantum Physics (3e)*, Wiley India Pvt Limited. 2007.
3. Jain M. C., *Quantum Mechanics: A Textbook for Undergraduates*, PHI Learning Private Limited 2012.
4. Griffiths D. J., *Introduction to Quantum Mechanics (2e)*, Pearson Education.
5. Eisberg R. and Resnick R., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2e)*, Wiley-India Pvt Limited. 2009.

CHM 4051: CHEMICAL BONDING [3 0 0 3]

Introduction to bonding, Classification. Ionic bond- Lattice energy, Born Haber cycle, Radius-ratio rules, Properties of ionic compounds, Covalent character in ionic bonds. Covalent bond-Covalency, Valence bond theory, Sigma and pi bond, Hybridization, VSEPR Theory, Molecular orbital theory, Bond order, Properties of covalent compounds. Coordination bond - Primary and Secondary valencies, ligands, Valence bond theory of complexes, Crystal field theory of octahedral and tetrahedral complexes, Low and high spin complexes. Metallic bond-Band theory of metals, Conductors, semiconductors and insulators. Secondary bonding- Hydrogen bonding, London forces and dipole-dipole interactions.

References:

1. J D Lee, "Concise Inorganic chemistry", Wiley India, 2012
2. B R Puri , L R sharma and K C Kalia, "Principle of Inorganic chemistry", Vishal Publishing Co., Punjab, 2017.
3. D F Shriver, P W Atkins, "Inorganic chemistry", Oxford India, 2014
4. A F Cotton, "Basic Inorganic chemistry", Wiley Publishers, 2007

CHM 4052: CHEMISTRY OF CARBON COMPOUNDS [3 0 0 3]

Introduction to Organic Compounds: Classification, Nomenclature; Alkanes: Homologous series, Preparation; Cycloalkanes: Ring size and strain, Applications; Alkenes: Markovnikov and anti-Markovnikov addition reactions, Reduction, applications; Alkynes: Acidity, preparation, Reduction of alkynes, applications; Alkyl halides: SN1, SN2, E1 and E2 reaction mechanisms; Alcohols: Classification, Acidity, organo-metallic reagents; Aromatic compounds: Electrophilic and nucleophilic substitution reactions; Mechanism of some named reactions; Carbonyl compounds: aldehydes and ketones, carboxylic acids and carboxylic acid derivatives; Heterocyclic compounds: Nomenclature, synthesis and reactivity of thiophene, pyrrole and furan; Carbon materials: Fullerenes, carbon thin films, nanotubes and carbon fibers; Carbon nanotubes: SWNT, MWNT, synthesis, properties and applications; Carbon nanomaterials applications.

References:

1. B S Bahl and Arun Bahl, "Advanced Organic Chemistry", S Chand, New Delhi, 2012.
2. Robert T. Morrison and Robert N. Boyd, "Organic Chemistry", Pearson, New Delhi, 2016.
3. P.S. Kalsi, "Organic Reactions and Their Mechanisms", New Age International Private Limited, New Delhi, 2017.
4. Ashutosh Tiwari and S. K. Shukla, "Advanced Carbon Materials and Technology", John Wiley & Sons, 2013.
B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

OPEN ELECTIVES

CHM 4301: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

References:

1. D.A. Skoog, J. Holler, F.T.A. Nieman, *Principles of Instrumental Analysis*, 5thEdn, Saunders, Philadelphia, 1992
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, 5thEdn, Saunders College Publishing, Philadelphia, 1988
3. *Vogel's Textbook of Quantitative Chemical Analysis*, GH Jeffery, John Wiley & Sons Inc, 5thEdn, 1989

CHM 4302: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]

Adsorption & Catalysis: Physisorption and chemisorption, Adsorption isotherms, Factors influencing adsorption, Adsorption of gases by solids, Adsorption from solution, Introduction to catalysis, Energetics, Catalytic cycles Solutions & Solubility: Ideal and non-ideal solutions, Raoult's law, Thermodynamics of ideal solutions, Vapor pressure and boiling point composition curves, Distillation behaviour of completely miscible & immiscible liquid systems, Azeotropes Colligative Properties: Determination of molar masses from vapor pressure lowering, Osmotic pressure, Boiling point elevation and Depression of freezing point, Vant Hoff's factor Colloids: Types, Preparation and purification of sols, General properties, Optical, Electrical & Kinetic properties of sols, stability of sols, Application of colloids, Emulsions & Gels- Types, Preparation, Properties and their applications.

References:

1. *Principles of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publications, New Delhi, (23e), 2008
2. *Principles of Physical Chemistry*, S.H. Maron, C.F. Prutton, IBH Publishing co. New Delhi, (4e), 1985
3. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West, F.J. Holler, R. Crouch, (4e),Thomson-Brooks, 2007

CHM 4303: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]

Introduction and principles of green chemistry, Examples, Atom economy, carbon efficiency, life cycle analysis, sustainable products, process and synthesis catalysis and green chemistry, examples of fine and bulk chemicals production, catalysts for clean technology. Application of ecofriendly approach to waste treatment. Cleaner production processes, clean synthesis in lab Scale, industrial examples, use of ecofriendly energies. Bio-pesticides, polymers & pharmaceutical products. Electrochemical synthesis, Alternate reaction media using water and other green solvents, ionic liquids & supercritical fluids; phase transfer catalysis.

References:

1. P.T. Anastas, J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001
3. P. T. Anastas, R. H. Crabtree, *Handbook of Green Chemistry and Catalysis*, Wiely-VCH, Weinheim, 2009

Inter Institute Open Electives

Centre for Creative and Cultural Studies (CCCS), Manipal

IIE 4301: ART APPRECIATION [3 0 0 3]

How to read a visual, how to enjoy or feel an art form, what is Creative Thinking? Indian Art: Heritage & Culture; Art Appreciation: Western Art, Artist & Art Movements: Raja Ravi Verma, Tagore, Da Vinci, Van Gogh; Aesthetics: Beauty, Feel & Expression; Art & Science; Art & Film; Art: Freedom & Society, to be an art literate. A journey to immerse in the world of Art.

IIE 4302: INDIAN CULTURE AND CINEMA - AN INTRODUCTION [3 0 0 3]

Introduction to Idea of Culture, Identity and tradition, Indian Cultural History, Indian cultural history, Time and space, Indian Art and heritage, Indus valley civilization – Indian Independence, Post-colonial India, Modern India, Indian Cinema, Body, language and feel, Film and culture, Evolution, Interpretation and Reflection, Indian Cinema, Media and the medium, Pioneers and classical films, Culture and art of cinema, Culture, Cinema and Society, Revolutions, ideas, innovations, Culture, Cinema and Peace, Message, purpose and the challenge.

Manipal Institute of Management, Manipal

IIE 4304: CORPORATE FINANCE [3 0 0 3]

Introduction to Corporate Finance, Financial Goal, Agency Problems, Managers vs Shareholders Goals, Concepts of Value and Return, Capital Budgeting Decisions, Cost of Capital, Calculation of the Cost of Capital in Practice, Financial and Operating Leverage, Capital Structure, Relevance of Capital Structure, Irrelevance of Capital Structure, Relevance of Capital Structure, Dividend Theory, Dividend Relevance, Dividend Relevance, Dividend and Uncertainty, Dividend Irrelevance, Principles of Working Capital Management.

References:
1. Brealey, R., Myers, S., Allen, F., & Mohanty, P. (2014). Principles of Corporate Finance (11e). New Delhi : Mc Graw Hill Education (India) Private Limited,.
2. Pandey, I. M. (2014). Financial Management (10e). New Delhi: Vikas publishers.
3. Ross, S. A., Westerfield, R. W., Jaffe, J., & Kakani, R. K. (2014). Corporate Finance (10e). New Delhi: Mc Graw Hill Education (India) Private Limited.
4. Parasuraman, N. R. (2014). Financial Management - A Step-by-Step Approach (1e.). New Delhi: Cengage Learning India Private Limited.

IIE 4305: INTERNATIONAL BUSINESS MANAGEMENT [3 0 0 3]

Historical perspective of international business, International business environment, Modes of entering international business, Cross-Culture and dynamic market understanding, Differences in Culture, Theories of international business, World Bank, World trade organization, Multinational Corporations and their involvement in International Business, Tariffs and quotas, Balance of Payment Account.

References:
1. Hill Charles, W. L., & Jain Arun, K. (2011). International Business: Competing in the Global Marketplace. (8e), Tata McGraw Hill.
2. Kumar, S. P., & Sanchari, S. (2012). International Business Management-A Global Perspective. New Delhi: Excel Books.

IIE 4306: BRAND MANAGEMENT [3 0 0 3]

Introduction to brand management, Developing a brand strategy, Brand resonance and brand value chain, Designing and implementing brand marketing programs to build brand equity, Measuring and interpreting brand performance, Designing and implementing brand architecture strategies, Managing brands.

References:
1. Keller, K. L., Parameswaran, M. G., Jacob, I. (2015). Strategic Brand Management (4e). Noida, India: Pearson Prentice Hall Publication.
2. Rowles, D., (2014). Digital Branding (1e.). UK: Kogan Page Limited.
3. Kapferer, J. N., (2012). The New Strategic Brand Management: Advanced Insights and Strategic Thinking (5e). UK: Kogan Page Limited

Centre for Integrative Medicine & Research (CIMR)

IIE 4307: YOGA [3 0 0 3]

Aim, Objectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconcepts of Yoga, Schools of Yoga, Ashtanga Yoga

Subjects by Industry Experts

IIE 4308: HEALTH ECONOMICS [3 0 0 3]

Economics: Understanding Economics, Efficiency, Rational decision making, Opportunity costs, Supply and demand, Price discovery, Health economics: Defining health, Human capital, what does supply and demand mean in the context of health? Arrow on the uncertainty and welfare economics, The Moral hazard, DALY and QALY, Efficiency: The Production possibility frontiers. The production function for health care. Health policy, Defining equity, Standards of healthcare provision Epidemiology, The Healthcare sector, The demand for health, Disease prevalence, The pharmaceuticals market, Cross country case studies.

References:
1. Sloan, Frank A., and Chee-Ruey Hsieh. Health economics. MIT Press, 2012
2. Annemans, L. Health economics for non-economists. An introduction to the concepts, methods and pitfalls of health economic evaluations. Academia Press, 2008
3. Jeffery, Roger. The politics of health in India. University of California Press, 1988.

IIE 4309: DIGITAL MEDICINE [3 0 0 3]

Present day practice of medicine. Limitations of scalability in the present framework. Introduction to computing, algorithms, big data, semantic web, mobility. Communication-WAN/LAN, 3G/4G and 5G. Patient/Electronic Health records. Experience with these records elsewhere Wearables, the physics of data capture. Practical demonstration of wearables Genomics, an introduction. Computational genomics including the software. Imaging –an introduction-ionizing and non-ionizing. Imaging software and science of diagnosis. How all the four 4 pillars-PHR/EHR, Wearables, Genomics and Imaging come together with software as the glue to change the world of medicine.

References:
1. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL, 2001
2. Durbin, Richard, Sean Eddy, Anders Krogh, and Graeme. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1999

Manipal College of Nursing Manipal

IIE 4310: MEDICAL EMERGENCY AND FIRST AID [3 0 0 3]

Principles of First Aid, First aid kit and equipment, emergency drugs, scene assessment, safety and identifying hazards, patient assessment, Basic Life Support and AED, triage, extrication/stretchers, ambulance. Describe the causes, signs and symptoms and management of respiratory emergencies, acute gastro-intestinal emergencies, musculoskeletal emergencies, dental, ENT and eye emergencies, renal emergencies, nervous system emergencies, hematological emergencies, endocrine emergencies, toxicological emergencies, environmental emergencies, pediatric emergencies, psychiatric emergencies, obstetrical emergencies

References:

1. Pollak, A.N. (2005). Emergency care and transportation of the sick and injured. Massachusetts: Jones and Bartlett publishers.
2. Keen, J. H. (1996). Mosby's Critical Care and Emergency Drug Reference. Missouri: Mosby's year book.
3. Walsh, M. (1990). Accident and emergency nursing. A new approach. Oxford: Butterworth Heinemann Ltd.
4. Sbaih, L. (1992). Accident and emergency Nursing. A nursing model. London: Chapman and Hall.
5. Sbaih, L. (1994). Issues in accident and emergency Nursing. London: Chapman and Hall.
6. Bourg, P., & Rosen, S. P. (1986). Standardized nursing care plans for emergency departments. Missouri: The C. V. Mosby Company.
7. Howard, P.K., &Steinmann, R. A. (2010). Sheehy's Emergency Nursing principles and practice. Missouri: Mosby Elsevier.
8. Sira.S, (2017). First Aid Manual for Nurses (First ed.), New Delhi: CBS Publishers & Distributors Pvt. Ltd.

IIE 4311: LIFE STYLE MODIFICATION AND COMPLEMENTARY AND ALTERNATIVE THERAPIES [3 0 0 3]

Principles and concepts of life style modification and various complementary and alternative therapies, Demonstrate skill in performing different yoga aasanas, guided imagery/Progressive muscle relaxation, meditation & Pranayama, reflexology, massage therapy, aerobics, laughter therapy

References:

1. Bhat Krishna K. The power of yoga. Suyoga publications; DK, 2006
2. M.M.Gore. Anatomy & Physiology of yogic practices; (5e), New age book.
3. K N Udupa. Stress and its management by yoga. (2e). Motilal Banarsidas publishers Pvt. Ltd, Delhi, 2007.
4. Yoga and total health. A monthly journal on the yoga a way of life.
5. Swami Satyananda Saraswati. Dynamics of yoga. (2e), Bihar school of yoga, Bihar 1997.

Welcomegroup Graduate School of Hotel Administration, Manipal

IIE 4312: INDIAN CUISINE AND CULTURE PRACTICAL [3 0 0 3]

Introduction to Indian cuisine, Basic Indian gravies, Rice cooking, Preparation of various rice products, Tandoor Cooking, Indian sweets, Comfort Food, Regional and sub-regional cuisine.

IIE 4313: FOUNDATION COURSE IN BAKING AND PATISSERIE PRACTICAL [3 0 0 3]

Introduction to Patisserie and Baking Principles, Special emphasis placed on the study of ingredient functions, Students will have the opportunity to apply basic baking techniques, Understanding fundamentals of yeast dough production, Emphasis on the application of ingredient functions, product identification and recipe interpretation occurs throughout the course, Pastry Basics and Pie dough, The fundamental production of classical European pastry based desserts are included, Techniques of Cake Making, Techniques of Cookie making, The course emphasizes the preparation and makeup techniques of various cookies.

References:

1. Wayne Gisslen – Professional Baking, (5e), John Wiley USA.
2. Haneman L.J. Bakery: Flour Confectionery HEINMAN.
3. Mermaid Books The Book Of Ingredients DOWELL PHILIP.
4. John Wiley Understanding Baking AMENDOLA JOSEPH.
5. New Age International, A Professional Text to Bakery and Confectionery, KINGSLEE JOHN.
6. Virtue And Company Ltd., The New International Confectioner: WILFRED J. FRANCE.
7. Charrette Jacques, Great Cakes and Pastries, TEUBNER CHRISTIAN.
8. Joseph Amendola, Baker's Manual, (5e), NICOLE REES.
9. Joseph Amendola, Understanding Baking, (3e), NICOLE REES.
10. Culinary Institute Of America, Baking and Pastry: Mastering the Art and Craft, JOHN WILEY.

IIE 4314: GLOBAL CUISINE & CULTURE- PRACTICAL [3 0 0 3]

European Cuisine: Familiarization of ingredients, recipes and preparation of different countries. North American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. South American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Asian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Australian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. African Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Molecular Gastronomy: Additives, Tools, and Recipes. Processed Food: Comparison and Critiquing. Mediterranean and European cuisine: Familiarization of ingredients, recipes and preparation of different countries.

References:

1. The Professional Chef - The Culinary Institute of America
2. Practical Cookery - Kinton, Ceserani and Foskett
3. Food Production Operation - Parvinder S. Bali
4. Professional Cooking - Wayne Gisslen
5. Cookery for the Hospitality Industry - Dodgshun Peters
6. Modern Cookery - Thangam E Phillips

School of Communication, Manipal

IIE 4315: REPORTING AND WRITING [3 0 0 3]

Introduction to news writing news in different media, news, definition of news, news values; types of news other theoretical issues relating to news writing. News Reporting Basic of news writing: structure of news reports; writing the lead; the changes in the composition of the lead; techniques of news gathering; sources of news. Reporting various types of reporting (Objective, Interpretative, Investigative,) General assignment reporting/working on a beat. Reporting for news agency, periodicals and magazines. Interviewing: doing the research, conducting the interview, types and formats of interviews, writing interviews

References:

1. Mencher, Melvin (2006): News Reporting and Writing, Mac-Graw Hill, Boston.
2. Scalnan, Christopher (2000): Reporting and Writing: Basics for the 21st Century, Harcourt College Publishers.
3. Harrington Walt (1997) Intimate Journalism: The Art and Craft of Reporting Everyday Life, Sage Publications.
4. Carole, Rich (2007), Writing and Reporting News: A Coaching Method, Thomson Learning Inc.Kamath, K.V. (1993): Journalists' Handbook, Vikas Publishing House.
5. Aggarwal, Vir Bala (2006): Essentials of Practical Journalism, Concept Publishing Company.

**IIE 4316: INTRODUCTION TO ADVERTISING &
PUBLIC RELATIONS [3 0 0 3]**

Introduction to advertising; Evolution and history of advertising; Influence of advertising on society and ethics. Advertising as part of marketing mix; Structure and types of ad agencies; Advertising planning; creative strategy and implementation (media strategy). The essentials of advertising on different media platforms – print, broadcast, internet and new media; discuss the difference in planning and execution using examples or campaign case studies. Public Relations-scope; definition; evolution; establish difference between PR and advertising; Identifying stakeholders and various Public Relation tools. Steps in developing a PR program/campaign-stating the problem, planning and programming, action and evaluation; Crisis communication; Ethical issues in Public Relations.

References:
1. Butterick, K (2012): Introducing Public Relations: Theory and Practice. New Delhi: SAGE Publications India Pvt. Ltd.
2. Cutlip, Center & Broom, (2000): Effective Public Relations.USA: Prentice Hall International.
3. Jaishri Jethwaney and Shruti Jain, (2012): Advertising Management. New Delhi: Oxford University Press
4. Reddi, C.V.N. (2009): Effective Public Relations and Media Strategy. New Delhi: PHI Learning Pvt. Ltd.
5. Sharma, S. & Singh, R. (2009): Advertising Planning and Implementation. New Delhi: PHI Learning Pvt. Ltd.

IIE 4317: BASIC PHOTOGRAPHY [3 0 0 3]

Photo Journalism: History of Photography and Photo Journalism. Photo Journalism: Definition, Nature, Scope and Functions of Photo Journalism – Qualification and Responsibilities of Photo Journalists, News Photographers and News Value, Types and Sources. Selection, Criteria for News Photographs – Channels of News Pictures – viz., Wire, Satellite, Agency, Stock, Picture Library, Freelancer, Photo Editing, Caption Writing, Photo – Presentation. Legal and Ethical aspects of Photography – Professional Organizations – Camera – Components and Types of Camera – Types of Lens, Types of Films, Types of Filters – Importance of Light and Lighting Equipments – Camera Accessories – Picture appreciation. Digital Camera – Digital Technology and its future – Darkroom Infrastructure – Film developing and Printing

References:
1. Basic Photography – Newnes
2. The Hamlyn Basic Guide to Photography – Hamlyn
3. Hamlyn Encyclopedia of Photography – Hamlyn
4. Photographing People – Guglielmezei
5. History of Photography – Cyernshem G R
6. Photo Journalism – Rothsteline
7. Techniques of Photo Journalism – Milten Feinberg
8. Freelance Photography – Jechsend Gedsey
9. Picture Editing – Stanley E Kalish and Clifton C Edom
10. News Photography – Jack Price
11. 1000 Ideas for better News Picture – High Sidley and Rodney Fox

IIE 4318: MEDIA PRODUCTION TECHNIQUES [3 0 0 3]

Print design elements – typography, colours, spacing, pictures, logos, graphics, principles of layout and design – basic writing skills. Photography – SLR camera, Lenses, Apertures and Shutter speeds, Exposure, Understanding light, Filters and assessories, composing a picture, developing and printing, creating special effects. Digital photography – digital camera – digital technology and its future. Television – Introduction to AV Media-pre-production, production, post-production. Show packaging-Camera-characteristics, parts and functions; Mounting accessories and movements. Shots-Types and Uses; Basic composition. Practical video recording process. Radio – Introduction to Radio-Microphone types, characteristics and uses; Cables and Connectors. Recording device-Types and Characters, Audio editing, Programme formats-news, drama, feature and PSA's and Advertising.

References:
1. Gerald Millerson, "Effective TV production"
2. Peter Jarvis, "The Essential TV director's Handbook
3. Hamlyn "Basic guide to photography"
4. Ralph Milton "Radio programming – a basic training manual"
5. Tomlinson Holman "Sound for film and television"
6. Reporting and writing by Melwin Mencher

IIE 4319: GRAPHIC & SKETCHING [3 0 0 3]

Basic Art Principles: Element of Art & Design, Contour Drawing, Composition Principles, Pencil shading, creating geometry model and shading. Basic Perspective: Still life sketching & Drawing, Styles of shading, Introduction to colors, color still life painting, Layout Design, Creating concepts for Design. Skeleton System, Body Proportions, Upper Body, Lower Body, Back, Hands and Legs. Text: Human Anatomy by Victor Perard, Dynamic Anatomy by Burne Hogarth. Gesture Drawing Tips, Line of Action, Dynamic Poses, Body Weight and Gravity, Clothing. Text: Figure Drawing by Anthony Ryder.

List of Practical's:
- 10 Drawings of Human Anatomy Study In Pencil
- 50 Drawings of Gesture Drawing In Pencil
- 5 Contour Drawing
- 2 Still Life Pencil Shading
- 2 Color Still Life
- 2 Layout Design

References:
1. Mastering Composition: Techniques and Principles to Dramatically Improve Your Painting (Mastering (North Light Books)) Hardcover – 25 Jan 2008 by Ian Roberts
2. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) Paperback – 1 by Beth Tondreau
3. Pencil Drawing: Learn how to develp drawings from start to finish with techniques for shading, contrast, texture, and detail (Artist's Library) Paperback – 1 Jan 1988 by Gene Franks
4. Drawing the Head and Figure – Jack Hamm
5. Dynamic Anatomy – Burne Hogarth
6. The artists complete guide to Human figure Drawing – Anthony Ryder
7. Human Anatomy – Victor Perard