Post Graduates Course of Study
(For batch 2023 onwards)

M. Tech. (Information and Cyber Security)
(Department of Computer Science and Engineering)

M. Tech. (Wireless Networks and Computing)
(Department of Information Technology)

M. Tech. (IC Design and Technology)
(Department of Electrical and Electronics Engineering)

Master of Business Administration
(Department of Management Studies)

ATAL BIHARI VAJPAYEE-
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY AND MANAGEMENT,
GWALIOR (MADHYA PRADESH)
(AN INSTITUTE OF NATIONAL IMPORTANCE, MINISTRY OF EDUCATION, GOVT. OF INDIA)

INDEX

Curriculum & Contents

M. Tech.
(Information and Cyber Security)

Department of Computer Science and Engineering

विश्वजीवनामृतं ज्ञानम्

ABV-Indian Institute of Information Technology & Management, Gwalior

2023

SCHEMA

Name of the program: M. Tech. (Information and Cyber Security)
(Credits: 75)

Name of the Department: Computer Science and Engineering

SEMESTER-I				
S. No.	**Subject Code**	**Title of the course**	**L-T-P**	**Credits**
1.	CS-601	Modelling and Simulation	3-0-0	3
2.	CS-602	Fundamentals of Cryptography	3-1-0	4
3.	CS-603	Advanced Computer Networks and Security	3-0-2	4
4.	CS-604	Implementation Techniques for Advanced Algorithms	3-0-2	4
5.	CS-605	Cyber Laws and Information Crime	3-0-0	3
			Total credits	**18**

SEMESTER-II				
S. No.	**Subject code**	**Title of the course**	**L-T-P**	**Credits**
1.	CS-606	Art of Engineering Research	2-0-2	3
2.	CS-607	Machine Learning	3-0-2	4
3.	CS-608	Cyber Forensics: Tools and Techniques	3-0-2	4
4.	CS-609	Formal Verification of Security Protocols	3-1-0	4
5.	CS-6XX	Elective I	3-0-0	3
6.	CS-6XX	Elective II	3-0-0	3
			Total credits	**21**

EXIT AFTER YEAR-1: Post Graduate Diploma in Information and Cyber Security

SEMESTER-III				
S. No.	Subject code	Title of the course	L-T-P	Credits
1	CS-6XX	Elective-III/MOOC	3-0-0	3
2	CS-6XX	Elective-IV/ MOOC	3-0-0	3
3	CS-698	Major Project Part I		12
			Total credits	18

SEMESTER-IV				
S. No.	Subject Code	Title of the course	L-T-P	Credits
1	CS-6XX	Elective-V OR Elective-VI/MOOC	3-0-0	3
2	CS-699	Major Project Part II		15*
			Total credits	18

*For students going on internship in Semester IV: Major Project Part II: 12 credits and additional Colloquium/Industrial Seminar: 3 credits.

SEMESTER-I	SEMESTER-II	SEMESTER-III	SEMESTER-IV	TOTAL CREDITS
18	21	18	18	**75**

Electives Courses

Electives I, III and V Category: Network Security Electives

S.No.	Subject Codes	Title of Courses	L-T-P
1	CS-611	Wireless & Mobile Security	3-0-0
2	CS-612	Intrusion Detection and Prevention	3-0-0
3	CS-613	Web application and Cloud security	3-0-0
4	CS-614	Malware Analysis	3-0-0
5	CS-615	Authentication and Access Control	3-0-0
6	CS-616	Digital Watermarking and Steganalysis	3-0-0
7	CS-617	IoT Protocols and Security	3-0-0
8	CS-618	Data Privacy in Social Networks	3-0-0
9	CS-619	Blockchain Technology	3-0-0

Electives II, IV and VI Category: System Security Electives

S.No.	Subject Codes	Title of Courses	L-T-P
1	CS-621	Software System Design	3-0-0
2	CS-622	Modern Cryptography	3-0-0
3	CS-623	Database Security	3-0-0
4	CS-624	Hardware Security	3-0-0
5	CS-625	Operating Systems Security	3-0-0
6	CS-626	Fault Tolerant System	3-0-0
7	CS-627	Quantum Cryptography	3-0-0
8	CS-628	Big Data and Cyber Fraud Analysis	3-0-0
9	CS-629	Secure System Engineering	3-0-0

Course Contents
(Core)

1	Semester	I
2	Type of course	Core
3	Code of the subject	CS-601
4	Title of the subject	Modelling and Simulation
5	Any prerequisite	Basic Mathematics
6	L-T-P	3-0-0
7	Learning Objectives of the subject	Develop mathematical models to represent real-world systems and problems. Apply simulation tools to solve complex problems in engineering, science, and management. Develop critical thinking skills in problem-solving and model validation.
8	Brief Contents	Introduction to probability: Joint and Conditional Probability, Random Variables, Bayesian Networks. Optimization: System Modelling and Optimization, Optimizing Linear Systems, Nonlinear Constrained Optimization. Game Theory: Concepts and Terminology, Solving a Game, Mechanism Design, Limitations of Game Theory.
9	Contents for lab	No

1	Semester	I
2	Type of course	Core
3	Code of the subject	CS-602
4	Title of the subject	Fundamental of Cryptography
5	Any prerequisite	Computer Networks, Information Systems Security
6	L-T-P	3-1-0
7	Learning Objectives of the subject	Describe the major security goals. Define security attacks that threaten security goals. Explain how various counter measures are used to protect security goals
8	Brief Contents	Introduction, Prime number generation, Shannon's theory of perfect secrecy, Traditional symmetric and asymmetric – key,

		Cryptographic attacks, Techniques, Substitution ciphers, Transposition ciphers, Stream ciphers, RSA cryptosystems, Rabin, El Gamal, Elliptic curve cryptosystems, Data Encryption Standard (DES) and Advanced Encryption Standard (AES), Message integrity, Message authentication and key management, Message integrity, Message authentication, Symmetric-key, Distribution, Kerberos, Public-key distribution.
9	**Contents for lab**	NA

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	CS-603
4	**Title of the subject**	Advanced Computer Networks and Security
5	**Any prerequisite**	Computer networks
6	**L-T-P**	3-0-2
7	**Learning Objectives of the subject**	The aim of the course is to enable students to develop specialized theoretical and practical knowledge of different computer network protocols, security risks and threats, weaknesses in communication systems and computer networks and the corresponding methods of protection and detection of attacks.
8	**Brief Contents**	CIA triad, User authentication, Access controls: security model, policy, and mechanisms, High performance switching and routing: introduction, Performance considerations, IP address lookup, Network security- threats, Weaknesses, Attacks and countermeasures, Honeypots, Domain key identified mail, Pretty good privacy, S/MIME
9	**Contents for lab**	Wireshark, Implementation of DoS attacks, detection and analysis; Implementation of IP spoofing attack; DoS attack with spoofed IP address, detection and analysis.

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	CS-604
4	**Title of the subject**	Implementation Techniques for Advanced Algorithms

5	**Any prerequisite**	Data Structure and Programming
6	**L-T-P**	3-0-2
7	**Learning Objectives of the subject**	To implement and learn the basic data structures and learn the appropriate algorithmic approach to a problem and implement various search and sorting techniques. To learn the appropriate algorithmic approach to a problem and implement various search and sorting techniques. Solve problems using fundamental algorithms. Demonstrate the ability to evaluate algorithms, justify that selection, and implement the algorithm in a particular context.
8	**Brief Contents**	Basics of linear and non-linear data structures, Asymptotic analysis, Recurrence relations, and Analysis of iterative and recursive algorithms. Searching and Sorting: Linear Search, Binary Search, Graph Algorithms, Introduction to recent research topics: Approximation Algorithms, Online Algorithms, Parameterized Algorithms.
9	**Contents for lab**	Implement linear and non-linear data structures, Binary trees, and Sorting techniques. Implementation of graph algorithms.

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	CS-605
4	**Title of the subject**	Cyber Laws and Information Crime
5	**Any prerequisite**	No
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	To understand the basics of cyber law and its related issues. To explain the basic information on cyber security To understand the issues those are specific to amendment rights. To have knowledge on copy right issues of software. To understand ethical laws of computer for different countries and Information and Technology Act, 2000.
8	**Brief Contents**	Introduction-cyber security, Private ordering solutions, Regulation and jurisdiction for global cyber security, Copyright-source of risks, Pirates, Internet infringement, Fair use, Postings, Criminal liability, First amendments, Data losing, Trademarks, Defamation, Privacy- common law privacy, Constitutional law, Federal statutes,

		Anonymity, Technology expanding privacy rights, Duty of care, Criminal liability, Procedural issues, Electronic contracts & digital signatures, Misappropriation of information, Civil rights, Tax, Evidence, Ethics, Legal developments, Late 1990 to 2000, Cyber security in society, Security in cyber laws case studies, General law and cyber law-a swift analysis. Evolution of the IT act, Genesis and necessity, Salient features of the it act, 2000, Various authorities under it act and their powers-penalties & offences, Amendments, Impact on other related acts (amendments), Cyber space jurisdiction, E – commerce and laws in India, Intellectual property rights, Domain names and trademark disputes, Sensitive personal data or information (SPDI) in cyber law, Cloud computing & law, Cyber law : international perspective, Cyber forensic and Computer crimes and types, Case laws: Indian & international cases
9	**Contents for lab**	No

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	CS-606
4	**Title of the subject**	Art of Engineering Research
5	**Any prerequisite**	No
6	**L-T-P**	2-0-2
7	**Learning Objectives of the subject**	To enable a student to develop their theoretical, methodological and research skills to enhance their ability to conduct rigorous research and reach to sound evidence-based conclusions. Understanding the nature of problem to be studied and identifying the related area of knowledge. Reviewing literature to understand how others have approached or dealt with the problem. Collecting data in an organized and controlled manner to arrive at valid decisions.
8	**Brief Contents**	Introduction to research, Analytical vs. Empirical methods, surveys, Controlled experiments, Ethnography and action research, Quantitative, Qualitative, and mixed methods, Choosing research methods, Validity threats. An empirical

research framework, Research problems, Literature reviews, Introduction to quantitative research, Study designs, Controlled experiments, Elements and methods, Example experiments, Data collection techniques, Analysis and interpretation of quantitative data, Descriptive statistics, sampling, Sampling distribution, Parameter estimation, statistical inference, Confidence interval and hypothesis testing, Tests of significance, Test of difference of mean and proportions, T-tests, ANOVA, Chi-square tests, Correlation, and regression, Review process, Review guidelines, Validity threats, Review decisions, Qualitative methods, Study designs, Elements, and methods, Data collection methods - primary and secondary sources, Types of data analysis methods, Survey research, Sampling methods, Survey study designs, Case studies, Introduction to mixed methods research, Study designs and method, Writing research papers, Purpose, nature and evaluation, Content and format, Research presentations, The art of scientific and technical writing.

9	**Contents for lab**	Problem statement practice Literature survey practice Technical paper writing – practice Presentation – practice

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	CS-607
4	**Title of the subject**	Machine Learning
5	**Any prerequisite**	Linear Algebra
6	**L-T-P**	3-0-2
7	**Learning Objectives of the subject**	To understand popular ML algorithms with their associated mathematical foundations for appreciating these algorithms. To help connect real-world problems to appropriate ML algorithm(s) for solving them and to enable formulating real world problems as machine learning tasks.
8	**Brief Contents**	Introduction to ML, Fundamentals of ML - PCA and Dimensionality reduction, Nearest neighbours and KNN, Linear regression, Decision tree classifiers, Notion of generalization and concern of overfitting, Notion of training, Validation, and testing; Connect to generalization and overfitting. Selected algorithms -

		ensembling and RF, Linear SVM, K means, Logistic regression, Naive bayes, Neural network learning - Role of loss functions and optimization, Gradient descent and Perceptron/Delta learning, MLP, Backpropagation, MLP for classification and regression, Regularization, Early Stopping, Kernels (with SVM), Bayesian methods, Generative methods, HMM, EM, PAC learning, Introduction to Deep Learning, CNNs, Popular CNN architectures, RNNs, GANS and Generative models, Advances in backpropagation and optimization for neural networks adversarial learning.
9	**Contents for lab**	To implement basic algorithms using basic machine learning libraries mostly in python. Gain hands-on experience in applying ML to problems encountered in various domains. In addition, obtain exposure to high-level ML libraries or frameworks such as TensorFlow, PyTorch.

	Semester	II
2	**Type of course**	Core
3	**Code of the subject**	CS-608
4	**Title of the subject**	Cyber Forensics: Tools and Techniques
5	**Any prerequisite**	Cryptography, Network Security
6	**L-T-P**	3-0-2
7	**Learning Objectives of the subject**	Overview of windows forensics; file system analysis; overview of memory forensics; anti-forensic techniques; hypervisor files and formats; forensic analysis of a virtual machine; overview of cloud forensics
8	**Brief Contents**	**Windows Forensics** - Volatile data collection, Non-volatile data collection, Registry Analysis, Browser Usage, Hibernate File Analysis, Crash Dump Analysis, File System Analysis, File Metadata and Timestamp Analysis, Event Viewer Log Analysis, MFT analysis, Timeline Creation, Evidence Collection in Operating system, **Memory Forensics** - History of Memory Forensics, x86/x64 architecture, Data structures, Volatility Framework & plugins Memory acquisition, File Formats – PE/ELF/Mach-O, Processes and process injection, Command execution and User activity, Networking, sockets, paged memory and advanced registry artifacts, Related tools – Bulk Extractor and YARA, Timelining memory, Recovering and tracking user activity,

		Recovering attacker activity from memory, Introduction to Anti-forensics, tools and techniques, **Virtual Machine Forensics** - Types of Hypervisors, Hypervisor Files and Formats, Use and Implementation of Virtual Machines in Forensic Analysis, Use of VMware to establish working version of suspect's machine, Networking and virtual networks within Virtual Machine, Forensic Analysis of a Virtual Machine, **Cloud Forensics** - Cloud Storage Forensic Framework, Dropbox analysis: Data remnants on user machines, Evidence source identification and analysis, Collection of evidence from cloud storage services, Examination and analysis of collected data. Google Drive: Forensic analysis of Cloud storage and data remnants, Evidence source identification and analysis - Collection of evidence from cloud storage services, Examination and analysis of collected data, Issues in cloud forensics.
9	**Contents for lab**	No

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	CS-609
4	**Title of the subject**	Formal Verification of Security Protocols
5	**Any prerequisite**	Basic knowledge of computer security and discrete mathematics
6	**L-T-P**	3-1-0
7	**Learning Objectives of the subject**	To understand the theoretical foundation behind a security protocol. To Understand the principles of formal verification and its application to security protocols. To Understand the various types of security protocols and their vulnerabilities. To Learn how to specify security properties and verify their correctness using formal verification tools.
8	**Brief Contents**	Basic of Logics: BNF, Labelled transition systems, Operational semantics, Protocol specification, describing protocol execution, Security properties: secrecy, authentication, Aliveness, Synchronization, the analysis of security protocols: abstract state machines, Belief logics, Constraint, Provable security, modelling guessable numbers, Modelling time, The BAN Kerberos Protocol, modelling ban Kerberos, Verifying ban Kerberos.

9	**Contents for lab**	No

Course Contents
(Electives)

1	Semester	II/III/IV
2	Type of course	Elective
3	Code of the subject	CS-611
4	Title of the subject	Wireless & Mobile Security
5	Any prerequisite	Mobile computing & wireless networks, security fundamentals
6	L-T-P	3-0-0
7	Learning Objectives of the subject	Issues and technologies involved in designing a wireless and mobile system that is robust against various attacks. Broad knowledge of the state-of-the-art and open problems in wireless and mobile security, enhancing potential to do research or pursue a career in this rapidly developing area. Learn various security issues related to GPRS and 4G/5G.
8	Brief Contents	Mobile communication history, Security – wired vs wireless, Security issues in wireless and mobile communications, Security requirements in wireless and mobile communications, Security for mobile applications, advantages and disadvantages of application – level security, Mobile devices security requirements, Mobile wireless network level security, Server level security. Application-level security in wireless networks: application of WLANs, Wireless threats, Some vulnerabilities and attach methods over WLANs, Security for wi-fi, Generations of cellular networks, Security issues and attacks in cellular networks, GSM security for applications, GPRS security for applications, UMTS security for applications, 3G security for applications, Some of security and authentication solutions, MANET, Some applications of MANETs, MANET features, Security challenges in MANET, Security attacks on MANET, External threats for MANET applications, Internal threats for MANET applications, Some of the security solutions. Ubiquitous computing, Need for novel security schemes for ubiquitous computing, Security challenges for ubiquitous computing, and security attacks on ubiquitous computing networks, Some of the security solutions for ubiquitous computing.
9	Contents for lab	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-612
4	**Title of the subject**	Intrusion Detection and Prevention
5	**Any prerequisite**	Computer Networks, Operating Systems, Information Systems Security
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	To give students practical, working knowledge in intrusion detection and traffic analysis. To gain an understanding of the workings of TCP/IP, methods of network traffic analysis and popular network intrusion detection systems.
8	**Brief Contents**	IDS/IPS definition and classification -Basic elements of attacks and their detection -Misuse detection systems, Anomaly detection systems and supervised learning in IDS, Testing IDS and measuring their performances, Computational complexity, Theoretic IDS models and quality criteria, Intrusion detection in virtual networks, Law Enforcement / Criminal Prosecutions – Standard of Due Care – Evidentiary Issues.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-613
4	**Title of the subject**	Web application and cloud security
5	**Any prerequisite**	Operating system, Distributed System, Information Security
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Cloud services facilitate access to server infrastructure which is managed by the provider, which includes data storage and access, security and scalability and updates.

		This course aims at providing the students an insight into the operations of cloud and introduces them to different cloud providers available.
8	**Brief Contents**	Introduction to cloud computing, Cloud service delivery models, Cloud deployment models, Cloud computing security, Scalable application on AWS, Provisioning application resources with cloud formation, AWS security, AWS directory service, AWS key management service, Cloud deployment models – Public, Private and hybrid, Trusted cloud initiative (TCI) and cloud trust protocol (CTP), Transparency as a service (TaaS) and Security as a service (SaaS), cloud security, Top threats to cloud security, Comparison of traditional it and cloud security.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-614
4	**Title of the subject**	Malware analysis
5	**Any prerequisite**	Information System Security, Machine Learning
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Learn how to dissect malware to gather information about the malware functionality, perform analysis on all major file types and understand how the system was compromised so that you can defend against future attacks.
8	**Brief Contents**	Introduction to malware, Types and goals of malware analysis process, Virtual machine setup, Analyzing malicious windows programs, Static analysis and dynamic analysis, Analysis of malicious documents, Malware defences.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-615
4	**Title of the subject**	Authentication and Access Control

5	**Any prerequisite**	Information System Security
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Introduce the concept of access control to information systems in applications, authentication, and accounting for end users and system administrators. Learn the security controls for access control including tokens, biometrics, and use of public key infrastructures (PKI).
8	**Brief Contents**	Access control and assessing risk, Business drivers and access control policies standards, Procedure and guidelines, unauthorized access – security breaches and mapping business challenges, Human nature – organizational behaviour and access control for information systems, Physical security and access control in the enterprise, Access control implementation for systems and remote workers, PKI infrastructure and encryption, Testing access control systems and assurance
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-616
4	**Title of the subject**	Digital Watermarking and Steganalysis
5	**Any prerequisite**	Image Processing, Information Security
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	To learn about the watermarking models and message coding. To learn about watermark security and authentication. To learn about steganography and perceptual models.
8	**Brief Contents**	Applications and properties, evaluating watermarking systems, Models of watermarking, Communication based watermarking, Geometric models of watermarking, Modelling watermarks detection by correlation, Informed embedding, Informed coding, Dirty paper codes, Perceptual model, Watson's model, Adaptive watermarking, Robust watermarking, Watermark security secret writing and steganography, Watermarking for copyright protection.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-617
4	**Title of the subject**	IoT protocols and security
5	**Any prerequisite**	Programming in C, Computer Network Fundamentals
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	The advanced topics of IoT security and privacy challenges. systematic analysis of IoT security hardware, communication, and system perspectives.
8	**Brief Contents**	Fundamentals, Architecture of IoTs, IoT security requirements, IoT privacy preservation issues, Attack Models – attacks to sensors in IoTs, Attacks to RFIDs in IoTs, Attacks to network functions in IoTs, Attacks to back-end systems, Security in front-end sensors and equipment, Prevent unauthorized access to sensor data, M2M security, RFID security, Cyber-physical object security, Hardware security, Front-end system privacy protection, Networking function security- IoT networking protocols, Secure IoT lower layers, Secure IoT higher layers, Secure communication links in IoTs, Back-end security -secure resource management, Secure IoT databases, Security products-existing testbed on security and privacy of IoTs, Commercialized products
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-618

4	**Title of the subject**	Data Privacy in Social Network
5	**Any prerequisite**	Fundamental knowledge of computing and programming
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Increase the understanding of privacy aspects on various online platforms. Understand the threats and defend user privacy through real-time and scalable systems.
8	**Brief Contents**	Various privacy breaches and its effects; Privacy cases, litigations, and outcomes, Difference between data security and data privacy; Contextual integrity theory and applications, Online Social Networks (OSN), Data collection from social networks, Challenges, Opportunities, and pitfalls in online social networks, Image and location privacy; Ethics; Conducting studies; Privacy from 3rd party trackers and advertisers, Phishing in OSM and identifying fraudulent entities in online social networks, Privacy policies.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-619
4	**Title of the subject**	Blockchain Technology
5	**Any prerequisite**	Basic cryptography and data structure
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Get an overview of blockchain technology, its history, benefits, drawbacks, and future. Examine the nascent blockchain technology and make an initial pass at identifying some of its major vulnerabilities. Design, build, and deploy distributed applications. Equip students with the skills necessary to create e-governance applications for the public good.
8	**Brief Contents**	Overview of blockchain technology, Peer-to-Peer networking, Blockchain categories, Mining mechanism, Blockchain architecture: Pros & Cons, Bitcoin & protocol, Architecture of blockchain- Block, Byzantine General problem and Fault tolerance, Merkle tree, transactions and fee, Anonymity, Reward, Private and public blockchain, Bitcoin transaction structure, Double spending problem, Introduction to consensus Problem real time of application of blockchain.

9	**Contents for lab**	No	

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-621
4	**Title of the subject**	Software System Design
5	**Any prerequisite**	Basic software engineering course
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Outline the software design process and demonstrate how the essential design principles are applied within it. Illustrate the essential elements of software structure and architecture in terms of styles, patterns and families of programs and frameworks. Demonstrate the application of quality analysis and evaluation principles. Employ function, object, data-structure, and component-based design methodologies in a typical software design project.
8	**Brief Contents**	Software design fundamentals, Key issues in software design, Concurrency, Control and handling of events, Error exception handling and fault tolerance, Software structure and architecture, design patterns, architecture design decisions, User interface design, Metaphors and conceptual models, Software design quality analysis and evaluation, Structural descriptions (static view), Behavioural descriptions (dynamic view), Software design strategies and methods
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-622
4	**Title of the subject**	Modern Cryptography
5	**Any prerequisite**	Fundamental knowledge of cryptography
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	To develop a framework to understand and implement cryptographic aspects.

		To enhance an ability to analyse a problem and identify and define the computing requirements for data security.
8	**Brief Contents**	Classical encryption techniques, Security attacks, Block cipher principles, Data Encryption Standard (DES), Triple DES, Advanced Encryption Standard (AES), Block cipher modes of operation, Blowfish, RC4 algorithm, Principles of public key cryptosystems, The RSA algorithm, Diffie Hellman key exchange, ElGamal Encryption, Elliptic curve cryptography, Authentication, MAC, Hash functions, Digital signatures, Authentication protocols, SHA, MD5, Zero-knowledge proof systems, Oblivious transfer, Multi-party secret sharing, Two-party computation using garbled circuits, fully homomorphic encryption.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-623
4	**Title of the subject**	Database Security
5	**Any prerequisite**	Knowledge of database management system
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Learn techniques to protect databases against compromises of their confidentiality, integrity and availability. Explain the place of database security in the context of security analysis and management.
8	**Brief Contents**	Database design and use of DBMS, Relational models, Relational algebra and design principles, Datalog, Physical security, Information system access control, Authorization, identification, Authentication, Accountability, Access control matrix, Use of views, Security logs and audit trails, SQL data control language (authorization graphs), Statistical database security, SQL injection, Proxy servers, Firewalls, Digital signatures, Certification authorities (SSL, Kerberos), Micro-databases, Linking attacks, k-anonymity, l-diversity, t-closeness, Differential privacy.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-624
4	**Title of the subject**	Hardware Security
5	**Any prerequisite**	Digital Logic Design, Information System Security, Computer Programming, Cryptography
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	This course covers basic concepts in the security of hardware systems. Understand the vulnerabilities in current digital system design process and various attacks to the hardware designs. Get acquainted with the tools and skills to build secure and trusted hardware.
8	**Brief Contents**	Digital system design: Basics and vulnerabilities, Active and passive attacks, reverse engineering, Counterfeiting, and design of hardware security primitives, Side channel attacks and countermeasures, Hardware trojan detection and trusted IC design
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-625
4	**Title of the subject**	Operating System Security
5	**Any prerequisite**	Operating Systems
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	This course is a study of the principles and concepts of Network Security from the perspective of the Operating System (OS). Students will examine the principles, practices, and policies related to hardening and securing Operating Systems, so they are impervious to security threats. It focuses on the vulnerabilities and the related countermeasures of various Operating Systems and Network Devices.
8	**Brief Contents**	System security, MS windows security, Linux security, UNIX security, Embedded and real-time OS, System reliability, OS security mechanisms, Security administration,

Delegation of authority, Group policy design, Security configuration, Password requirements, security services, Protection models, Protection levels, protection domains, Capabilities, Sharing, System kernel security, Resource control, Secure booting, Firewalls and border security, Security models and policies, Security levels, Authentication, Confidentiality, Integrity, Access control strategies access matrix, Access control list, mandatory, Discretionary, Monitoring, Auditing, accountability, Privilege, account security, File system protection, Registry security, Threat analysis, Security attacks, Security-hardened operating, New risks, Threats, and vulnerabilities associated with the Microsoft Windows operating system. Emphasis on Windows latest versions, on the desktop, and windows Server latest versions. Emphasis on how to use tools and techniques to decrease risks arising from vulnerabilities in Microsoft windows operating systems and applications, OS hardening, Application security, and incident management, among other issues.

9	Contents for lab	No

1	Semester	II/III/IV
2	Type of course	Elective
3	Code of the subject	CS-626
4	Title of the subject	Fault Tolerant Systems
5	Any prerequisite	Probability and Statistics
6	L-T-P	3-0-0
7	Learning Objectives of the subject	This course introduces basic concepts of design and implementation of fault tolerance in general systems. The purpose of this course is to establish fault tolerance as a measure to improve the dependability of systems in the presence of faults and correlating this dependability with the effects to the system and functional safety. The students will be exposed with the quantitative and qualitative methodology used for computation of fault tolerance.
8	Brief Contents	Basic concept of reliability, Fundamentals of dependability, Dependability evaluation, Test generation, Fault diagnosis and self-repair, Fault-Tolerant design of Digital Systems, Self- checking and Fail-safe logic,

		Design for testability, Verification and validation, Software fault tolerance, Case studies
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-627
4	**Title of the subject**	Quantum Cryptography
5	**Any prerequisite**	Familiarity with basic notions in cryptography (encryption, authentication, security definitions.
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Basic understanding about Quantum Information and Computation. Getting an overall understanding about Quantum Key Distribution and Secret Sharing protocols. To obtain the flavour of quantum supremacy over classical computation. Design reliability models for software systems.
8	**Brief Contents**	Introduction to quantum computing, Quantum money and its attacks, Mathematical model for quantum mechanics, Quantum algorithms (Lattice cryptography, Dihedral Hidden Subgroup Problem, Other Post-quantum Cryptosystems) and their attacks, Quantum encryption and notions of security. The quantum one-time pad, Measuring randomness, Extractors and privacy amplification, Information reconciliation, Two-party quantum cryptography, Quantum true random number generators, Other cryptologic issues.
9	**Contents for lab**	No

1	**Semester**	II/III/IV
2	**Type of course**	Elective
3	**Code of the subject**	CS-628
4	**Title of the subject**	Big Data and Cyber Fraud Analysis
5	**Any prerequisite**	Basic concepts of mathematics and information security
6	**L-T-P**	3-0-0

7	Learning Objectives of the subject	Formulate and evaluate reasons for using data analysis to detect frauds in the cyberspace. Make users familiar with different types of cybercrimes and acquire necessary knowledge and skill to prevent the occurrence of such crimes in organizations.
8	Brief Contents	Cyberspace, Attack, Attack vector, Attack surface, Threat, risk, Vulnerability, Exploit, Exploitation, Hacker, Non-state actors, Cyber terrorism, Introduction to cybercrime: Concepts and techniques, Channels of cybercrimes, Cybercrime methods, Computer insecurity, Computer fraud protection, Incident of cybercrimes, Cybercrime risk management, Cyber forensics, Online transactions, Global payment processing, Payment cards & data security, electronic card frauds - ATM cards, Credit cards, Smart cards, Cyber law in India, Information technology act – 2000, Regulatory compliance.
9	Contents for lab	No

1	Semester	II/III/IV
2	Type of course	Elective
3	Code of the subject	CS-629
4	Title of the subject	Secure System Engineering
5	Any prerequisite	Software Engineering
6	L-T-P	3-0-0
7	Learning Objectives of the subject	Assess software security requirements to prevent data loss. Design software to meet software security requirements. Develop strategies to mitigate security vulnerabilities. Develop guidelines for operational security. Conduct software security reviews and audits. Develop a software security monitoring policy.
8	Brief Contents	Software vulnerabilities, Software security and software quality assurance, Security requirement gathering principals and guidelines, Secure software architecture, Architecture risk analysis, Software security knowledge for architecture and design, Security guideline and attack patterns, Testing software vulnerability in SDLC, Mitigating Software Vulnerabilities in SDLC, Static analysis techniques, Security testing, Operating software security, Maintaining software security
9	Contents for lab	No

Curriculum & Contents

M. Tech.
(Wireless Networks and Computing)

Department of Information Technology

विश्वजीवनामृतं ज्ञानम्

ABV-Indian Institute of Information Technology & Management, Gwalior
2023

SCHEMA

Name of the program: M. Tech. (Wireless Networks and Computing)
(Credits: 74)

Name of the Department: Information Technology

S.No.	Course Code	Course Name	L-T-P	Credits
		SEMESTER – I		
1.	IT 601	Probability and stochastic process	3-1-0	4
2.	IT 602	Wireless networks	3-0-0	3
3.	IT 603	Mobile computing	3-0-0	3
4.	IT 604	Modelling and simulation	3-0-0	3
5.	IT 6XX	Elective-I	3-0-0	3
6.	IT 605	Network and computing lab	0-0-6	3
			Total	**19**

S.No.	Course Code	Course Name	L-T-P	Credits
		SEMESTER - II		
1.	IT 606	Next generation networks	3-1-0	4
2.	IT 607	Graphs and networks	3-0-0	3
3.	IT 608	Machine learning	3-0-2	4
4.	IT 609	Engineering research methodology	2-0-0	2
5.	IT 6XX	Elective-II	3-0-0	3
6.	IT 6XX	Elective-III	3-0-0	3
			Total	**19**

EXIT AFTER YEAR-1: Post Graduate Diploma in Wireless Networks and Computing

S.No.	Course Code	Course Name	L-T-P	Credits
		SEMESTER - III		
1.	IT 6XX	Elective-IV/MOOC-I	3-0-0	3
2.	IT 6XX	Elective-V/MOOC-II	3-0-0	3
3.	IT 698	Thesis Part-I/ Internship	0-0-24	12
			Total	**18**

		SEMESTER - IV		
S.No.	**Course Code**	**Course Name**	**L-T-P**	**Credits**
1.	IT 6XX	Elective-VI/MOOC-III	3-0-0	3
2.	IT 699	Thesis Part-II	0-0-3	15
			Total	**18**

Semester-I	Semester-II	Semester-III	Semester-IV	Total Credits
19	19	18	18	**74**

Electives Courses

S.No.	Subject Codes	Title of Courses	L-T-P
1	IT 611	Network design and optimization	3-0-0
2	IT 612	Grid and peer-to-peer computing	3-0-0
3	IT 613	Cloud computing and security	3-0-0
4	IT 614	IoT protocols and security	3-0-0
5	IT 615	High speed network	3-0-0
6	IT 616	Machine vision	3-0-0
7	IT 617	Nature inspired computing	3-0-0
8	IT 618	Computer graphics and multimedia	3-0-0
9	IT 619	Advance machine learning	3-0-0
10	IT 620	Special topics in AI	3-0-0
11	IT 621	Information theory and coding	3-0-0
12	IT 622	Detection and estimation theory	3-0-0
13	IT 623	Adaptive signal processing	3-0-0
14	IT 624	Queuing theory	3-0-0
15	IT 625	Digital signal processing	3-0-0
16	IT 626	Modern cryptography	3-0-0
17	IT 627	Cognitive radio	3-0-0
18	IT 628	Digital watermarking and steganalysis	3-0-0
19	IT 629	Game theory and its application	3-0-0

Course Contents
(Core)

1	Semester	I
2	Type of course	Core
3	Code of the subject	IT 601
4	Title of the subject	Probability and stochastic process
5	Any prerequisite	None
6	L-T-P	3-1-0
7	Learning objectives of the subject (in about 50 words)	Many complex systems are modeled using stochastic processes. This course will introduce students to basic stochastic processes tools that can be utilized for performance analysis and stochastic modeling.
8	Brief contents	Axioms of probability, Probability space, Conditional probability, Independence, Baye's rule, Random variable, Some common discrete and continuous distributions, Distribution of functions of random variable, Moments, Generating functions, Two and higher dimensional distributions, Functions of random variables, Order statistics, Conditional distributions, Covariance, Correlation coefficient, Conditional expectation, Modes of convergences, Law of large numbers, Central limit theorem. Definition of stochastic process, Classification and properties of stochastic processes, Simple stochastic processes, Stationary processes, Discrete and continuous time Markov chains, Classification of states, Limiting distribution, Birth and death process, Poisson process, Steady state and transient distributions, Simple Markovian queuing models (M/M/1, M/M/1/N, M/M/c/N, M/M/N/N).
9	Contents for lab (If applicable)	N/A

1	Semester	I
2	Type of course	Core
3	Code of the subject	IT 602

4	Title of the subject	Wireless networks
5	Any prerequisite	Communication system
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	After successful completion of this course, students will come across various wireless technology evolved for wireless transmission/reception. This course also deals an overview of communication theory particularly different modulation schemes, fading due to environment, multiplexing techniques, and role of antennas.
8	Brief contents	Introduction to the course- Wireless network technology; Wireless LANs, Wireless WANs, and Wireless MANs. Wireless vs. wired networks. Antennas- types of antenna, Antenna models, Antenna diversity, Gain. Isotropic radiator vs. Directed radiator. Modes of signal propagation; Modulation schemes -ASK, FSK, PSK, AM, FM, and PM. Multiplexing methods - Frequency multiplex, Time multiplex, and CDMA. Bit error-rate (BER). TCP/IP basics, 802.11 (WiFi)-components and architecture, WLAN: IEEE 802.11b, 802.11a, and 802.16 (WiMaX), Mesh and adhoc networks, 802.16 internals. Frequency hopping spread spectrum (FHSS)-slow and fast hopping, FHSS transmit/receive, OFDM, ALOHA
9	Contents for lab (If applicable)	No lab is associated with the course.

1	Semester	I
2	Type of course	Core
3	Code of the subject	IT 603
4	Title of the subject	Mobile Computing
5	Any prerequisite	Computer Networks
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	We will cover interesting topics across a variety of mobile systems (wireless LANs, cellular systems, and sensor networks), and revisit the design of the various layers of the networking stack in the context of wireless communication. The course will comprise of lectures, four problem sets, exams (midsem and endsem), and a course project.

| 8 | **Brief contents (module wise)** | Overview of wireless and mobile systems (wireless LANs, cellular systems, sensor networks, etc.) and the challenges therein. The radio channel and wireless physical layer design. Medium access, Multiplexing, Link adaptation. Multi-hop routing protocols, Routing metrics. Multicast, Multi-hop data forwarding, Opportunistic routing. Solutions to handle mobility at various layers of the networking stack. TCP behavior over wireless, Other transport layer issues. Energy efficiency, Localization, Security. Smartphone-based platform architectures and applications. Future directions: Dynamic spectrum access, Heterogeneous networks, Internet of things. |
| 9 | **Contents for lab (If applicable)** | N/A |

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 604
4	**Title of the subject**	Modelling and simulation
5	**Any prerequisite**	Engineering mathematics, and Probability and statistics
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To learn the application of mathematics and statistics in the real-life problems.
8	**Brief contents (module wise)**	Introduction concept of a system, Modeling and simulation of real world problems, Classification of models and examples, Static and dynamic models, Principles used in modeling. System studies subsystems, Corporate models, Block diagram of modeling and simulation, System analysis, System design. Mathematical models, Mathematical models in population dynamics, Epidemic. System simulation the technique of simulation, The Monte Carlo method, Types of system simulation, Continuous and discrete time simulation. Probability concepts in simulation stochastic variables, Discrete and continuous probability distributions, Measures of probability functions, Random numbers generation, Stochastic processes: Poisson process, Markov process, Queuing theory, Reliability. Linear programming in simulation introduction, Transportation problem, Assignment problem and other simulation techniques in operation research.

9	Contents for lab (If applicable)	No lab is associated with this course.

1	Semester	I
2	Type of course	Core
3	Code of the subject	IT 605
4	Title of the subject	Network and computing lab
5	Any prerequisite	No
6	L-T-P	0-0-6
7	Learning objectives of the subject (in about 50 words)	Understand basics of MATLAB, NS2, OPNET Able to perform basic computational techniques Understand types of computational method
8	Brief Contents (module wise)	Introduction to MATLAB, Vectors in MATLAB, Efficient programming techniques system of linear equations: Solution for a system of linear equations, Solving a system of linear equations, Inverse matrix, Decomposition (Factorization), Iterative methods to solve equations, Interpolation and curve fitting: Interpolation by Lagrange, Newton, and Chebyshev polynomial, Newton Raphson method, Secant method, Newton method for a system of nonlinear equations, Numerical differentiation/integration: Difference approximation for first derivative, Approximation error of first derivative, Numerical integration and quadrature, Trapezoidal method and Simpson method, Optimization: Unconstrained optimization, Constrained optimization, MATLAB built-In routines for optimization, Matrices and eigenvalues: Eigenvalues and eigenvectors, Power method, Jacobi method partial differential equations: Elliptic, Hyperbolic, and Parabolic PDE, Computer networks and the layering concept, Layering concept, OSI and TCP/IP reference models, System modeling, Basics of computer network simulation, Time-dependent simulation, A simulation example: A single channel queuing system. Introduction to network simulator 2 (NS2), Basic architecture, Installation, Directories and convention, Running NS2 simulation, A simulation example, Including C++ modules into NS2 and the make utility. Introduction of simulation and OPNET, Outline ways to study a system advantages of simulation OPNET modeler main features of OPNET simulator, A simulation example how to use this software for simulating and modeling computer networks.
9	Contents for lab (If applicable)	

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 606
4	**Title of the subject**	Next generation networks
5	**Any prerequisite**	It is desirable to have the knowledge of data networking and telecommunications principles.
6	**L-T-P**	3-1-0
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will able to learn emerging network technologies, their features, challenges, advantages, and disadvantages. To learn how broadband data and multimedia services are carried out to users over a common multi-service infrastructure.
8	**Brief contents**	Introduction To next generation networks (NGN): Communication and networking in coming era, Technologies influencing change, NGN services, Network infrastructure convergence, Services convergence etc., Overview of wireless network and technologies GSM, 1G, 2G, 3G and 4G, Bluetooth, Radio frequency, Overview of TCP/IP, LANs, WANs. Optical networks, Wire-line and wireless networks, General packet radio service (GPRS): GPRS and packet data network, Network architecture, Operation, and data services in GPRS. Applications of GPRS, Billing, and charging in GPRS, Ad-hoc network: Architecture and protocols, Wireless LAN, IEEE802.11a, 802.11b standards, Wireless LAN architecture, Mobile ad hoc networks, and Sensor network.
9	**Contents for lab (If applicable)**	No lab is associated with this subject.

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 607
4	**Title of the subject**	Graphs and networks
5	**Any prerequisite**	None
6	**L-T-P**	3-0-0

7	Learning objectives of the subject (in about 50 words)	The objective of the course is, in addition to logical foundations, Theoretical developments and development of the basic skills to tackle problems in graph theory. It is also aimed at understanding how various problems arising from real life or sciences as well as recreational puzzles can be converted to graph theoretic problems like shortest paths, network flows, chromatic numbers, connectivity etc.
8	Brief contents	Introduction to graphs, Paths and circuits, Trees and fundamental circuits, Spanning tree, Matrix tree theorem, Euler graph, Hamiltonian graph, Isomorphism, Network flows, Ford-Fulkerson theorem. Cut-sets and cut vertices, Planar and dual graphs, Embedding, Kurtowski theorem, Euler identity, Matrix representation of graphs, Coloring, Edge coloring, Chromatic number, Brooks theorem, Five-color theorem, Matching, Directed graph, Underlying graph, Outdegree, In-degree, Connectivity, Orientation, Eulerian directed graphs, Hamilton directed graphs, Arborescence, Tournament, Acyclization, Applications of graph theory: In switching and coding theory, Electrical network analysis
9	Contents for lab (If applicable)	No lab is associated with this subject.

1	Semester	II
2	Type of course	Core
3	Code of the subject	IT 608
4	Title of the subject	Machine learning
5	Any prerequisite	Introductory courses on probability theory and linear algebra. Knowledge of basic programming languages such as python and MATLAB.
6	L-T-P	3-0-2
7	Learning objectives of the subject (in about 50 words)	After successful completion of this course, students will able to relate/understand/solve several day-to-day real-time with machine learning algorithms. The objective of this course is to familiarize the students with different machine learning algorithms ranging basic linear classifier/regression modeling problems to non-linear classification problems using deep neural network.
8	Brief contents	Introduction to the course of machine learning (ML): What and why? Classification, Regression, Sequence modeling. Introducing prerequisites of ML, Linear classifier and classification problem, Gradient descent algorithm, Underfitting vs. over-fitting problem, Training, Testing, and Validation process, Supervised vs. unsupervised classification, Bayesian classifier: Decision boundaries; Nearest neighbour methods, and Support vector machine (SVM); Unsupervised learning: k-means and hierarchical clustering, Feature extraction and feature selection; Dimensionality reduction techniques: PCA, LDA and ICA, Introduction to neural networks: Modelling and

		applications to logic gates. Backpropagation learning algorithm: Training and testing, Introduction to convolution neural network (CNN): AlexNet, VGG architectures. Introduction to auto-encoder and generative adversarial networks (GAN).
9	**Contents for lab (If applicable)**	Study and demonstration of data preprocessing on the dataset. The aim of this experiment is to illustrate some of the basic data preprocessing such as loading of the dataset, and use of various filters, Implement a project on data mining, which includes the demonstration of data collection and mining process, Building classification models, and performance evaluation of prediction models.

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 609
4	**Title of the subject**	Engineering research methodology
5	**Any prerequisite**	Basic mathematics
6	**L-T-P**	2-0-0
7	**Learning objectives of the subject (in about 50 words)**	To enable researchers (Ph.D. and M. Tech. students), irrespective of their discipline in developing the most appropriate methodology for their research studies. To make them familiar with the art of using different research methods and techniques.
8	**Brief contents**	Research, Types of research, Research vs. research methods, Research process, Relevant and quality research. Problem-solving in engineering, Identification of research topic, Problem definition, Literature survey, Literature review, Research design, Models in general, Mathematical models, Model classifications, Simulation models, Steps in a simulation study, Simulation software, Validation, Data collection, and Applications, Formulation of hypothesis, Testing of hypothesis, Analysis of variance, Design of experiments, Multivariate analysis, Simple regression and correlation, Measurement and scaling techniques, Data checking, Data analysis, Statistical, Graphical and numerical data analysis, Interpretation of results in research, need for interpretation, Accuracy, Precision, Uncertainty and variability, Repeatability and reproducibility, Error definition and classification, Analysis of errors, Statistical analysis of errors, Basic communication model, Preparing papers for journals, Synopsis of research work, Reference citation, Listing of references. Ethics in research, Intellectual property rights, Copyright laws, Patent rights.
9	**Contents for lab (If applicable)**	No lab is associated with this subject.

Electives Courses Contents

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 611
4	Title of the subject	Network design and optimization
5	Any prerequisite	Basics of wireless communications
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	Students will acquire knowledge of the planning and optimization of wireless networks and their specifications. The course will discuss the working principles of different types of wireless networks and their performance optimization
8	Brief contents	Fundamentals of wireless communications, Networks planning principals for cellular networks, 4G (LTE) architecture, Features and call flow, Network (RAN) performance and optimization, LTE introduction, LTE network design basics, Optimization principles, Coverage optimization, Capacity optimization, Capacity and latency optimization, Energy and spectrum efficient wireless network design and optimization
9	Contents for lab (If applicable)	

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 612
4	Title of the subject	Grid and peer to peer computing
5	Any prerequisite	Operating systems, Networks
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	This course is an advanced elective and covers material relating to distributed computing fundamentals, grid computing middleware, and high-performance applications. The prerequisites for the course are operating systems, and networks. A prior course on distributed systems is an added advantage.

| 8 | **Brief contents** | Grid Computing: Introduction to grid computing, Classification of grids, Introduction to service oriented computing. Peer-to-Peer (P2P) concepts in grids: Introduction to P2P systems, Overlays unstructured P2P systems (Gnutella, Freenet), Structured P2P systems (distributed hash tables - chord, pastry), Integrating unstructured and structured P2P systems, Introduction to P2P security - sybil attacks. Grid computing middleware: Vishwa: a reconfigurable P2P middleware for grid computations. Grid security and resource management: grid security-a brief security primer-PKI-X509, Certificates-grid security, Grid scheduling and resource management-scheduling paradigms, Working principles of scheduling, A review of condor, SGE, TPBS and TLSF-grid scheduling with QoS. Current P2P systems: Napster, Gnutella, KazaA, FreeNet, Pastry, Tapestry. |
| 9 | **Contents for lab (If applicable)** | No lab is associated with the course |

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 613
4	**Title of the subject**	Cloud computing and security
5	**Any prerequisite**	
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	The course objective is to familiarize the students with the fundamentals of cloud computing architectures, protocols, and best practices intended for delivering cloud based enterprise IT services and business applications.
8	**Brief contents**	Fundamentals of cloud computing and architectural characteristics: Cloud deployment, Infrastructure as a Service (IaaS), Cloud computing roles, etc. Risks and security concerns. Security design and architecture for cloud computing: Guiding security design principles for cloud computing - Secure isolation, Comprehensive data protection, End-to-end access control, Monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for cloud security, Common attack vectors and threats. Secure isolation of physical & logical infrastructure; Data protection for cloud infrastructure and service, Network and storage, Verified and measured boot, Firewalls, IDS, IPS and honeypots.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 614
4	Title of the subject	IoT protocols and security
5	Any prerequisite	Fundamentals of internet of things
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	To understand the architectural overview of IoT and analyse basic protocols in wireless sensor network. Design IoT applications in different domain and be able to analyse their performance. Implement basic IoT applications on embedded platform.
8	Brief contents	Overview of IoT, IoT-an architectural overview– Building an architecture, Main design principles and needed capabilities, Reference architecture IoT architecture-State of the art – introduction. Functional view, Information view, Deployment and operational view. Network & communication aspects Wireless medium access issues. Challenges in IoT design, Development challenges, Security challenges. Domain specific applications of IoT home automation, Industry applications, Surveillance applications, Other IoT applications. Developing IoTs introduction to python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python. IoT data link layer & network layer protocols. Transport & session layer protocols. Service layer protocols & security service layer.
9	Contents for lab (If applicable)	No lab is associated with the course

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 615
4	Title of the subject	High speed network
5	Any prerequisite	Digital circuits and network technology

6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will able to learn high speed networks, traffic and congestion management system. Study of wireless network operations, resource allocation, service management.
8	**Brief contents**	Introduction to high-speed networks (HSNs), Congestion and traffic management, QOS in IP networks, Wireless network and its operations, Network management, configuration selection method-MIB-SNMP-XMLCORBA-COPS-VPNS-mobile IP-voice over IP.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 616
4	**Title of the subject**	Machine vision
5	**Any prerequisite**	Machine learning
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	In this course, students will gain a broad understanding of the algorithms used for image segmentation, feature extraction and object detection. They will also understand the challenges involved in end-to-end machine vision system along with image acquisition, model deployment and actuation. Students will be able to develop convolution neural network for object recognition and deploy them on the edge for manufacturing industry.
8	**Brief contents**	Introduction to image processing system- Thresholding, Image enhancement, Contrast stretching, Image histograms, Filters, Image sharpening, Gradient based edge detection, Finding corners, Using scale and orientation to build neighborhood, SIFT, SURF, HOG feature detection, Computing local features, and segmentation, Convolutional neural networks, Padding, Strided convolution, Convolution over volume, One layer convolution, Pooling, Object localization, Object detection, Classic networks, Transfer learning, ImageNet challenge, Feature extraction from videos and parallelization, Image acquisition.

9	Contents for lab (If applicable)	

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 617
4	Title of the subject	Nature inspired computing
5	Any prerequisite	Basic mathematics, Data structures, and Algorithms
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	It introduces a new paradigm of computing and solving problems. It has great applications in artificial intelligence, Data mining, Machine learning, and real-world design and optimization problems.
8	Brief contents	Introduction to evolutionary computation: Representation, Initial population, Fitness function, Selection, Reproduction operators, Stopping conditions, Evolutionary versus classical computation; Genetic algorithm: Canonical genetic algorithm, Crossover, Mutation, Control parameters, Genetic algorithm Variants, Applications; Differential evolution, Particle swarm optimization, Artificial bee colony algorithm. ANN introduction, Evolution, McCulloh-Pitts neuron, Linear separability, Hebb network; Perceptron networks, Adaptive linear neuron, Multiple Adaptive linear neuron, Back-propagation Network, Radial basis function network; Associative memory network, Heteroassociative memory network, Bidirectional associative memory, Hopfield network, Iterative autoassociative memory network, Temporal associative, Self-organizing maps, Linear vector quantization, Counter propagation network.
9	Contents for lab (If applicable)	

1	Semester	
2	Type of course	Elective

3	Code of the subject	IT 618
4	Title of the subject	Computer graphics and multimedia
5	Any prerequisite	
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	Computer graphics is the illustration field of computer science. Its use today spans virtually all scientific fields and is utilized for design, presentation, education and training. Computer graphics and its derivative, visualization, have become the primary tools by which the flood of information from computational science is analysed.
8	Brief contents	Introduction of computer graphics, Graphic displays, Mid-point circle generating algorithm, and parallel version of these algorithms. Three Dimensional: 3-D geometric primitives, 3-D object representation, 3-D transformation, 3-D viewing, Projections, 3-D clipping. Transformations: Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Windowing and clipping: Viewing pipeline, Viewing transformations, 2-D clipping algorithms- Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against non-rectangular clip windows; Weiler and Atherton polygon clipping, Curve clipping, Text clipping; Hidden lines and surfaces: Back face detection algorithm, Depth buffer method. Multimedia basics – Multimedia applications – Multimedia system architecture – Evolving technologies for multimedia – Defining objects for multimedia systems – Multimedia data interface standards – Multimedia databases. Compression and decompression – Data and file format standards – Multimedia I/O technologies – Digital voice and audio – Video image and animation – Full motion video – Storage and retrieval technologies.
9	Contents for lab (If applicable)	Graphic displays, Viewing, Projections, 3-D clipping. Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, 2-D clipping algorithms- Cohen Sutherland line clipping algorithm

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 619

4	**Title of the subject**	Advance machine learning
5	**Any prerequisite**	Linear algebra, Statistics and machine learning
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	
8	**Brief contents**	Convolutional neural networks, Recurrent neural networks, Timeseries processing, Transformer networks, Semantic segmentation, Generative models, Generative adversarial networks model interpretation: Introduction, Sample complexity bound for learning axis parallel rectangles. Definition of PAC learning. A Theory of the learnable – valiant PAC learnability of finite hypothesis classes, Empirical risk minimization, Agnostic PAC learnability of finite hypothesis class, Uniform convergence, No free lunch theorem, VC dimension, Sauer lemma, Growth function, Fundamental theorem of statistical learning theory, Nonuniform learnability, Structural risk minimization.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 620
4	**Title of the subject**	Special topics in AI
5	**Any prerequisite**	Machine Learning.
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	The chief objective is to teach modern methods of probabilistic reasoning that are commonly used in many parts of computer science, including but not limited to artificial intelligence. Such methods have become extremely important and transforming the approach to a great variety of computational problems, in the field of computer science itself, and broadly across many application fields.

8	**Brief contents**	Overview of probability theory, Bayes networks, Independence, I-maps, Undirected graphical models, Bayes networks and Markov networks, Local models, Template based representations, Exact inference: Variable elimination; Clique trees, Belief propagation, Tree construction, Approximate inference: Sampling Markov chains, MAP inference, Inference in temporal models, Learning graphical models, Parameter estimation, Bayesian networks and shared parameters, Structure learning, Structure search, Partially observed data, Gradient descent, EM, Hidden variables, Undirected models, Undirected structure learning causality, Utility functions, Decision problems, Expected utility, Value of information
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 621
4	**Title of the subject**	Information theory and coding
5	**Any prerequisite**	Students should have brief idea about linear algebra.
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	This course gives brief knowledge about the basic algebraic relationships of entropy, relative entropy, and mutual information. In this course students are going to learn how to compress the data using source coding and how to make data transmission reliable using channel coding. It introduces the basic principles of encoding, decoding, error detecting and error correcting techniques.
8	**Brief contents**	Information theory: Introduction, Discrete memory less source, Binary source. Entropy, Relative entropy, and Mutual information, Channel capacity, Data compression Examples of codes, Kraft inequality, Optimal codes, Bounds on the optimal code length, Kraft inequality for uniquely decodable codes, Huffman codes, Shannon–Fano coding, etc. Error detecting and error correcting code, Block codes, Cyclic codes, Convolution codes.
9	**Contents for lab (If applicable)**	Nil

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 622
4	Title of the subject	Detection and estimation theory
5	Any prerequisite	Student must have basic knowledge about linear algebra, probability and random process.
6	L-T-P	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Detection theory involves detecting one hypothesis from two or more than two hypotheses. This may be done based on Bayes detection, Minmax detection, NP test. Estimation theory is a branch of statistics that deals with estimating the values of parameters based on measured empirical data that has a random component using various estimators. In general, the information that one wishes to extract from such observation is unknown to the observer, it is useful to cast detection and estimation problems in a probabilistic framework in which unknown behaviour is assumed to be random. Applications of the theory of signal detection and estimation are in many areas, such as communications, automatic control, telecommunication, radar etc.
8	**Brief contents**	Review of Gaussian variables and processes, Statistical Decision Theory: Bayesian, Minimax, and Neyman-Pearson decision rules, Likelihood ratio, Composite hypothesis testing, Detection of Deterministic Signals: Matched filter detector and its performance. Detection of random signals: Estimator-correlator, Linear model, General Gaussian detection. Nonparametric detection: Detection in the absence of complete statistical description of observations. Estimation of signal parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Sufficient statistics. Signal estimation in discrete-time: Linear Bayesian estimation, Weiner filtering, Dynamical signal model, Discrete Kalman filtering.
9	**Contents for lab (If applicable)**	

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 623
4	Title of the subject	Adaptive signal processing

5	**Any prerequisite**	Digital signal processing
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Development of various adaptation algorithms and assessing them in terms of convergence rate, computational complexity, robustness against noisy data, hardware complexity, numerical stability. The course will present several examples of adaptive filter applications like channel equalization, echo cancellation, noise cancellation, interference suppression.
8	**Brief contents**	Introduction to adaptive systems: Definitions, Characteristics, Applications, Example of an adaptive system. The adaptive linear combiner – Description, Weight vectors, Desired response performance function – Gradient & mean square error. Development of adaptive filter theory & searching the performance surface: Introduction to filtering – Smoothing and prediction – Linear optimum filtering, Problem statement, Principle of orthogonally – Minimum mean square error, Wiener-Hopf equations, Error performance – Minimum mean square error, Steepest descent algorithms: LMS algorithm & applications: Stability & performance analysis of LMS algorithms – LMS gradient & stochastic algorithms – Convergence of LMS algorithm, RLS algorithm. Statement of Kalman filtering problem, Innovation process, Estimation of state using the innovation process- Expression of Kalman gain, Filtering example estimation of state from observations of noisy observed narrow band signals. Target tracking using only DOA.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 624
4	**Title of the subject**	Queuing theory
5	**Any prerequisite**	Basic knowledge of engineering mathematics and statistics
6	**L-T-P**	3-0-0

7	Learning objectives of the subject (in about 50 words)	To teach the applications of queuing theory related to computer networks.
8	Brief contents	Basics of probability and statistics, Random processes-introduction, Classification, Stationary process – Wide sense stationary, Strict sense stationary, Markov process, Markov chain, Problems based on Markov process. Transition probabilities, Limiting distributions, Poisson process - Properties, Poisson process - Problems Queuing system – Introduction, Markovian models, Birth and death Process, Little's formula, M/M/1, Infinite capacity, M/M/1, Finite capacity, M/M/c, Infinite capacity, M//M/c, Finite capacity and finite population, M/M/ queue. Non Markovian queues- M/G/1 queue, GI/M/1 queue, GI/M/m queue, GI/G/1 queue, M/G/m queue, GI/G/m queue, Pollaczek-Khinchine formula. Priority queues- Queues with preemption, Queues with time dependent priorities. Series queues, Open networks, Closed networks, Batch service, Batch arrival.
9	Contents for lab (If applicable)	No

1	Semester	
2	Type of course	Elective
3	Code of the subject	IT 625
4	Title of the subject	Digital signal processing
5	Any prerequisite	Signals & systems
6	L-T-P	3-0-0
7	Learning objectives of the subject (in about 50 words)	In this course, we will mainly study the following topics: signal representation in time domain, Fourier transform, sampling theorem, linear time-invariant system, discrete convolution, z-transform, discrete Fourier transform, and discrete filter design. After this course, the students should be able to understand how to analyse a given signal or system using tools such as Fourier transform and z-transform; how to process signals to make them more useful.
8	Brief contents	Review of signals and systems: Discrete time complex exponentials and other basic signals-scaling of the independent axis and differences from its continuous-time counterpart-system properties (Linearity, Time-invariance, Memory, Causality, BIBO stability)-LTI systems, Convolution,

		Correlation, Continuous-time Fourier series and Fourier transform. Sampling discrete-time Fourier transform (DTFT) Z-transform. Frequency domain analysis of LTI systems. Discrete Fourier Transform (DFT), FIR, IIR, Filter Design.
9	**Contents for lab (If applicable)**	NA

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 626
4	**Title of the subject**	Modern cryptography
5	**Any prerequisite**	
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To make the students understand the process of deciphering coded messages without being told the key. To study of codes and the art of writing and solving them. To give motivation towards recent research development in the field of cryptography, cryptanalysis, and steganography. Overall this course explores modern cryptographic (code making) and cryptanalytic (code breaking) techniques in detail.
8	**Brief contents**	Number theory basics, Modular arithmetic fields, Binary fields, Primes, GCD and Chinese reminder theorems, Pseudorandom bits and sequences, Extended Euclidean algorithm and application Fermat's Little theorem and application, Euler phi function, Block ciphers in mathematical way, DES historical ciphers, Public key cryptography, RSA, Two fish, Digital signatures, Key management techniques, Identification and entity authentication, Hash function and data integrity.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 627

4	**Title of the subject**	Cognitive radio
5	**Any prerequisite**	Digital communication
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject (in about 50 words)**	The students will be enabled to understand and acquire knowledge in cognitive networks. To emphasis on knowledge-building to understand architectures for various networks. To provide a complete understanding on concepts, to identify the pros and cons of designing a cognitive network and SDR.
8	**Brief Contents**	Introduction of various generation of wireless communication, Spectrum scarcity, Cognitive radio (CR) architecture, Functions of cognitive radio, Fundamental challenges and issues in designing cognitive radio. Spectrum access models, Dynamic spectrum access (DSA), Underlay, Overlay, and hybrid cognitive radio, Potential applications of cognitive radio. Interference temperature/channel estimation, Detection of spectrum holes, Practical spectrum sensing approaches, Collaborative sensing, External sensing. Framework of trust in CRN; Trusted association and routing; Trust with learning; Security in CRN. Introduction to SDR. Evolution of SDR baseband requirements. SDR architectures - ideal SDR architectures, Realistic SDR architecture. SDR and cognitive radio relationship.
9	**Contents for lab (If applicable)**	No lab is associated with the course.

| 1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 628
4	**Title of the subject**	Digital watermarking and steganalysis
5	**Any prerequisite**	No
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject (in about 50 words)**	The objective of the course makes students familiar about digital watermarking and steganography.

| 8 | **Brief Contents** | Information hiding, Steganography, and watermarking, Importance of digital watermarking, Applications and properties. Models of watermarking: Communication-based models of watermarking, Geometric models of watermarking, Modelling watermark detection by correlation; Basic message coding: Mapping messages into message vectors, Error correction coding, Detecting multi-symbol watermarks; Watermarking with side information: Informed embedding, Watermarking using side information, Dirty-paper codes; Robust watermarking: Approaches, Robustness to volumetric distortions, Robustness to temporal and geometric distortions; Watermark security: Security requirements, Watermark security and cryptography, Some significant known attacks; Content authentication: Exact authentication, Selective authentication, Localization, Restoration; Notation and terminology, Information-theoretic foundations of steganography, Practical steganographic methods, Minimizing the embedding impact; Steganalysis: Steganalysis scenarios, Some significant steganalysis algorithms. |
| 9 | **Contents for lab (If applicable)** | No lab is associated with the course. |

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	IT 629
4	**Title of the subject**	Game theory and its application
5	**Any prerequisite**	Basic knowledge of engineering mathematics and statistics
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To teach the applications of game theory, auction and equilibrium.
8	**Brief contents**	Introduction to game theory, Dominant strategies and Nash equilibrium, Alternate strategies: Maximin, Maximax, and Minimax regret solvability, N-player games, Mixed strategy, Subgame perfection in discrete choice games, Continuous games and imperfect competition, Infinitely repeated games, Tacit collusion, Simultaneous-play, Bayesian games, Applications of Bayesian games: Auctions and voting, Cournot's duopoly with imperfect information, Radio spectrum, With arbitrary distribution of valuations, Extensive form game

		with perfect information, Stackelberg model of duopoly, Buying votes, Committee decision-making, Repeated games, The Prisoner's dilemma, General result, Supermodular game and potential game, Wireless networks: Resource allocations, Admission control, Routing in sensor and ad-hoc networks, Modeling network traffic and strategic network formation, Rubinstein bargaining model with alternating offers, Nash bargaining solution, Multi armed bandit problem.
9	**Contents for lab (If applicable)**	

Curriculum & Contents

M. Tech.
(IC Design and Technology)
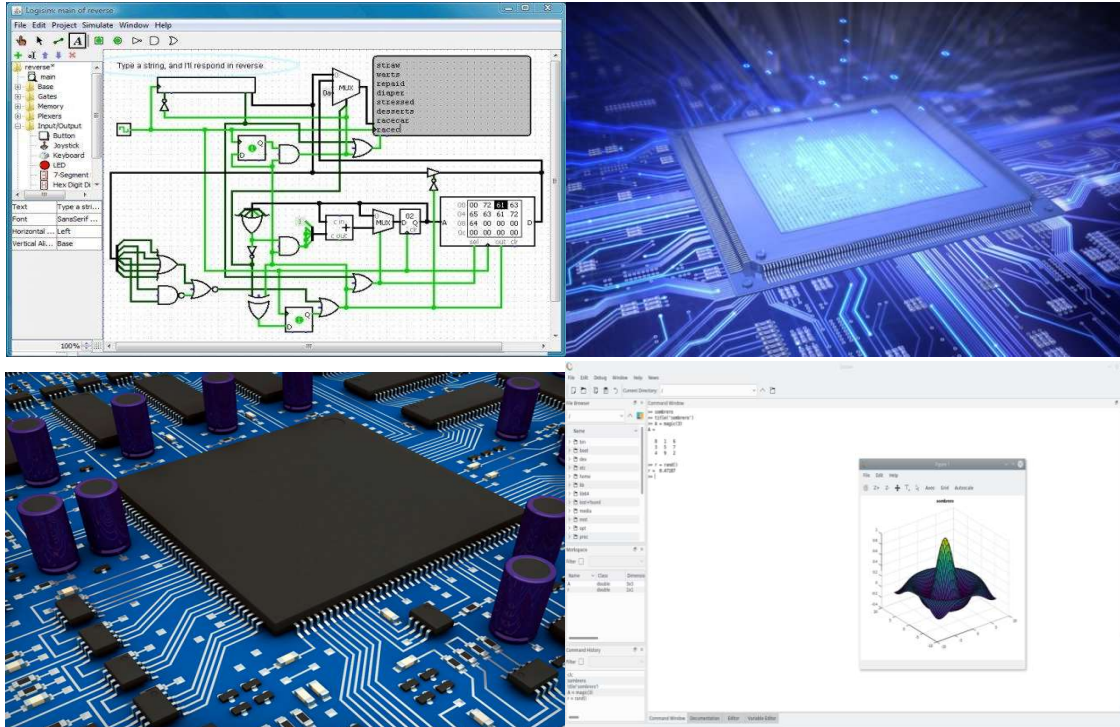
Department of Electrical and Electronics Engineering

विश्वजीवनामृतं ज्ञानम्

ABV-Indian Institute of Information Technology & Management, Gwalior
2023

SCHEMA

Name of the program: M. Tech. (IC Design and Technology)
(Credits: 78)

Name of the Department: Electrical and Electronics Engineering

Semester-wise Subject Allocation:

		SEMESTER -I		
S. No.	**Subject Code**	**Title of the course**	**L-T-P**	**Credits**
1.	EE-601	Digital IC Design	3-0-0	3
2.	EE-602	System Design using HDL	3-0-0	3
3.	EE-603	CAD for VLSI	3-0-0	3
4.	EE-604	IC Technology	3-0-0	3
5.	EE-605	Device Modelling and Simulation	3-0-0	3
6.	EE-606	Advanced IC Design and Technology Lab-1	0-1-4	3
7.	EE-XXX	Elective 1	3-0-0	3
			Total Credits	**21**

		SEMESTER -II		
S. No.	**Subject Code**	**Title of the course**	**L-T-P**	**Credits**
1.	EE-607	Analog IC Design	3-0-0	3
2.	EE-608	Design Verification and Testing	3-0-0	3
3.	EE-609	Engineering Research Methodology	2-0-0	2
4.	EE-610	Machine Learning	3-0-2	4
5.	EE-611	Advanced IC Design and Technology Lab-II	0-1-4	3
6.	EE-XXX	Elective- II	3-0-0	3
7.	EE-XXX	Elective-III	3-0-0	3
			Total Credits	**21**

EXIT AFTER YEAR-1: Post Graduate Diploma in IC Design and Technology

SEMESTER -III				
S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	XXX	Elective-IV/MOOC course	3-0-0	3
2.	XXX	Elective-V/MOOC course	3-0-0	3
3.	EE-698	Major Project part I/Internship	-	12
			Total Credits	**18**

SEMESTER -IV				
S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	XXX	Elective-VI/MOOC course	3-0-0	3
2.	EE-699	Major Project part II/Internship	-	15
			Total Credits	**18**

List of Electives

S. No.	Subject Code	Course	L-T-P	Credits
1.	EE-051	Device and interconnect modeling	3-0-0	3
2.	EE-052	VLSI Signal Processing	3-0-0	3
3.	EE-053	Low Power VLSI	3-0-0	3
4.	EE-054	Microcontroller and Embedded Systems	3-0-0	3
5.	EE-055	Memory Devices and Circuits	3-0-0	3
6.	EE-056	VLSI Architecture	3-0-0	3
7.	EE-057	Hardware Security	3-0-0	3
8.	EE-058	FPGA Based System Design	3-0-0	3
9.	EE-059	Quantum Electronics	3-0-0	3
10.	EE-060	RF Circuit Design	3-0-0	3
11.	EE-061	Mixed Signal SoC Design	3-0-0	3
12.	EE-062	AI-Accelerator Design	3-0-0	3
13.	EE-063	System-on-Performance Chip Design	3-0-0	3
14.	EE-064	Embedded Software	3-0-0	3
15.	EE-065	High Performance Computing Systems	3-0-0	3
16.	EE-066	Special Topics in IC Design and Technology	3-0-0	3
17.	EE-067	Sensors for autonomous system	3-0-0	3
18.	EE-068	Network on Chip	3-0-0	3

Course Contents
(Core)

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	EE-601
4	**Title of the subject**	Digital IC Design
5	**Any prerequisite**	NIL
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	This course aims to convey knowledge of basic concepts of digital VLSI circuit design using CMOS and state-of-the-art device technologies with an emphasis on "hands-on" IC design using ECAD/CAD tools. Emphasis is on the circuitdesign, optimization, and layout of very high speed, high density or low power circuits for use in applications such as processors, signal and memory and periphery. Special attention will be devoted to the most important challenges facing digital circuit designers today and in the coming decade, being the impact of scaling, deep submicron effects, interconnect, signal integrity, power distribution and consumption for energy efficient and PVT aware real-time applications. Students should be able to apply their knowledge of electronics and engineering in the design of CMOS integrated circuits and digital VLSI design as per the need of current academia and VLSI industry.
8	**Brief Contents**	Introduction and future prospects, Evolution of CMOS transistor structure, Modeling of transistor using SPICE, Inverters static characteristics, Inverters switching characteristics and interconnect effects; Combinational logic circuits, Sequential logic circuits, Dynamic logic circuits, Semiconductor memories, Low power logic circuits, High-speed circuits.

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	EE-602
4	**Title of the subject**	System Design using HDL
5	**Any prerequisite**	Digital Electronics in UG
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	Correctly describe the detailed behaviour of given standard and few special application based digital logic circuits as defined by Verilog HDL, state diagrams, or other means, including those circuits related to modern computer architecture. Translate system requirements into a practical digital design using Verilog HDL, Xilinx Vivado, and FPGA prototyping boards.

		Model the digital designs including FSMs to Processor architectures using the knowledge of HDL Language.
		Apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs.
8	**Brief Contents**	Basic concepts of hardware description languages (VHDL, Verilog HDL), Logic and delay modeling, Structural, Data-flow and Behavioral styles of hardware description, Architecture of event driven simulators, Operators, Operands, Operator types, Blocking and non-blocking statements, Delay control, Generate statement, Event control, Sequential Logic Design, FSM, Configuration Specifications, Sub-Programs, Test Benches.
		Types of Reconfigurations, Details study of FPGA, Design tradeoffs, Bidirectional wires and switches, FPGA Placement: Placement Algorithms, FPGA Routing, Timing Analysis, Network Virtualization with FPGAs, On-chip Monitoring Infrastructures, Multi-FPGA System Software, Logic Emulation, Applications, High Level Compilation

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	EE-603
4	**Title of the subject**	CAD for VLSI
5	**Any prerequisite**	Digital Design
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject**	The main objective of this course is to provide in-depth understanding of the theoretical as well as practical concepts of the designing algorithms for CAD toolsfor VLSI design. The students will be able to identify and develop new algorithmsand CAD tools for VLSI design. The scope of this course is also to visualize new Design Automation (DA) research problems in view of the challenges of designing multi-core and/or many-core system-on-chip in the nanometer regime. Another objective of this course is to give the exposure to machine learning and deep learning algorithms for designing efficient hardware in IOT era.
8	**Brief Contents**	Introduction to VLSI-CAD, module generation, PLAs and FPGAs, Digital hardware modeling, benchmark circuits (ISCAS'85, ISCAS'89…), Simulation algorithms design verification, graph datastructure and algorithms for VLSI-CAD, High-level synthesis, Algorithms for physical design automation, slicingand non-slicing floorplans, polar graphs and adjacency graphs for floorplans, Introducing NOC as a future SOC paradigm, Timing analysis, SDC, set-up & hold time concept, timing exceptions, set-up & hold calculations, noise analysis.

1	Semester	I
2	Type of course	Core
3	Code of the subject	EE-604
4	Title of the subject	IC Technology
5	Any prerequisite	Nil
6	L.T.P.	3-0-0
7	Learning Objectives of the subject	Students will be able to learn the flow of IC Design which includes fundamental of fabrication of chip, input output packaging, interconnection network. To demonstrate a clear understanding of CMOS fabrication flow, input/output circuits, chip packaging. Get the idea of data flow in interconnection network, routing and topology basics.
8	Brief Contents	Chip Design flow using Full custom, Semicustom approach CMOS Technology, GaAs Technology, Bipolar-CMOS-DMOS (BCD) Technology, Advanced Process Technology CMOS Process flow, IC Manufacturing, Input Output Interfacing, Input Circuits, Output circuits, ESD, Packaging, Signal Integrity. Electrical Testing, Yield, Future trends, and Challenges: Challenges for integration, system on chip, Novel Devices, Chip packaging

1	Semester	I
2	Type of course	Core
3	Code of the subject	EE-605
4	Title of the subject	Device Modelling and Simulation
5	Any prerequisite	Electronics Devices and Circuits
6	L-T-P	3-0-0
7	Learning Objectivesof the subject	The objective of the course is to provide the fundamental knowledge for understanding the basic concepts of semiconductor devices. Upon successful completion of the course, students will be able to graspfundamental knowledge of semiconductor devices for Integrated Circuit design. Be able to model the devices and circuits using SPICE.

| 8 | **Brief Contents** | Device Level Modeling: PN Junction, MOSFET, Limitation of long channel analysis, Short-channel effects, Technology nodes and ITRS, Physical & technological challenges to scaling, nonconventional MOSFET (FDSOI, SOI, Multi-gate MOSFETs), Compact modelling, Verilog-A model

 Interconnect Modelling: Introduction to VLSI Interconnects. Distributed RC interconnect model, Elmore delay, Equivalent Elmore model for RLC interconnects (Distributed model), Two-pole model of RLC interconnects from ABCD parameters Circuit Modelling: Circuit simulation using available device model, Netlist, System Modelling |

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	EE-606
4	**Title of the subject**	Advanced IC Design and Technology Lab-I
5	**Any prerequisite**	NIL
6	**L-T-P**	0-1-4
7	**Learning Objectivesof the subject**	The lab experiments of this course will provide an exposure how the fundamental and advanced theory, design concepts, principles of the core courses studied in 1st semester can be applied in practice. The objective of the course is to provide the fundamental knowledge for understanding the flow of IC Design using EDA tool and further better approaches/solutions for more effective design. The fundamentals of HDL language, concept to design the system using the HDL Language and implementation of the design on FPGA Boards. RTL to GDS flow which will cover the basic concepts of physical design. Upon successful completion of the course, students will be able to grasp fundamental steps and flow of IC Design using EDA tools.
8	**Brief Contents**	The complete IC layout design and its implementation using EDA tool. Provide the in-depth concept and flow for implementation of IC Design, CMOS logic, Circuit analysis with change in the device parameters, Impact of parasitics on circuit performance. Fundamentals of Verilog HDL, different levels of abstraction, tasks and directives, Concept to design the FSM and microarchitecture, Timing and delay simulations, Fundamentals of Physical Design during RTL to GDS flow, Physical Synthesis.
9	**Contents for lab**	Schematic and Layout analysis of inverter, AND gate, OR gate, NAND gate, NOR gate, XOR gate and XNOR gate (pre layout simulation and post layout simulation), IC fabrication process. Implementation of all the basic and universal gates using HDL, combinational circuits, sequential circuits, FSM implementation, memory design, Micro-architecture implementation. Automation of FPGAs. Physical Design, Partitioning, Floor plan, Placement and Routing, Timing analysis

1	Semester	II
2	Type of course	Core
3	Code of the subject	EE-607
4	Title of the subject	Analog IC Design
5	Any prerequisite	Digital IC Design
6	L-T-P	3-0-0
7	Learning Objectives of the subject	On completion of this course, the students will be able to: Acquire a basic knowledge of analog IC design including small signal models, and analog MOS processes. Design of single stage and differential stage amplifiers with and without current mirror circuits, respectively. Analyze the frequency responses of single-stage amplifiers. Analyze and design two-stage operational amplifier. Identify the different types of noises in analog integrated circuits.
8	Brief Contents	Small signal Models, Amplifiers and Current sources: Large Signal and Small-Signal analysis of common source stage, Source Follower, Common Gate Stage, Cascode, Folded Cascode, Differential amplifier, current Sources, Basic Current Mirrors, Cascode Current Mirrors and current mirror based differential amplifier, Frequency Response of Amplifiers, Feedback, Operational Amplifier, Noise, Determination of dominants poles; Compensation and relocation of poles and zeros, Basic concepts to design PLL and ADC

1	Semester	II
2	Type of course	Core
3	Code of the subject	EE-608
4	Title of the subject	Design Verification and Testing
5	Any prerequisite	CAD for VLSI
6	L-T-P	3-0-0
7	Learning Objectives of the subject	The main objective of this course is to provide in-depth understanding of the problems encountered in testing large circuits, approaches to detect and diagnose the faults and methods to improve the design to make it testable. The students will be able to develop algorithms and tools for VLSI testing, designing of testable and trustworthy circuits. The scope of this course is to particularly address the challenges in the VLSI testing domain and get motivated towards research in this field.
8	Brief Contents	Introduction and Fault Modeling, Testing Techniques, Time frame expansion methods, Boolean Satisfiability, Transitive-closure based and Neural Network based approaches, Fault Simulation, Design for

Testability and Built-in-self-test, Controllability and observability measures, TEMEAS, SCOAP, Ad-hoc design built-in-logic-block-observer (BILBO), Linear feedback shift register (LFSR), Theory of LFSRs, Design for Trust Techniques: Different Types of Attacks, Counter Measures for different types of attacks, Prevention based Approaches, Importance of verification, Verification plan, Verification flow, Levels of verification, Verification methods and languages, Introduction to Hardware Verification methodologies, Verifications based on simulation, Analytical and formal approaches. Functional verification, Timing verification, Formal verification. Basics of equivalence checking and model checking

1	Semester	II
2	Type of course	Core
3	Code of the subject	EE-609
4	Title of the subject	Engineering Research Methodology
5	Any prerequisite	NIL
6	L-T-P	2-0-0
7	Learning Objectives of the subject	Demonstrate the ability to choose appropriate methods for research aims and objectives. Understand the limitations of particular research methods. Develop skills in qualitative and quantitative data analysis and presentation. Develop advanced critical thinking skills. The main objective of this course is to introduce the basic concepts in research methodology in Science, Engineering and Technology. This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project. This will also enable the students to prepare report writing and framing Research proposals for their course projects, internship projects and dissertations.
8	Brief Contents	Introduction to research - Research Methods in Engineering, Research paper analysis, Data analysis of reported data, Advance trends in electrical and electronics engineering, Review Process, Review guidelines, Qualitative Methods, Study Designs, The nature and types of qualitative research, Survey Study Designs, Case Studies. Introduction to Mixed Methods Research, Study Designs and Method. Cutting edge challenges and their solution. Writing research papers, purpose, nature and evaluation, content and format, Research Presentations, The Art of Scientific and Technical Writing.

1	Semester	II
2	Type of course	Core
3	Code of the subject	EE-610
4	Title of the subject	Machine Learning
5	Any prerequisite	NIL
6	L-T-P	3-0-2
7	Learning Objectives of the subject	To understand popular ML algorithms with their associated mathematical foundations for appreciating these algorithms, To help connect real-world problems to appropriate ML algorithm(s) for solving them and to enable formulating real world problems as machine learning tasks
8	Brief Contents	Introduction to ML, Fundamentals of ML - PCA and Dimensionality Reduction, Nearest Neighbours and KNN, Linear Regression, Decision Tree Classifiers. Notion of Generalization and concern of Overfitting, Notion of Training, Validation and Testing; Connect to generalisation and overfitting. Selected Algorithms - Ensembling and RF, Linear SVM, K Means, Logistic Regression, Naive Bayes, Neural Network Learning - Role of Loss Functions and Optimization, Gradient Descent and Perceptron/Delta Learning, MLP, Backpropagation, MLP for Classification and Regression, Regularisation, Early Stopping, Kernels (with SVM), Bayesian Methods, Generative Methods, HMM, EM, PAC learning, Introduction to Deep Learning, CNNs, Popular CNN Architectures, RNNs, Advances in Backpropagation and Optimization for Neural Networks Adversarial Learning.
9	Contents for lab	To implement basic algorithms using standard machine learning libraries. Gain hands-on experience in applying ML to problems encountered in various domains. In addition, obtain exposure to provide solutions for complex and special application based problems using high-level ML libraries or frameworks such as TensorFlow, PyTorch.

1	Semester	II
2	Type of course	Core
3	Code of the subject	EE-611
4	Title of the subject	Advanced IC Design and Technology Lab-II

5	Any prerequisite	NILL
6	L-T-P	0-1-4
7	**Learning Objectivesof the subject**	The lab experiments of this course will provide an exposure how the fundamental and advanced theory, design concepts, principles of the core/elective courses studied in 2nd semester can be applied in practice. The objective of the course is to provide the fundamental knowledge for understanding the flow of IC Design using EDA tool and further better approaches/solutions for more effective design. The objective of the course is to provide the fundamental knowledge of Analog IC Design using Cadence EDA tool. In-depth introduction to the System Verilog, efficient verification using System Verilog.
8	**Brief Contents**	Design steps to implement the Analog circuits using EDA tools, Provide the in-depth concept and flow for implementation of IC Design, Circuit analysis with change in the device parameters, Impact of parasitics on circuit performance. Improvements for RTL design and synthesis; Verification enhancements such as object-oriented design; Assertions and randomization.
9	**Contents for lab**	SystemVerilog RTL design and synthesis including different data types, literals, procedural blocks, statements, and operators. Tasks and functions, hierarchy and connectivity features, and interfaces. Classes, constrained random stimulus, coverage, strings, queues and dynamic To draw the schematic, perform simulation and find the gain for common source, common drain and common gate amplifier. The layout of the same, simulate the layout for ac analysis and comment on the results. Design a current mirror circuit and verify its operation. Design an active load single-stage amplifier. Design a differential amplifier and find out the gain. Op-amp design and analysis. Design of PLL and ADC for mixed signal SoC applications

Course Contents
(Electives)

1	Type of course	Elective
2	Code of the subject	EE-051
3	Title of the subject	Device and Interconnect Modelling
4	Any prerequisite	NIL
5	L-T-P	3-0-0
6	Learning Objectives of the subject	Upon the completion of this course, the students will be able to: Apply the concept of MOS modelling in IC design Understand the advanced interconnect materials. Acquire knowledge about Technology trends, Device and interconnect. Scaling, Identify basic device and Interconnect Models. Perform RLC based Interconnect analysis. Analyse the problem with existing material in deep submicron.
7	Brief Contents	Technology trends, Device and interconnect scaling, Interconnect Models: RC model and RLC model, Effect of capacitive coupling, Effect of inductive coupling, Transmission line model, Power dissipation, Interconnect reliability, Driver and Load Device Models, Interconnect Analysis, Time domain analysis, RLC network analysis, RC network analysis and responses in time domain, S domain analysis, Circuit reduction via matrix approximation, Analysis using moment matching, Crosstalk Analysis, Advanced Interconnect Materials. Moore law, Technology nodes and ITRS, Physical & Technological Challenges to scaling, Two terminal MOS Device threshold voltage modelling, C-V Characteristics, Four terminal MOSFET threshold voltage I-V modelling, Short channel effect (SCE), High-K gate dielectric, Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs). Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs) and advanced VLSI devices and interconnects

1	Type of course	Elective
2	Code of the subject	EE-052
3	Title of the subject	VLSI Signal Processing
4	Any prerequisite	Digital Circuit, and Signals & Systems
5	L-T-P	3-0-0
6	Learning Objectives of the subject	This course aims at providing comprehensive coverage of the important techniques for designing efficient VLSI architectures for DSP. This course will enable students to understand industrial challenges in the implementation of DSP systems, like capability to process high throughput data in real-time, as well as requiring less power and less chip area.

7	**Brief Contents**	Graphical representation of DSP algorithms, Signal flow graph (SFG), Data flow graph (DFG) and dependence graph (DG), High-level transformation, Critical path, Retiming of DFG, Critical path minimization by retiming, Loop retiming and iteration bound, Cutset retiming, Design of pipelined DSP architectures. Parallel realization of DSP algorithms, Unfolding theorem, Polyphase decomposition, Hardware efficient parallel realization of FIR filters, 2-parallel and 3-parallel filter architectures, Hardware minimization by folding, Delay optimization by folding, Lifetime analysis. Pipelining digital filters, Combining parallel processing with pipelining in digital filters and for advanced VLSI signal processing.

1	**Type of course**	Elective
2	**Code of the subject**	EE-053
3	**Title of the subject**	Low Power VLSI
4	**Any prerequisite**	Digital Electronics
5	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	Correctly describe the detailed behaviour of given digital logic circuits as defined by Verilog HDL, state diagrams, or other means, including those circuits related to modern computer architecture. Translate system requirements into a practical digital design, making use of modern engineering tools such as Xilinx Vivado, Verilog HDL, and FPGA prototyping boards. Demonstrate the ability to modify existing HDL code to meet new system requirements. Demonstrate hands-on test bench and prototyping skills to ensure that a design meets the specified system requirements.
7	**Brief Contents**	Introduction: Need for low-power VLSI chips, Sources of power dissipation on Digital Integrated circuits, Dynamic dissipation, Static Dissipation, Technology & Device innovation, Emerging Low power approaches, Low power design techniques at architecture and system levels, Power consumption of dedicated hardware vs. software implementations of systems, Low power architecture, RTL design techniques for low power, UPF, Low power random access memory circuits, Power analysis and design at system level and state-of-the-art low power applications

1	**Type of course**	Elective
2	**Code of the subject**	EE-054
3	**Title of the subject**	Microcontroller and Embedded System
4	**Any prerequisite**	Nil
5	**L-T-P**	3-0-0

6	**Learning Objectives of the subject**	This course aims to convey knowledge of basic concepts of embedded system design required for every state-of-the-art electrical/electronic system in the form of autonomous and real–time computing machine embodied within them. Emphasis is on the features and characteristics of embedded system, design metrics, embedded system design flow, processor, memory and input output interfacing and input output devices, assembly language, hardware description language, I/O interface design and programming, real-time operating system, hardware-software co-design and co-simulation. Special attention will be devoted to the most important challenges facing embedded system designers today and in the coming decade.
7	**Brief Contents**	Introduction to Real Time Embedded System; Embedded system, Real time, Conventional architecture, Major components of ESD, Design issues, Design metrics and Design methodology, Task level design approach, structural layout, Structure of ES, ASIC Microprocessor, DSP, Microcontroller, ASIC, Memory and FPGA Introduction to Computing, 8051 Microcontroller developed by Intel, 8051 interfacing to external memory, LCD, ADC and sensors, Advanced microcontroller: ARM University program: ARM architecture fundamentals., State-of-the-art Processor, FPGA (Virtex-7 series, ZedBoard, Basys 3 Artix-7), DSP, Microcontroller, ASIC and Memory chips used in various real time embedded autonomous and intelligent applications.

1	**Type of course**	Elective
2	**Code of the subject**	EE-055
3	**Title of the subject**	Memory Devices and Circuits
4	**Any prerequisite**	Digital Electronics
5	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	The objective of the Memory Design is to acquaint the students with memory cells, memory peripherals, novel SRAM cells, next-generation memory, memory architecture, memory structure in processing unit. The subject gives the platform to analyze the read/write/hold operations of different memory structures using CAD tools.
7	**Brief Contents**	Overview of volatile memory, Non-volatile memory, On-chip memory, On-chip memory types. Review of CMOS circuit design, Sensing circuitry basics, Read/write assist circuitry and other peripheral circuitries, Next generation SRAM cell. Introduction to DRAM, High speed DRAM architectures, Open and folded arrays organizations, Bandwidth, latency, and Cycle time, Power, Timing circuits. STT-MRAM, Data migration policy for hybrid cache. Operation of FLASH memories (FLASH array sensing and programming), Charge Pump circuits. Basic of memory compiler for SRAM architecture using scripting language, Memory unit in MPU/MCU.

1	Type of course	Elective
2	Code of the subject	EE-056
3	Title of the subject	VLSI Architecture
4	Any prerequisite	System Design using HDL
5	L-T-P	3-0-0
6	Learning Objectivesof the subject	The course objective is to cover the architecture design of VLSI systems and subsystems with the notion of optimization for area, speed, power dissipation, cost and reliability. Different aspects of VLSI system design and its applications in various field. The course also discusses traditional and state of the art analog and digital VLSI architectures optimized techniques.
7	Brief Contents	ISA, Datapath and control path design, Single Cycle MIPS , 5 Stage pipeline MIPS, CISC Architecture, RISC architecture, Arithmetic unit design, Fixed point and floating point, memory units, Optimization, Instruction level parallelism, Super scalar processor, Multi-core and multi thread Architecture, Network on chip, Dynamically reconfigurable gate array, Static vs dynamic reconfiguration, Single context vs multi-context dynamic reconfiguration, Full vs partial run time reconfiguration.

1	Type of course	Elective
2	Code of the subject	EE-057
3	Title of the subject	Hardware Security
4	Any prerequisite	VLSI Design
5	L-T-P	3-0-0
6	Learning Objectives of the subject	Learning the state-of-the-art security methods and devices, better understanding of attacks and providing countermeasures against them, CMOS implementation of hardware security primitives, Attacks on cyber-physical systems
7	Brief Contents	Module I: Fundamentals of hardware security and trust for integrated circuits. Physical and invasive attacks, Side-channel attacks and Countermeasures, Physically unclonable functions, Hardware-based true random number generators, Hardware Trojan, Hardware security primitives, CMOS PUF implementations Module II: Watermarking of Intellectual Property (IP) blocks, FPGA security, Passive and active metering for prevention of piracy, Access control, Hardware Trojan detection and isolation in IP cores and integrated circuits counterfeit ICs

1	Type of course	Elective
2	Code of the subject	EE-058
3	Title of the subject	FPGA Based System Design
4	Any prerequisite	Nil
5	L-T-P	3-0-0
6	**Learning Objectives of the subject**	The goal of the course is to study the basic principles and methods of FPGA prototyping. Understanding of principles of IC prototyping; hardware and software; design strategies and methods
7	**Brief Contents**	ROM, SPLD, CPLD Architecture and Features of FPGA and designing techniques. Architecture of ROM – ROM Programming – Architecture of SPLDs – SPLDs programming – Architecture of CPLDs – Basics of FPGAs– Structure of FPGAs Implementation of Digital circuits in FPGA processor, Education FPGA kit – FPGA pin assignment – Interfacing Input/Output devices with FPGA, SPI, I2C, I3C, UART protocol RTL design System Design Examples using Xillinx FPGAs – Traffic light Controller, Real Time Clock, VGA, Keyboard, LCD, Embedded Processor Hardware Design

1	Type of course	Elective
2	Code of the subject	EE-059
3	Title of the subject	Quantum electronics
4	Any prerequisite	Digital IC Design
5	L-T-P	3-0-0
6	**Learning Objectives of the subject**	The course gives an introduction to solid state physics, and will enable the student to employ classical and quantum mechanical theories needed to understand the physical properties of solids. Emphasis is put on building models able to explain several different phenomena in the solid state.
7	**Brief Contents**	The crystal structure of solids, Introduction to quantum mechanics: Principles of Quantum mechanics, Application of Schrodinger's Wave Equations, Introduction to Quantum Theory of Solids: The kronig-Penney Model, Electrical conduction in Solids, DOS, Statistical Mechanics, The semiconductor in Equilibrium Carrier transport Phenomenon, Non-equilibrium Excess Carriers in Semiconductor, PN-Junction, MOSCAP, Thin film Transistors, QCA

1	**Type of course**	Elective
2	**Code of the subject**	EE-060
3	**Title of the subject**	RF Circuit Design
4	**Any prerequisite**	Analog IC Design
5	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	Get the idea of various parameters of interest in RF systems. To understand issues involved in design for GHz frequencies. To understand theoretical background relevant for design of active and passive circuits for RF front end in wireless digital communication systems.
7	**Brief Contents**	Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications, Active devices for RF circuits: SiGe MOSFET, GaAs pHEMT, HBT and MESFET. RF Amplifier design: single and multi-stage amplifiers. Review of analog filter design. Voltage references and biasing. Low Noise Amplifier design: noise types and their characterization, LNA topologies, Power match vs Noise match. Linearity and large-signal performance, RF Power amplifiers: General properties. Class A, AB and C Power amplifiers. Class D, E and F amplifiers. Modulation of power amplifiers, Analog communication circuits, Phase-locked loops, Oscillators and synthesizers.

1	**Type of course**	Elective
2	**Code of the subject**	EE-061
3	**Title of the subject**	Mixed Signal SoC Design
4	**Any prerequisite**	Analog IC Design
5	**L-T-P**	3-0-0
6	**Learning Objectivesof the subject**	At the end of the course the student will be able to: Understand the significance of different biasing styles and apply them aptly fordifferent circuits. Design basic building blocks like sources, sinks, mirrors, up to layout level. Comprehend the stability issues of the systems and design Op-amp fullycompensated against process, supply and temperature variations. Identify suitable topologies of the constituent sub systems and correspondingcircuits as per the specifications of the system Design Analog integrated system including parasitic effects upto tape-out.
7	**Brief Contents**	Process and temperature independent compensation, Resistor Equivalence of a Switched Capacitor, Parasitic-Sensitive Integrator, Parasitic-Insensitive Integrators, Signal-Flow-Graph Analysis, Noise in

Switched-Capacitor Circuit.
Performance of Sample-and-Hold Circuits, Ideal D/A Converter, Ideal A/D Converter, Quantization Noise, Charge-Redistribution A/D, Resistor-Capacitor Hybrid, Basic Phase-Locked Loop Architecture, Voltage Controlled Oscillator, Divider Phase Detector, Loop Filer, PLL in Lock, Linearized Small-Signal Analysis, Second-Order PLL Model , Jitter and Phase Noise, Period Jitter, Probability Density Function of Jitter, Ring Oscillators, LC Oscillators, phase Noise of Oscillators, jitter and Phase Noise in PLLS

1	Type of course	Elective
2	Code of the subject	EE-062
3	Title of the subject	AI-Accelerator Design
4	Any prerequisite	NIL
5	L-T-P	3-0-0
6	Learning Objectivesof the subject	This course provides in-depth coverage of the architectural techniques used to design accelerators for training and inference in machine learning systems. Get exposure of implementation of CNN network in FPGA board. Get an idea about data system bus used in communication between different system blocks. To design energy-efficient accelerators, develop the intuition to make trade-offs between ML model parameters and hardware implementation techniques.
7	Brief Contents	Deep understanding of Neural networks, Linear algebra fundamentals and accelerating linear algebra, Implementation of Deep Learning Kernels, Zynq series FPGA architecture, interface knowledge, high speed protocol (Ethernet 100/10 Gbps), c/c++ coding for Vivado SDK, activation function verilog implementation, classification layer HDL implementation, SPI, I2C, I3C, UART protocol RTL design.

1	Type of course	Elective
2	Code of the subject	EE-063
3	Title of the subject	System-on-Performance Chip Design
4	Any prerequisite	NIL
5	L-T-P	3-0-0
6	Learning Objectivesof the subject	This course provides in-depth coverage of System-on-Performance Chip Design. Design, optimize, and program a modern System-on-a-Chip to analyse and characterize its computational requirements computational task, and identify performance bottlenecks. Characterize and develop real-time solutions. Implement both hardware and software solutions, formulate hardware/software tradeoffs, and perform hardware/software codesign.
7	Brief Contents	Architectural building blocks and heterogeneous architecture, Hardware-Software Codesign, Embedded Software, Interfacing, Computational

		requirements and system analysis, Concurrency, Real Time, Design-space formulation and exploration, Costs and metrics (energy, area, runtime, reliability, predictability), Quantitative design and analysis.

1	Type of course	Elective
2	Code of the subject	EE-064
3	Title of the subject	Embedded Software
4	Any prerequisite	Nil
5	L-T-P	3-0-0
6	Learning Objectives of the subject	Analyze and explain the control-flow and data-flow of a software program and acycle-based hardware description. Transform simple software programs into cycle-based hardware descriptionswith equivalent behavior and vice versa. Partition simple software programs into hardware and software components, and create appropriate hardware-software interfaces to reflect this partitioning. Identify performance bottlenecks in a given hardware-software architecture and optimize them by transformations on hardware and software components.
7	Brief Contents	Design of embedded systems, Architectures and platforms for embedded systems, General purpose vs. application specific architectures, Reconfigurable Systems, Modeling techniques, Models of computations, Synchronous finite statemachines, Time and synchrony, Co-design finite state machines, System design with the POLIS system, Performance analysis and co-simulation, Static analysis techniques,Co-simulation of heterogeneous systems with Ptolemy, Optimization techniques for design space exploration, Software synthesis and code generation, Retargetable compilers, System-level power/energy optimization Mapping and scheduling for low energy, Real-time scheduling with dynamic voltage scaling.

1	Type of course	Elective
2	Code of the subject	EE-065
3	Title of the subject	High Performance Computing Systems
4	Any prerequisite	VLSI Architecture
5	L-T-P	3-0-0
6	Learning Objectives of the subject	To get in-depth analysis of issues in High Performance Computing systems including: (1) Parallel Computing (2) New Processor Architectures, (3) Power-Aware Computing and Communication, (4) Advanced Topics on Peta scale Computing and Optical Systems.

		To understand parallel models of computation such as dataflow, and demand-driven computation.
7	**Brief Contents**	Parallel Processing Concepts; Levels and model of parallelism: Instruction, Transaction, Task, Thread, Memory, Function, Data Flow models, Demand-driven computation; Parallel architectures: Superscalar architectures, Multi-core, Multi-threaded, Server and cloud; Fundamental design issues in HPC: Load balancing, scheduling, Synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; Fundamental limitations in HPC, Benchmarking HPC, Scalable storage systems, Accelerated HPC, Power-aware HPC Design.

1	**Type of course**	Elective
2	**Code of the subject**	EE-066
3	**Title of the subject**	Special Topics in IC Design and Technology
4	**Any prerequisite**	NIL
5	**L-T-P**	3-0-0
6	**Learning Objectives**	This will focus on special topics of contemporary relevance and interest to both VLSI industry and state-of-the-art research.
7	**Brief Contents**	It will cover current research and development topics and in line with VLSI industry and may cover all aspects from Device Technology to chip design flow through ASIC and FPGA.

1	**Type of course**	Elective
2	**Code of the subject**	EE-067
3	**Title of the subject**	Sensors for Autonomous System
4	**Any prerequisite**	Nil
5	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	Acquire knowledge about Micro Sensors, Get the idea about sensor application for autonomous system, sensor technology for real-time applications. Modern control methods that can be used to mathematically model or estimate the function of real systems, A range of autonomous decision-making approaches, including optimization to ensure desired outcomes

7	**Brief Contents**	Introduction and historical background, Microsensors : Sensors and characteristics, Integrated Smart sensors, Sensor Principles/classification-Physical sensors. Methods for data acquisition, and issues associated with different techniques (e.g. Nyquist, noise, etc.), modelling dynamic systems using transfer functions, with a particular focus on electro-mechanical systems, multiple-input-multiple-output systems, feedback control methods using observability and parameter estimation, rule based and optimization approaches, hardware development, system dependability (reliability, availability and safety); fault detection, diagnosis and prognosis

1	**Type of course**	Elective
2	**Code of the subject**	EE-068
3	**Title of the subject**	Network on Chip
4	**Any prerequisite**	NIL
5	**L-T-P**	3-0-0
6	**Learning Objectives of the subject**	Upon completion of this course, students will be able to: incorporate hundreds of cores into a single chip, Router microarchitecture, Flow control, Routing algorithms, Designing Power efficient NoC, Three dimensional networks-on-chip architectures, Analyze test and fault tolerance of Communications in NOC, Apply the 3D Integration procedures in NOC
7	**Brief Contents**	Introduction to NoC, OSI layer rules in NoC, Interconnection Networks in Network-on-Chip Network Topologies, Switching Techniques, Routing Strategies, Architecture Design, Switching Techniques and Packet Format, Asynchronous FIFO Design, Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design, Routing Algorithms, Test and Fault Tolerance of NOC, 3-D integration of NOC.

Curriculum & Contents

Master of Business Administration (MBA)

Department of Management Studies

विश्वजीवनामृतं ज्ञानम्

ABV-Indian Institute of Information Technology & Management, Gwalior

2023

SCHEMA

Name of the program: Master of Business Administration
(Credits: 109)

Name of the Department: Management Studies

Focus of MBA-I Year: The first year of the programme is to intend to impart the general management principles and practices along with analytical ability required for modern businesses.

Focus of MBA-II Year: The second year of the programme is intended to provide the specialized and sectorial management ability on the blend of technology embedded analytics canvas. The students can flexibly choose their area of specialization the six baskets of electives. While the four massive open online courses of the complements the chooses basket of elective openly to meet the business need as student foresee.

Credit Requirement: First Year (Semester I+II+ Summer Term): 24+27+4=55
Second Year (Semester III+IV): 30+24=54
Total Credits: 109

SEMESTER – I

S. No	Course Code	Title of the Course	L-T-P	Credits
1.	MS601	Principles and Practices of Management	3-0-0	3
2.	MS602	Business Statistics	3-0-0	3
3.	MS603	Business Economics	3-0-0	3
4.	MS604	Business and Legal Environment	3-0-0	3
5.	MS605	Financial Reporting and Control	3-0-0	3
6.	MS606	Organizational Behavior	3-0-0	3
7.	MS607	IoT and Big Data Management	3-0-0	3
8.	MS608	International Business	3-0-0	3
9.		Computational laboratory (based on semester courses)	Part of course credit	
		Total Credits		**24**

SEMESTER – II

S. No	Course Code	Title of the Course	L-T-P	Credits
1.	MS609	Human Resource Management	3-0-0	3
2.	MS610	Operations Management	3-0-0	3
3.	MS611	Marketing Management	3-0-0	3
4.	MS612	Financial Engineering and Management	3-0-0	3
5.	MS613	Business Research Method	3-0-0	3
6.	MS614	Decision Modelling and Optimization	3-0-0	3
7.	MS615	Artificial Intelligence and Machine Leaning	3-0-0	3
8.	MS616	Project Management	3-0-0	3
9.		Massive Open Online Course (MOOC-1)	0-0-6	3
10.		Computational laboratory (based on semester courses)	Part of course credit	
		Total Credits		**27**

EXIT AFTER YEAR-1: Diploma in Management

Summer Term

1	MS697	Course Code	Summer term of 6-8 weeks (Industry project. R&D Project etc.)	0-0-08	4

Summer Term Evaluation: To be evaluated during third semester of the MBA programme

Remark: If some student quits the MBA programme after successful completion of the first year the student may be awarded "Diploma in Management".

SEMESTER – III

S. No	Course Code	Title of the Course	L-T-P	Credits
1	MS618	Strategic Management	3-0-0	3
2	MS619	Entrepreneurship and Innovation	3-0-0	3
3	MS620	Business Process Management	3-0-0	3
4	MS621	Business Ethics and Sustainability	3-0-0	3
5		Elective-I	3-0-0	3
6		Elective-II	3-0-0	3
7		Elective-III	3-0-0	3
8		Massive Open Online Course (MOOC-2)	3-0-0	3
9	MS698	Major Project Part-I	0-0-12	6
		Total Credits		**30**

SEMESTER – IV

S. No	Course Code	Title of the Course	L-T-P	Credits
1		Elective-IV/ Massive Open Online Course (MOOC-3)	3-0-0	3
2		Elective-V/ Massive Open Online Course (MOOC-4)	3-0-0	3
3	MS699	Major Project Part-II	0-0-24	18
		Total Credits		**24**

Composition of Electives: A student has to choose 07 electives from the basket of 04 MOOC courses and 05 Departmental Electives. The composition of electives shall be as minimum 03 from the departmental electives, minimum 02 from MOOC electives and remaining two electives may be flexibly chosen either from the department or from MOOC electives.

List of suggested courses for MOOC: MOOC courses should be relevant to the area of management programs catering the need of specialization and relevant to the frontier areas of technology, information technology or management fulfilling the modern business needs and are not being offered as in-house courses of ABV-IIITM Gwalior.

Specialization in the MBA degree: A student will be able to earn specialization in a particular area(s) by earning a minimum of *09 credits (ordinarily equal to 03 courses) through in-house elective courses*. Details of specialization will be part of the transcript issued to a student.

Exit Option from MBA Program: A student can exercising the option of program exit after completing First Year of the DoMS MBA. In such scenario the student may be awarded the **certificate of *Post Graduate Diploma in Management.***

List of indicative electives
(Odd and Even Semesters)

Specialization Basket 01: Information Technology and Systems

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS001	Digital Production System	3-0-0	3	Odd
2	MS002	IT Products and Intellectual Property Rights	3-0-0	3	Even
3	MS003	Management of Digital Technologies	3-0-0	3	Odd
4	MS004	Knowledge Management	3-0-0	3	Even
5	MS005	Service-Oriented Computing	3-0-0	3	Odd
6	MS006	Social Networks Analytics	3-0-0	3	Even
7	MS007	Software Project Management	3-0-0	3	Odd
8	MS008	Software Quality Management	3-0-0	3	Even
9	MS009	Programming for Business Intelligence	3-0-0	3	Odd
10	MS010	Strategic Planning of Information Systems	3-0-0	3	Even

Specialization Basket 02: Technology and Operations Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS011	Business Systems Simulation	3-0-0	3	Odd
2	MS012	Service Operations Management	3-0-0	3	Even
3	MS013	Sustainable Supply Chain Management	3-0-0	3	Odd
4	MS014	Technology Management	3-0-0	3	Even
5	MS015	Technology and Operations Strategy	3-0-0	3	Odd
6	MS016	Total Quality Management	3-0-0	3	Even
7	MS017	World Class Production Systems	3-0-0	3	Odd
8	MS018	Emerging Areas in Technology and Operations Management	3-0-0	3	Even
9	MS019	New Products and Services Development	3-0-0	3	Odd
10	MS020	Project Management			

Specialization Basket 03: Human Resource Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS021	Compensation Management	3-0-0	3	Odd
2	MS022	Change Management	3-0-0	3	Even
3	MS023	Corporate Social Responsibility	3-0-0	3	Odd
4	MS024	Competency Management	3-0-0	3	Even
5	MS025	Human Resource Information System	3-0-0	3	Odd
6	MS026	Emerging Areas in Human Resource	3-0-0	3	Even
7	MS027	Organization Theory and Development	3-0-0	3	Odd
8	MS028	Leadership and Talent Management	3-0-0	3	Even
9	MS029	Training and Development	3-0-0	3	Odd
10	MS030	Management of Employee Relations	3-0-0	3	Even

Specialization Basket 04: Finance

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS031	Corporate Restructuring	3-0-0	3	Odd
2	MS032	Corporate Tax Planning	3-0-0	3	Even
3	MS033	Economic and Financial Modeling	3-0-0	3	Odd
4	MS034	Entrepreneurial Finance	3-0-0	3	Even
5	MS035	Management of Financial Services	3-0-0	3	Odd
6	MS036	Financial Risk management	3-0-0	3	Even
7	MS037	Personal Wealth Management	3-0-0	3	Odd
8	MS038	International Finance	3-0-0	3	Even
9	MS039	Project Appraisal and Finance	3-0-0	3	Odd
10	MS040	Security Analysis and Portfolio Management	3-0-0	3	Even

Specialization Basket 05: Marketing Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS041	Consumer Behavior	3-0-0	3	Odd
2	MS042	Advertisement and Sales Promotion Management	3-0-0	3	Even
3	MS043	Product and Brand Management	3-0-0	3	Odd
4	MS044	E-marketing	3-0-0	3	Even
5	MS045	Retail Management	3-0-0	3	Odd
6	MS046	International Marketing	3-0-0	3	Even
7	MS047	Sales and Distribution	3-0-0	3	Odd
8	MS048	Marketing Research	3-0-0	3	Even
9	MS049	Service Marketing	3-0-0	3	Odd
10	MS050	Strategic Marketing	3-0-0	3	Even

Specialization Basket 06: Management of Social Sector

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS051	Public Policy and Processes	3-0-0	3	Odd
2	MS052	Public Private Partnerships	3-0-0	3	Even
3	MS053	Sustainable Development	3-0-0	3	Odd
4	MS054	Management of Rural and Social Sector	3-0-0	3	Even
5	MS055	Information Technology Enabled Services	3-0-0	3	Odd
6	MS056	Management of Non-Formal Organization	3-0-0	3	Even
7	MS057	Healthcare System Management	3-0-0	3	Odd
8	MS058	Emerging Areas in Management of Social Sector	3-0-0	3	Even
9	MS059	Infrastructure Management	3-0-0	3	Even

Course Contents
(Core)

1	Programme	MBA
2	Semester	I
3	Type of course	Core
4	Code of the subject	MS601
5	Title of the subject	Principles and Practices of Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Element of Management is concerned with the way in which organizations manage their resources. The aim is to explore the concepts of management, managers, and organizations in today's dynamic environment. This course outline illustrates the varied backgrounds, skills, and characteristics required for successful managers. It continues with an examination of the functions of management, managerial roles and diverse nature of modern business organizations, and rewards and challenges offered by a career in management.
9	Brief Contents	Explain what is meant by the term management, Classify the three levels of managers and identify the primary responsibility of each group, Describe the difference between managers and operative employees, Explain the skills and roles manager, Describe the value of studying management, Identify the relevance of popular humanities and social science courses to management practices, Define planning. Explain the potential benefits of planning, Distinguish between strategic and tactical plans, Define management by objectives and identify its common elements, Outline the steps in the strategic management process, Explain SWOT analysis, Describe the steps in the decision-making process, Identify the assumptions of the rational decision-making model, Define certainty, risk, and uncertainty as they relate to decision making, Identify the two types of decision problems and the two types of decisions that are used to solve them, Describe the advantages and disadvantages of group decisions, Identify and define the six elements of organization structure, Contrast mechanistic and organic organizations, Summarize the effect of strategy, size, technology, and environment on organization structures, Contrast the divisional and functional structures, Define leader and explain the difference between managers and leaders, Describe the skills that visionary leader exhibit, Explain the styles and theories of leadership, Define Motivation at work, Techniques of motivation, Theories of motivation, Explain what is meant by the term learning organization, Define control, Describe three approaches to control, Explain why control is important, Describe the control process, Distinguish among the three types of control, Describe the qualities of an effective control system, Explain how controls can become dysfunctional
10	Contents for lab	No

1	Programme	MBA
2	**Semester**	I
3	**Type of course**	Core
4	**Code of the subject**	MS602
5	**Title of the subject**	Business Statistics
6	**Any prerequisite**	Basic knowledge of mathematics and statistics
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To understand the role of statistics in the field of business management. To understand the process associated with statistical decisions, defining and formulating problems, analysing the data, and using the results in decision making.
9	**Brief Contents**	Introduction to Statistics, Charts and Graphs, Measures of central tendency, Measures of dispersion, Probability, Discrete probability distribution, Continuous probability distribution Sampling and sampling distributions, Statistical inference: Estimation for single populations, Statistical inference: Hypothesis testing for single population, Statistical inference: Hypothesis testing for two populations, Analysis of variance and Experimental designs, Hypothesis testing for categorical data (chi-square test), Simple linear regression analysis , Multiple regression analysis, Time series and Index numbers, Statistical quality control, Non-parametric statistics, Statistical decision theory
10	**Contents for lab**	Application of appropriate statistical software

1	Programme	MBA
2	**Semester**	I
3	**Type of course**	Core
4	**Code of the subject**	MS603
5	**Title of the subject**	Business Economics
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Managerial Economics is the use of economic theory and mathematical and statistical techniques in order to examine how a firm can make optimal managerial decisions given the constraints it faces. The main objective of this course is to equip students with the necessary theory and techniques and the ability to apply them in order to inform and enhance managerial decision making. Topics covered include: goals of the firm, optimization techniques, demand theory and estimation, forecasting and measurement, theory of production and estimation, cost theory and estimation, pricing and output determination under different market structures, game theory, and pricing in practice.
9	**Brief Contents**	Introduction to Economics; Nature and Scope of Management Economics, Significance in decision-making and fundamental

concepts, Consumer behaviour and typical characteristics of Indian consumer, Consumer decision making process, Indian market: characteristics, Objectives of a firm, Demand Analysis, Law of Demand, Exceptions to the law of Demand, Determinants of Demand. Elasticity of Demand- Price, Income, Cross and Advertising Elasticity, Uses of Elasticity of Demand for managerial decision making, Measurement of Elasticity of Demand, Demand forecasting meaning, significance and methods, Supply Analysis, Law of Supply, Supply Elasticity, Analysis and its uses for managerial decision making, Production concepts & analysis, Production function, single variable-law of variable proportion, two variable-Law of returns to scale, Cost concept and analysis, short-run and long-run cost curves and its managerial use, Market Equilibrium and Average Revenue Concept, Market Structure: Perfect Competition, features, determination of price under perfect competition, Monopoly: Feature, pricing under monopoly, Price discrimination, Monopolistic: Features, pricing under monopolistic competition, product differentiation, Oligopoly: Features, kinked demand curve, cartels, price leadership, Pricing strategies Price determination, Full cost pricing, Product line pricing, Price skimming, Penetration pricing, National Income; Concepts and various methods of its measurement, Inflation, types and causes, Business cycle, Profit concept and major theories of profits; Dynamic Surplus theory, Risk & Uncertainty bearing theory and Innovation theory

10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	I
3	**Type of course**	Core
4	**Code of the subject**	MS604
5	**Title of the subject**	Business and Legal Environment
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	This course will give orientation to the students about different forms of organizations, functions in organizations, business environment and strategies, along with an exposure to basic elements of company laws, economics laws, industrial and labour laws, foreign exchange management act in business perspective.
9	**Brief Contents**	Concepts of Vision and Mission statements, Types of Environments, Business Environment with reference to Global integration, Forms of business organisation: Scales of business; Emerging trends in business, Company Laws: The Companies Act 2013, Limited Liability Partnership Act, 2008, The insolvency and bankruptcy code 2016, Economic Laws: FDI Policy-Foreign Direct Investment in India and abroad, External Commercial Borrowing (ECB), Formalities-Establishment of

Branch Office of a foreign entity in India, Foreign Trade Policy-Opportunities of commerce/finance professional in foreign trade-Procedure of import and export-Export promotion schemes and initiatives, Competition Commission of India-Compliance of competition law, Industrial and Labour laws: Overview of Industrial Policy of Govt. of India, Regulatory Mechanism under IDRA, MSME Development Act, Advantages of MSMEs and their role and significance in economic development, Central and State Schemes for MSME Promotion-Udyog Aadhar, Foreign Exchange Management Act: Features and Application-Opportunities for Indian Business Challenges, Foreign Contribution (Regulation) Act 2010

10	Contents for lab	No

1	Programme	MBA
2	Semester	I
3	Type of course	Core
4	Code of the subject	MS605
5	Title of the subject	Financial Reporting and Control
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After the completion of this course, students will be able to understand the role and relevance of financial accounting in management and its implications for a business entity, and utility of cost and management accounting information as a vital input for management and decision-making process.
9	Brief Contents	Introduction, nature and scope of financial and management accounting, GAAP and accounting environment, Principles, concepts and conventions of accounting, Accounting process, Construction of profit and loss statement, Balance sheet and cash flow statement, Concept of financial statements analysis, Horizontal and vertical Analysis, Trend analysis, Ratio analysis, Cash flow statement analysis, Cost accounting and information, Types of cost, Preparation of cost sheet, Activity-based costing, Concepts of budget and budgetary control, Static and flexible budgets, Preparation of sales budget, Production budget, Material budget, Cash budget, Master budget, Concept of standard costing and variance analysis, Setting of standards, Analysis of material variances, Labour variances and overhead variances, Marginal costing and absorption costing, Marginal costing, and its applications, Cost-volume-profit analysis, Concept of contribution and break-even analysis and its uses, Margin of safety and angle of incidence.
10	Contents for lab	No

1	**Programme**	MBA
2	**Semester**	I
3	**Type of course**	Core
4	**Code of the subject**	MS606
5	**Title of the subject**	Organizational Behavior
6	**Any prerequisite**	General Understanding of Management Functioning
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To provide a comprehensive analysis of individual and group behaviour in the organizations. To provide an understanding of how organizations can be managed more effectively and at the same time enhancing the quality of employees work life.
9	**Brief Contents**	What is organizational behaviour?, OB as an interdisciplinary subject ,The Individual: Diversity in the organizations, attitudes and job satisfaction, emotions and moods, personality and values, perception and individual decision making, motivation concepts, motivation: from concepts to applications The Group: Foundations of group behaviour, understanding work teams, communication, leadership, power and politics, conflict and negotiations, foundations of organization structure, The Organization system Organizational culture, human resource policies and practices, organizational change and stress management
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	I
3	**Type of course**	Core
4	**Code of the subject**	MS607
5	**Title of the subject**	IoT and Big Data Management
6	**Any prerequisite**	Fundamentals of Computer/ Computer organization and any programming language
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon course completion, students will be able to: Understand deploying smart applications on different IoT platforms. Develop Interface of various sensors, I/O devices and I/O peripherals with N/W Protocols. Understand the impact of big data for business decisions and strategy. Gain hands-on experience on large-scale analytics tools to solve some open big data problems. Understand the concept and challenge of big data and why existing technology is inadequate to analyze the big data
9	**Brief Contents**	Design principles and needed capabilities, AI applications in IoT Applications, Sensing, Actuation, Basics of networking, M2M and IoT technology fundamentals- devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT, Components selection criterion for implementing IoT application, Hardware components

		computing (Node MCU, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces, Software components-programming API's (using Python/Node.js/Arduino), Sensors interfacing: Interfacing of temperature, Humidity, Light, Accelerometer, Ultrasonic, IR/PIR, Camera etc, Communication and I/O components, Interfacing: bluetooth, WiFi, GSM, Displays and touch sensor etc., Types of Digital Data, Introduction to Big Data, Big Data Analytics, Relational Databases & SQL, Data Cleansing and Preparation, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, analyzing data with Hadoop, Hadoop Streaming, IBM Big Data Strategy, Infosphere Big Insights and Big Sheets, HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data ingest with Flume and Scoop and Hadoop archives, NoSQL, Types of NoSQL database, Advantages, New SQL, Comparison of SQL, NoSQL and NewSQL., Supervised learning with regression and classification techniques, Bias-Variance trade-off, Model validation approaches, Logistic regression, Linear discriminant analysis, Quadratic discriminant analysis, Ensemble methods: random forest neural networks, Deep learning unsupervised learning and challenges for big data analytics, Clustering, associative rule mining, Challenges for big data analytics prescriptive analytics, Creating data for analytics through designed experiments, Creating data for analytics through active learning, Creating data for analytics through reinforcement learning.
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	III
3	**Type of course**	Core
4	**Code of the subject**	MS608
5	**Title of the subject**	International Business
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The goal of this course is to introduce participants to the field of international business. This course will make participants familiar with three basic areas: underlying theories of international business, environmental factors affecting international activities, and the management of business functional operations in an international context. In addition, participants will learn how to analyse international situations and evaluate contemporary issues in international business.
9	**Brief Contents**	Background for International Business: Globalization and International Business, Comparative Environmental Frameworks: The Cultural environments facing business, The Political and Legal environments facing business, The

Economic environments facing business, Globalization and Society, Theories and Institutions: Trade and Investment: International trade and Factor mobility theory, Governmental Influence on trade, Cross-National cooperation and agreements World Financial Environment Global Foreign: Exchange markets, The Determination of Exchange rates, Global capital markets, Global Strategy, Structure, and Implementation: The Strategy of international business, Country evaluation and selection, Export and Import, Direct investment and Collaborative strategies, The Organization of international business, Managing International Operations: Marketing globally, Global operations and supply-chain management, International accounting and finance issues, International human resource management

10	Contents for lab	No

1	Programme	MBA
2	Semester	II
3	Type of course	Core
4	Code of the subject	MS609
5	Title of the subject	Human Resource Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Human Resource Management (HRM) is concerned with the way in which organizations manage their people. The aim is to chart some of the broad terrain of a rapidly developing field of study in order to prepare the students for the more finely grained treatment of specific HRM topics. This course outline examines the recent rise of HRM, the effects of the changing context of work on HRM, what it involves, and the strategic nature of HRM practice, its impact on organizational performance and the changing role of HRM function.
9	Brief Contents	Define HRM, Describe the Nature, Feature and Scope of HRM, Describe the major activities of HRM, Explain the skills and roles of Human Resource manager, Why HRM is important to all managers, List the challenges and opportunities of HR manager, Define Job Analysis, Explain types of Job analysis, Understand Job Analysis Process, Describe the basic methods of collecting the Job analysis information, Define HR planning, Describe the need and objectives of HR planning, Understand the HR planning model, Explain the factors affecting HR planning, Define Recruitment, Explain essential steps for Recruitment Planning, Understand Recruitment model, Describe sources of Recruitment, Explain the Pros and Cons of recruitment, Define selection , Steps / process of selection, Define Employee training, Explain need and objectives of training, Differentiate between training and development, Describe the principles, areas and benefits of training, Understand the Training Methods, Describe Training system model, Understand levels of training evaluation, Define Career

		and its related terms, Understand stages of growth and career, Describe Career-planning process and its responsibility, Understand the benefits of Career development system, Know the career program for special target groups, Explain the Model or Designing organizational career development, Define Performance appraisal, Explain why it is important to effectively appraise performance, Understand features, purposes and objectives of performance appraisal. Describe the methods of performance appraisal. List the criticism of performance appraisal.
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core
4	**Code of the subject**	MS610
5	**Title of the subject**	Operations Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Understand the role of operations in both manufacturing and service organizations. Describe the importance of facilities location decision in the end-to-end supply chain. Develop understanding of a range of inventory models available their contextual suitability. Employ different quality prescriptive and the tools of statistical process control.
9	**Brief Contents**	Operations and strategy: nature, evolution and scope of production and operations management, Emerging trends in operations management, Operations strategy: linkage with competitive strategy and formulation of operations strategy, Facility Planning: facilities location: globalization of operations, Factors affecting location decisions, Location planning methods, Linkage with supply chain network design decisions, Process Management: Design of production process and facility layout, Process design and analysis, Design of products and services: process of product and service design, Tools, Critical chain, Just-in-time, Lean operations and Toyota production system, Inventory Management: deterministic models, Probabilistic models: multi-period and single period (news vendor) models, Selective inventory models, Aggregate production planning (APP), Master production schedule (MPS), Materials requirements planning (MRP), Quality management, Statistical process control (SPC), Process capability and Six Sigma.
10	**Contents for lab**	Simulation exercises on Arena

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core

4	Code of the subject	MS611
5	Title of the subject	Marketing Management
6	Any prerequisite	Basic understanding of microeconomics
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the fundamental marketing concepts and the processes that influences the market orientation of a firm. To understand the role of marketing within the organization. To recognize the importance of marketing in the competitive world. To analyze critically the marketing process and its relationship with the environment within which it operates. To broadly look at the role of Marketing as a key element within an organization's strategy.
9	Brief Contents	Introduction to Marketing- Definition of marketing, Marketing environment, Business models and value chain, Segmentation and targeting- Concept of segmentation, Bases of segmentation (B2C & B2B), Targeting, Application in real life scenario, Positioning and differentiation- Differentiation parameters, POP& POD, Competition, Consumer Behavior- Consumer decision making process, factors influencing consumer behavior, B2B Marketing- Organizational decision making process, buying roles, Marketing strategy (product, service and pricing decisions)- Product strategy, branding, service, pricing strategy, Marketing strategy (place decisions)- Channels of distribution, Distribution strategy, Marketing strategy (promotion decisions)- Integrated marketing communication, Advance topics in marketing- Predictive, contextual, augmented and agile marketing.
10	Contents for lab	Simulation on marketing environment Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA
2	Semester	II
3	Type of course	Core
4	Code of the subject	MS612
5	Title of the subject	Financial Engineering and Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course aims at providing an understanding of financial engineering and management concepts. This will enable to understand how corporations make investment & financing decisions with dynamic risk exposures. It will help develop the financial engineering fundamentals for proper risk mitigation.
9	Brief Contents	Changing Financial arena and associated risks, Financial engineering as a response to increased risks, Types of Risks and Risk management, Financial markets, Financial institutions,

		Financial services, Financial instruments,. Financial Management: Nature, Scope, and Objectives of financial management, Time value of money, Risk and return, Capital Structure and Cost of Capital: Capital structure theories and leverage, Optimum capital structure, Measurement of specific costs, Computation of overall cost of capital. Financing Decision: Long-term financing, Short-term financing, Term financing, Venture capital. Capital Budgeting: Principles, Techniques, Measurement, evaluation, and involved risk analysis, Working Capital Management: Planning of working capital, Working capital financing, Cash management, Receivable management and Inventory management. Dividend Policy Decision: Dividend and valuation, Determinants of dividend policy, The Futures Markets, Static and dynamic hedging, Devising a Hedging Strategy Using Futures, Stock Index Futures, Value at Risk (VaR), Short Term and Long Term Interest Rate Futures, Foreign Currency Futures and Commodity Futures, Options Markets; Properties of Stock Option Prices; Option Pricing Models – Binomial Model, Black-Scholes; Model, Single Period Options –Calls and Puts, Option Strategies, Multi-Period Options – Caps, Floors, Collars, Captions, Swaptions and Compound options, Cross-currency Futures and Options, Structure of a Swap, Interest Rate Swaps, Currency of Swaps, Commodity Swaps, Other Swaps, Credit Risk and Credit Derivatives, Credit default swaps, Role of a Swap Dealer. Basics of FRAs, Emerging Innovations and recent trends
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core
4	**Code of the subject**	MS613
5	**Title of the subject**	Business Research Methods
6	**Any prerequisite**	Basic knowledge of business statistics
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To design and execute a basic survey research project. To understand the research tools and techniques for executing a business project and decision making.
9	**Brief Contents**	Introduction to business research: Business research methods: An introduction, business research process design, Research design formulation: Measurement and scaling, questionnaire design, sampling and sampling distributions, Sources and collection of data: Secondary data sources, data collection: survey and observations, experimentation, fieldwork and data preparation, Data analysis and presentation: Statistical inference: hypothesis testing for single population, hypothesis testing for two populations, analysis of variance and

experimental designs, hypothesis testing for categorical data (chi-square test), non-parametric statistics, Correlation and simple linear regression analysis, Multivariate analyses (Multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling, correspondence analysis), Result presentation: Presentation of results, report writing

10	**Contents for lab**	Data analysis and presentation: Statistical inference: hypothesis testing for single population, hypothesis testing for two populations, analysis of variance and experimental designs, hypothesis testing for categorical data (chi-square test), non-parametric statistics, Correlation and simple linear regression analysis, Multivariate analyses (Multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling, correspondence analysis)

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core
4	**Code of the subject**	MS614
5	**Title of the subject**	Decision Modelling and Optimization
6	**Any prerequisite**	Basic Knowledge of Mathematics, Probability distributions and Statistics.
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The objectives of the course is to acquaint the student with the applications of Operations Research to business and industry and help them to grasp the significance of analytical techniques in decision making
9	**Brief Contents**	Introduction to Operation Research, Overview of how Operations Research and Analytics professionals analyse problems, Introduction to Linear Programming Solving Linear Programming problems: The Simplex method, The Theory of the Simplex Method, Duality theory, Linear Programming under Uncertainty, Other Algorithms for Linear Programming, The Transportation and Assignment problems Network Optimization models Dynamic Programming, Integer Programming, Nonlinear Programming, Metaheuristics, Game Theory, Decision Analysis, Queueing Theory, Inventory Theory, Markov Decision Processes, Simulation
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core
4	**Code of the subject**	MS615

5	**Title of the subject**	Artificial Intelligence and Machine Learning
6	**Any prerequisite**	Statistics, linear algebra, matrix, probability, programming languages and data modelling.
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon course completion, students will be able to: Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem. Formalize a given problem in the language/framework of different AI methods. Implement basic algorithms using basic machine learning libraries mostly in python. Gain hands-on experience in applying ML to problems encountered in various domains. Obtain exposure to high-level ML libraries or frameworks such as TensorFlow, PyTorch.
9	**Brief Contents**	Introduction to AI: Definitions, Historical foundations, Basic elements of AI, Characteristics of intelligent algorithm, AI application areas, Neural network representation, Neural networks as a paradigm for parallel processing, Linear discrimination, Gradient descent, Logistic discrimination, Perceptron, Training a perceptron, Multilayer perceptron, Back propagation algorithm, Recurrent networks, Dynamically modifying network structure, Basic concepts, Hypothesis space search, Genetic programming, Models of evolution and learning, Parallelizing genetic algorithms, State space search, Production systems, Search space control: depth-first, breadth-first search, Heuristic search - hill climbing, Best-first search, Branch and Bound, Problem reduction, Constraint satisfaction end, Means-end analysis, Need of machine learning, Types of machine learning, Supervised learning: k-nearest neighbours, Linear regression, Logistic regression, Classification, Support vector machines, Neural networks, Unsupervised learning: clustering (k-means, hierarchical, EM), Auto-encoders, Dimensionality reduction, Learning by agents, Intelligent agent, Online learning, Batch learning, Markov Decision Processes, Temporal difference learning, Dynamic programming, Hyperparameters, Deep learning, Optimization techniques.
10	**Contents for lab**	Use Python/Jupyter notebooks/ google Colab for programming and hand out assignments Machine learning platforms: TensorFlow, Scikit-Learn etc. It may be good to have both theory and programming components in the assignment/homework component, to allow students to appreciate and learn both aspects of AI and machine learning

1	**Programme**	MBA
2	**Semester**	II
3	**Type of course**	Core
4	**Code of the subject**	MS616
5	**Title of the subject**	Project Management

6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Students will be able to understand to manage the scope, cost, timing, and quality of the project, as defined by project stakeholders. Align the project to the organization's strategic plans and business justification throughout its lifecycle. Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements in consultation with stakeholders. Implement project management knowledge, processes, lifecycle and the embodied concepts, tools and techniques in order to achieve project success. Apply project management practices to the launch of new programs, products, and services
9	Brief Contents	Introduction to Project Management: Concept of a project; categories of project, project development cycle, tools & techniques of project management, forms of project organizations, project management theory, various stages of planning, designing and managing projects, Development of Project Matrices, Critical Success factors and key performance indicators, Project Organization, Scheduling & Planning: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM; Bar Charts, Milestone Charts, Gantt Charts, Estimating Project Costs and Project Selection: Estimation of activity and project costs, means of financing, financial projections, Qualitative and Quantitative Methods of Project identification and selection, Developing the Project Schedule: Activity Sequencing, Precedence Network Diagram, Project Resource levelling and allocation in projects, network techniques and timelines, crashing of projects: time vs. cost trade-off, Program Evaluation and Review Technique, Critical Path Method, Project Scheduling, Basics of Scheduling, project management tools, Project Execution and Control: Assessing and managing costs and gains, crashing of projects: time vs. cost trade-off, earned value method, Managing Project Risks: Probabilistic aspects of projects; risk management; Principles & Concepts of project Risks Management, Risk Assessment, Risk control; critical chain project management.
10	Contents for lab	No

1	Programme	MBA
2	Semester	I
3	Type of course	Core
4	Code of the subject	MS618
5	Title of the subject	Strategic Management
6	Any prerequisite	No
7	L-T-P	3-0-0

8	**Learning Objectives of the subject**	After the completion of this course students will be able to understand the organization and the environment in which it functions and competes. The student should be able to integrate acquired knowledge of other functional areas with the body of the knowledge of strategic management and be able to deploy all as a unified tool to analyse and formulate the actions that shall deliver the intended results.
9	**Brief Contents**	Concept of strategy and strategic management, Difference between corporate planning and strategic planning, Strategic management model, Different levels of strategies, Relevance of strategic management in 21st century, Strategic intent-vision and mission statement, Organisational objectives, Setting objectives, Organisational values and its impact, External and internal Environment and analytical tools- evaluating the company's strategic environment, SWOT analysis, PESTEL analysis, Competitive analysis, Porter's five force model, Internal Assessment- strategic capability: fit and stretch concept, Porter's value chain analysis, Core competencies, Organisational capabilities, Resource analysis and synergy, Strategies in action- Functional level- Achieving superior efficiency- Economics of scale, Experience curve, Just-in-Time, Six-sigma, Business level-cost leadership, Differentiation & focus strategies, Growth strategies, Corporate level- integration, Diversification, Acquisition, Mergers & joint venture, Short term corporate strategies-stability, Retrenchment, and turnaround, Portfolio and other analytical models- BCG matrix, GE/McKinsy matrix, Corporate parenting, Evaluation of strategy- suitability, Acceptability, and feasibility, Implementing strategies-resource allocation, Structure and strategy, Organisation culture, Balance score card.
10	**Contents for lab**	No

1	**Programme**	MBA
2	**Semester**	III
3	**Type of course**	Core
4	**Code of the subject**	MS619
5	**Title of the subject**	Entrepreneurship and Innovation
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Course is designed for preparing students to take of Entrepreneurial journey on the basis of innovative ideas. The content is highly focused to start venture to making business mature up-to international level.
9	**Brief Contents**	Entrepreneurship, Creativity and innovation, Business planning process, Institutions supporting entrepreneurs, Family businesses, International entrepreneurship opportunities, Informal risk capital and venture capital, Managing growth.
10	**Contents for lab**	No

1	Programme	MBA
2	Semester	III
3	Type of course	Core
4	Code of the subject	MS620
5	Title of the subject	Business Process Management
6	Any prerequisite	Courses on functional areas of management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Describe and evaluate the development of process management and tasks of process holders in organizations. Assess the importance of the strategic perspective of business process management. Analyse and model strategic and operational business processes. Employ process performance indicators and measures.
9	Brief Contents	Orientation: Process perspective, Components of processes, Evolution of processes, Process life-cycle, Process identification, Process architecture, Process selection, Process modeling: Introduction to BPMN, Business objects, Process decomposition, Process Discovery: Process discovery, Methods, Process modeling, Process model quality assurance, Process Analysis: qualitative process analysis, Value-added analysis, Waste analysis, Stakeholder analysis, Root-cause analysis, Quantitative process analysis: flow analysis, Queues, Simulation, Process redesign, Transactional methods, Transformational methods, Process aware information systems: Types of process aware information systems, Process implementation with executable models, Process monitoring, Process as enterprise capability
10	Contents for lab	BPMN modeling software (open source) for modeling of processes

1	Program	MBA
2	Semester	III
3	Type of course	Core
4	Code of the subject	MS621
5	Title of the subject	Business Ethics and Sustainability
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon course completion, students will be able to: Develop skills in recognizing and analysing ethical issues. Define cross cultural variations and similarities in organizational practices in corporate social responsibility and business ethics. Understand sources of organizational ethical culture and to design ethical programs designed to accomplish specific objectives in organizations. Develop ethical leadership skills and practices

9	**Brief Contents**	Business ethics- an overview, Concepts and theories of business ethics, Emerging business ethics issues, Ethical decision making in business, Creating an ethical organization globalization and business ethics, Stakeholders and business ethics, Social responsibility and ethics, Issues in social responsibility, Implementing stakeholders' perspective, Stakeholder and issue management approaches, Managing corporate responsibility with external stakeholders, Corporate governance and ethical leadership, Kohlberg's six stages of moral development, Levels of ethical analysis, Concept of corporate integrity, Issues in corporate governance, good corporate governance - obligations towards society and stake holders, Ethics in consumer protection, Role of government agencies, SEBI, judiciary in ensuring ethical practices, Ethics and Indian business, Marketing ethics, Ethics in human resource management, financial management, banking and insurance.
10	**Contents for lab**	No

Course Contents
(Electives)

List of electives from the specialization basket of Information Technology and Systems

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS001	Digital Production System	3-0-0	3	Odd
2	MS002	IT Products and Intellectual Property Rights	3-0-0	3	Even
3	MS003	Management of Digital Technologies	3-0-0	3	Odd
4	MS004	Knowledge Management	3-0-0	3	Even
5	MS005	Service-Oriented Computing	3-0-0	3	Odd
6	MS006	Social Networks Analytics	3-0-0	3	Even
7	MS007	Software Project Management	3-0-0	3	Odd
8	MS008	Software Quality Management	3-0-0	3	Even
9	MS009	Programming for Business Intelligence	3-0-0	3	Odd
10	MS010	Strategic Planning of Information Systems	3-0-0	3	Even

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS001
5	**Title of the subject**	Digital Production System
6	**Any prerequisite**	Operations Management
7	**L-T-P**	3-0-0

8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Appreciate role of digital manufacturing. Analyse various computing models. Employ information and communication technologies for design of digital production systems.
9	Brief Contents	Science of digital manufacturing: operation mode and architecture of digital manufacturing system, Modeling theory and method of digital manufacturing science, Theory system of digital manufacturing science, Computing manufacturing in digital manufacturing science: computing manufacturing methodology, Manufacturing computational model, Theoretical units in manufacturing computing, Manufacturing informatics in digital manufacturing science: Principal properties of manufacturing information, Measurement, Synthesis and materialization of manufacturing information, Integration, sharing and security of manufacturing information, Intelligent manufacturing in digital manufacturing science: Intelligent multi-information sensing and fusion in the manufacturing process, Knowledge engineering in the whole life cycle of manufacturing product, Autonomy, Self-learning, Adapting of manufacturing system, Intelligent manufacturing system
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS002
5	Title of the subject	IT Products and Intellectual Property Rights
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The course is designed to impart the value driven IT products development including software, and firmware/hardware of different industrial requirements. Through understanding of the Intellectual property rights, the learner acquaint with the protection of new IT product from business threat.
9	Brief Contents	Industry Need analysis for IT product development, The Design thinking for new IT product development, Tools and Techniques of IT product development, Software design analysis, Firmware design, Product prototyping, Value analysis, Intellectual property rights for Software and Firmware, Industry-Market fit performance, Evaluation of product
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS003
5	Title of the subject	Management of Digital Technologies

6	Any prerequisite	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The course has been designed to provide comprehensive and in-depth coverage of all important aspects of modern digital technologies on the principle of industrial applications to maximize the efficiency, effectiveness and business performance. It is primarily intended for students who wish to pursue a career in mapping industrial design on the digital system.
9	**Brief Contents**	Introduction of Industry 4.0. Business System engineering and Management through Digital Technologies, Digital Transformation and Business Transition to industrial revolution 5.0. Concepts of Industry 5.0-sustainability, human centricity and system resilience through digital technologies, Understanding Blockchain principles, technology and its applications, Introduction of sensory inputs, data acquisition and applications, Introduction of Business data cloud and management, Human-system interface concept, principles, and design, Introduction of Cyber Physical System and understanding design cases
10	**Contents for lab**	No

1	**Program**	MBA/IPG MBA
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS004
5	**Title of the subject**	Knowledge Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Develop an integrated and comprehensive perspective of knowledge management as a strategic function. Identify the strategic contexts of knowledge management and the role of organisational structure and processes. Discuss the frameworks, techniques, and the nature of IT support for managing knowledge. Delineate the role of innovations in knowledge creation. Raise and resolve issues in knowledge protection for sustaining competitive advantage. Provide a platform for sharing experiences in knowledge management.
9	**Brief Contents**	The Nature of knowledge: Introduction to knowledge management, The nature of knowing, Leveraging knowledge, Intellectual capital, Strategic management perspectives, Creating knowledge, Organisational learning, The learning organisation, Knowledge management tools and systems, Knowledge management tools: component technologies, Knowledge management systems, Mobilising knowledge,

		Enabling knowledge contexts and networks, Implementing knowledge management.
10	**Contents for lab**	Case study exercises

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS005
5	**Title of the subject**	Service-Oriented Computing
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Service delivery lifecycle and associated phases. Analysis and conceptualization of services and micro-services. Service design through web. Modern service APIs and contract versioning techniques for web services
9	**Brief Contents**	Introduction of Service Oriented Architecture design and development , Case examples and case descriptions, Understanding Service-Orientation- Business Automation, Design paradigm, Design principles, Silo-based application architecture, Effects of service-orientation on the enterprise, Service-orientation and the concept of application and integration, The Service composition, Goals and benefits of Service-Oriented computing, Four pillars of Service-orientation, Understanding SOA- The Four characteristics of SOA: Business-driven, Vendor-neutral, Enterprise-centric, Composition-centric, Design priorities; The Four common types of SOA, The End result of Service-orientation and SOA, SOA Project delivery strategies, SOA project stages, SOA adoption planning, Service inventory analysis, SOA modelling, Contract, Logic design, Service development, Testing, Deployment and maintenance, Usage and monitoring, Understanding layers with services and micro services, Analysis and modelling with Web services and Micro services, Analysis and modelling with REST services and Micro services
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS006
5	**Title of the subject**	Social Networks Analytics
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The main learning objective with this course is to enable students to put Social Network Analysis projects into action in a planned, informed and efficient manner. This overarching goal involves the following subtasks: Formalize different types

		of entities and relationships as nodes and edges and represent this information as relational data .Plan and execute network analytical computations. Use advanced network analysis software to generate visualizations and perform empirical investigations of network data. Interpret and synthesize the meaning of the results with respect to a question, goal, or task. Collect network data in different ways and from different sources while adhering to legal standards and ethics standards.
9	**Brief Contents**	Overview on network analysis, The Network analysis process and methodology, Network visualization, When images do not suffice: Network analytical measures, Models and simulation of network evolution, Models and simulation of diffusion in networks, Subgroups and cliques clustering, Block models, Ego networks, Reciprocity, Social capital, structural holes, equivalence; Network Data: Ethics, Privacy, Legality, Introduction: Using text data for network analysis, natural Language Processing and Relation Extraction from Texts Construct: A model of meta-network dynamics, Usage of network analysis for investigating crime, Relational methods for analysing covert networks
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS007
5	**Title of the subject**	Software Project Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The students will be able to understand the principles of project management. Comprehend the fundamental principles of project management, including project planning, scheduling, resource allocation, and risk management. Develop a project plan that includes a work breakdown structure, critical path analysis, resource allocation, budgeting and time management.
9	**Brief Contents**	Introduction and Software Project Planning: Fundamentals of software project management (SPM), Need identification, Vision and scope document, project management cycle, SPM objectives, Management spectrum, SPM framework, Software project planning, Planning objectives, Project plan, Types of project plan, Structure of a software project management plan, Software project estimation, Estimation methods, Estimation models, Decision process, Project Organization and Scheduling: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Ways to Organize Personnel, Project schedule, Scheduling objectives; Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM, Bar Charts:

Milestone Charts, Gantt Charts, Project Monitoring and Control: Dimensions of Project Monitoring & Control, Earned Value Analysis, Earned Value indicators: Budgeted Cost for Work Scheduled (BCWS); Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Interpretation of Earned Value Indicators, Error Tracking; Software Reviews, Types of Review: Inspections, Deskchecks, Walkthroughs, Code Reviews, Pair Programming, Software Quality Assurance and Testing: Testing Objectives, Testing Principles, Test Plans, Test Cases, Types of Testing, Levels of Testing, Test strategies, Program correctness, Program verification & validation, Testing automation & Testing tools, Concept of Software quality; Software quality attributes; Software Quality Metrics and indicators; The SEI Capability Maturity Model CMM), SQA activities, Formal SQA Approaches: Proof of correctness, Statistical quality assurance, Cleanroom process, Project Management and Project Management Tools: Software Configuration Management: Software Configuration items and tasks; Baselines; Plan for Change, Change control, Change Requests management, Version Control; Risk management: Risks and risk types, Risk Breakdown Structure (RBS); Risk Management process: Risk identification, Risk analysis, Risk planning, Risk monitoring; Cost Benefit analysis; Software Project management tools: CASE tools, Planning and Scheduling tools, MS-Project.

| 10 | **Contents for lab** | No |

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS008
5	**Title of the subject**	Software Quality Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Students will be able to develop a comprehensive understanding of the concepts and practices related to software quality management. Gaining knowledge of software quality standards, testing techniques, and software metrics. Evaluate the effectiveness of quality management strategies, such as continuous improvement, risk management, and quality assurance.
9	**Brief Contents**	Introduction to Software Quality: Defining Software Quality, Software quality, Attributes and specification, Cost of quality defects, faults, failures, Defect rate and reliability, Defect prevention, Reduction and containment, Overview of different types of software review, Introduction to measurement and inspection process, Documents and metrics, Software Quality Metrics: Product Quality Metrics: Defect density, Customer problems metric, Customer satisfaction metrics, Function points,

In-process quality metrics: Defect arrival pattern, Phase-based defect removal pattern, Defect removal effectiveness, Metrics for software maintenance: Backlog management index, Fix response time, Fix quality, Software quality indicators, Software Quality Management and Models: Modeling process, Software reliability models: The Rayleigh model, Exponential distribution and Software reliability growth models, Software reliability allocation models, Criteria for model evaluation, Software quality assessment models: Hierarchical model of software quality assessment. Software Quality Assurance: Quality Planning and Control, Quality improvement process, Evolution of software quality assurance SQA, Major SQA activities, Major SQA issues, Zero defect software, SQA techniques, Statistical quality assurance, Total quality management, Quality standards and processes, Software Verification, Validation & Testing: Verification and validation, Evolutionary nature of verification and validation, Impracticality of testing all data and paths, Proof of correctness, Software testing, Functional, structural and Error-oriented analysis & testing, Static and dynamic testing tools, Characteristics of modern testing tools.

| 10 | **Contents for lab** | No |

1	**Program**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS009
5	**Title of the subject**	Programming for Business Intelligence
6	**Any prerequisite**	None
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon course completion, students will be able to: Derive actionable insights from data, thus allowing to make data-driven, strategic and tactical business decisions. Design and implement an algorithm to conduct technical calculations, manipulate data and create graphical user interfaces. Identify the technological architecture that makes up Business Intelligence systems
9	**Brief Contents**	Business Intelligence (BI): Effective and timely decisions, Data, Information and knowledge, Role of mathematical models, BI architectures, Ethics and BI, Decision support systems: definition of system, Representation of the decision-making process, Definition of decision support system, Development of a decision support system, Customer Relationship Management (CRM), ERP, and BI, Importance of data and relevance in industry, Statistical learning vs. machine learning, Types and phases of analytics, Data pre-processing and cleaning: data manipulation steps, Normalizing data, Sampling, Missing value treatment, Outliers, Exploratory data analysis: data visualization using matplotlib, Seaborn libraries, Creating graphs, Summarizing data, Descriptive statistics, Univariate analysis,

Bivariate analysis, Querying and reporting, Building Ad-Hoc queries, Building on-demand self-service reports, Enhancing and modifying data access, Pull-oriented data access, Push-oriented data access dashboards, Executive Information System (EIS) engine, Metric system and KPIs, business intelligence dashboards, Learning SQL query structure with examples, Data management and query system OLTP and OLAP and their data models, Data warehousing, ETL and data integration dashboard creation using Tableau, Power BI, The relevance of BI in application to analytics industry and different domains such as marketing models: relational marketing, Sales force management, Logistic and production models: supply chain optimization, Optimization models for logistics planning, Revenue management systems.

| 10 | **Contents for lab** | No |

	Programme	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS010
5	**Title of the subject**	Strategic Planning of Information Systems
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The strategic use of information systems as a means for acquiring competitive advantage. Integration of concepts and methodologies with skills acquired in the field of information systems and technology in the development of a comprehensive information systems prototype. Measurable benefits in the alignment of business processes with information systems solutions. The course provides students with the opportunity to apply systems concepts and techniques in the design of an information system.
9	**Brief Contents**	Introduction to strategic information systems , Business environment issues, The process of strategic information systems , Current business situation analysis , Identify an opportunity , The role of business information systems , Information systems strategies , Strategic information systems management, Organization of the information systems technologies , Software , Hardware, Database , Communications ,Networking , Evaluation of possible IS solutions, Project Management, Cost Benefit Analysis, Functional requirement, System specifications , Information systems benefits , Strategic information management , Managing the information resource
10	**Contents for lab**	No

List of electives from the specialization basket of Technology and Operations Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS011	Business Systems Simulation	3-0-0	3	Odd
2	MS012	Service Operations Management	3-0-0	3	Even
3	MS013	Sustainable Supply Chain Management	3-0-0	3	Odd
4	MS014	Technology Management	3-0-0	3	Even
5	MS015	Technology and Operations Strategy	3-0-0	3	Odd
6	MS016	Total Quality Management	3-0-0	3	Even
7	MS017	World Class Production Systems	3-0-0	3	Odd
8	MS018	Emerging Areas in Technology and Operations Management	3-0-0	3	Even
9	MS019	New Products and Services Development	3-0-0	3	Odd
10	MS020	Operational Intelligence	3-0-0	3	Even

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS011
5	**Title of the subject**	Business Systems Simulation
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Understanding the principles and techniques of simulation modeling for business systems. Understanding the key components of a business system and how they interact with each other. Learning how to analyse and interpret simulation results to make informed decisions. Understanding the limitations of simulation modeling and the assumptions that need to be made. Learning how to optimize simulation models to achieve business objectives. Understanding the ethical implications of simulation modeling and the importance of data privacy and security. Learning how to apply simulation modeling in different industries and applications, such as manufacturing, logistics, healthcare, finance, and customer service.
9	**Brief Contents**	Introduction to Business System Simulation: Overview of the benefits of simulation modeling, The various types of simulation models, and the different tools and software used for simulation modelling, System Dynamics: Modeling approach on the feedback loops and dynamic relationships between different variables in a system, Topics covered include stock and flow diagrams, feedback loops, and system dynamics models, Discrete-Event Simulation: Modeling the discrete events and processes that occur in a system, such as customer arrivals, order processing, and inventory movements, Topics covered include event scheduling, process modeling, and queuing theory, Agent-Based Simulation: Modeling individual agents or entities within a system, such as customers,

		employees, or machines. Topics covered include agent behaviour modeling, agent interactions, and emergent behaviour, Optimization and Analysis: Various techniques used to optimize a simulation model and analyse the results, including sensitivity analysis, scenario analysis, and statistical analysis. Applications of Business System Simulation: Case studies and examples of how simulation modeling is used in different industries and applications, such as manufacturing, logistics, healthcare, finance, and customer service.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS012
5	**Title of the subject**	Service Operations Management
6	**Any prerequisite**	Operations Management
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Define services along with their nature and classification. Assess factors related to location and capacity planning. Employ design principles in development of service delivery systems. Analyse requirements to ensure maintainability and reliability in services.
9	**Brief Contents**	Matrix of service characteristics, Taxonomy of services, Challenges in operations management of services, Aggregate capacity planning for services, Facility location, Subjective and objective factors, Service design and delivery systems, layouts in services, Job and work design in services-safety and physical environment, Effect of managing queues, Automation, Operations standards and work measurement, Determinants of quality in services, Measurement, control and improvement of quality of services, Concept of a total quality service, Dynamics of service delivery system, Scheduling for service operations, Personnel and vehicles, Supply chain and distribution of services, Maintainability and reliability in services, Total productive maintenance (TPM) in services, Case studies of exemplary professionally managed services.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS013
5	**Title of the subject**	Sustainable Supply Chain Management
6	**Any prerequisite**	Operations Management
7	**L-T-P**	3-0-0

8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Develop an understanding of the role of supply chain in an overall value creation. Analyse different modes of transportation, different design options of transportation network in a supply chain, their applicability under different contexts and the trade-offs in transportation design. Describe the importance of reverse logistics in market places as well as market spaces. Design sustainable supply chains.
9	Brief Contents	Evolution of SCM, Issues of SCM, Competitive strategy vis-à-vis supply chain strategy, Achieving strategic fit, Managing inventory in a supply chain, Deterministic models, Probabilistic models (multi-period and single period). Managing risk and uncertainty in a supply chain: quick response strategy, Postponement strategy, Tailored sourcing strategy, Transportation in a supply chain: role of transportation in a supply chain, Modes of transportation and their performance characteristics, Design options for a transportation network, Trade-offs in transportation design, Supply chain coordination: Bullwhip effect - causes and consequences, Bullwhip effect quantification, Impact of centralized information on bullwhip effect, Mitigating strategies, Information sharing and incentives, Strategic sourcing in SCM: Role of sourcing in a supply chain, Framework for make/buy decisions, Supplier scoring and assessment, Supply contracts and supply chain performance, Big data analytics in SCM: Significance of big data in supply chain, Relevant tools, Reverse logistics: Reverse logistics in manufacturing organizations and ecommerce firms.
10	Contents for lab	SCM software like SAP SCM, Logility, Perfect Commerce, Oracle SCM etc.

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS014
5	Title of the subject	Technology Management
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Define types of innovation, innovators and innovation environment. Describe the nature and extent of technological change and potential roles of incremental and disruptive innovation in creating and sustaining firm competitiveness. Perform feasibility and viability of new product development proposal from various perspectives.
9	Brief Contents	Introduction, Understanding innovation, Levels and types of innovation, Key drivers of innovation, Sources of innovation, and the relationship between innovation and research and technology development. understanding creativity as a building block to

		innovation, Innovation management, Framework for the management of innovation, Public sector services innovation, Diffusion of innovation creating organizational innovative effectiveness, Strategic aspects of technology, Critical factors in managing technology innovations, Critical issues/factors in choice of technology and processes; Indian context, Technology portfolio, Open innovation, New technology transfer-channels, Modes, Levels and issues, Absorption, adaption and adoption of technology, Technology considerations in lean environment, Strategic role of R&D, New R&D approaches, Strategic evaluation of technology investments, New product development and life cycle management, Understanding product platform strategy, Commercialization of core competencies, Marketing new products and technologies, Role, rationale and requisites of a national technology policy, IPR and licensing issues, Role of WTO.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS015
5	**Title of the subject**	Technology and Operations Strategy
6	**Any prerequisite**	Operations Management
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Appreciate the nature, need and scope of operations strategy. Describe the strategic role of transformation processes and associated flows. Develop and analyse innovation, new product and process development strategies. Employ process of operations strategy in terms of sustainable alignment.
9	**Brief Contents**	Need for Operations Strategy, Impact of globalization on Operations Management, The Marketing link in the Operations Strategy -Role in competitive advantage, Time-based competitiveness and other criteria of success, The Sandcone model, Process of designing, analysing and implementing operations' strategies, Strategic management of transformation processes and flow strategies, Strategic choices in layout and capacity planning, Managing innovations and new product and process development strategies, Strategic purchasing and supply management, Outsourcing decisions, Strategic Purchasing Portfolio analysis, Operations improvement strategies, Breakthrough vs. continuous, The direct, Develop and deploy strategies, The market strategy, Bohn's stages of process matrix, Measures of performance, Process of Operations strategy, Sustainable alignment, Methodology of operations strategy formulation, Process of operations strategy formulation, Integrated management systems
10	**Contents for lab**	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS016
5	Title of the subject	Total Quality Management
6	Any prerequisite	Basic Knowledge of Probability and Statistics
7	L-T-P	3-0-0
8	Learning Objectives of the subject	This course provides learners with an understanding of quality control and improvement systems. This course will help participants to: Understand the principles of total quality management. Choose appropriate statistical techniques for improving processes. Develop the organizational, competitive and economic potential of quality. Integrate fundamental principles with the practice of total quality management.
9	Brief Contents	Evolution and Importance of Total Quality Management: Introduction, Importance of Quality, Evolution of Quality, What is Total Quality Management, Quality Pioneers, Active Living and Health Environment for TQM: Quality Leadership and Management Commitment, Employee Empowerment, Organizational Culture and Change, Team Building, TQM Infrastructure: Supplier relation and partnership, Continuous Improvement process lesson, Developing TQM action plan, TQM and Other Continuous Improvement Systems: Quality Standards, Six Sigma, Benchmarking, Just in Time, Stabilizing and Improving a Process: Defining and Documenting a Process, Diagnosing and Improving a Process, Statistical Process Control, Variables and Attributes Charts, The Fork Model For Quality Management- Management's Commitment to Transformation Lesson, Education and Daily Management, Cross-Functional Management, Quality Policy Management
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS017
5	Title of the subject	World Class Production Systems
6	Any prerequisite	Operations Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Appreciate the concept and need of world class manufacturing. Employ frameworks of various product and process design structures and systems in modern manufacturing. Analyse the implementation of TQM, JIT and Theory of Constraints. Appreciate philosophy and principles of

		Japanese manufacturing especially Toyota Production System (TPS).
9	**Brief Contents**	World Class Manufacturing (WCM): Concepts and Evolution, Understanding the linkage between Operations Strategy and WCM, Agile Manufacturing: Distinction between flexibility and agility, Model for implementing flexible and agile manufacturing, Flexible Manufacturing System (FMS), Concepts and components, Modern product and process design concepts and considerations, Assembly lines and batch manufacturing; group technology (GT), Total Quality Management (TQM): Roadmap to Implementation of TQM in manufacturing, Six Sigma approach, Just-in-Time (JIT) and Lean Operations, Theory of constraints (ToC), Japanese manufacturing techniques particularly Toyota Production System, Japanese vs American manufacturing focus, Critical elements of JIT, Operational Framework for concurrent implementation of TQM and JIT, Total Productive Maintenance (TPM): Concepts and Evolution, Metrics of TPM, Overall Equipment Effectiveness (OEE), Roadmap to TPM implementation in modern manufacturing, Computer Integrated Manufacturing System (CIMS): A framework for computer integrated enterprise issues involved in CIMS, Benchmarks for excellence in operational performance with global examples, Significance of implementation of concurrent operations management initiatives, Metrics of operational excellence in global context.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS018
5	**Title of the subject**	Emerging areas in Operations and Technology Management
6	**Any prerequisite**	Operations management
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Describe role of sustainable operations management. Design operations management along globally dispersed distributed networks. Develop nimble factories for supporting a lot size of one.
9	**Brief Contents**	Digital supply chains, Computer aided design and integrated manufacturing, A Focus on the employee experience, Flexible, blended workplace environments, Mobile communications and collaboration, Scaling production according to demand, Building the customer relationship.
10	**Contents for lab**	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS019
5	Title of the subject	New Products and Services Development
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	On completion of the course, students will be able to: Describe the nature and techniques of innovation and new product development. Discuss and reflect on the role of marketing in different phases of new product development. Explain the phases and intermediate results in new product development process. Apply theories of innovation to demonstrate the best level of practice in each problem situation within the context of new product development. Develop and implement a new product strategy for an enterprise.
9	Brief Contents	Product Conception: Product Basics Consumer problems and unmet need Empathy, Personas, User Stories Identifying New Product Opportunities using Data Market Research for New Product Development Idea Generation & Need Analysis Concept testing using Surveys-Customer Discovery Product potentiality and Conjoint analysis Design Thinking for B2C, B2B Products and Services, Product Design: Product Design Process - 7 Stages Product specifications and features Visual Design Elements Tools for Design of Digital Products User experience (UX) design Introduction to Software Tools used to design Engineering Products Quality Function Deployment, Value engineering methodology, Iterative design optimisation, Design for manufacturing, Prototyping: What is Minimum Viable Products (MVP)? Types of MVP Hypothesis Testing, A/B Prototype development for Digital Products, Wireframing 3D Printing and 3D Cutting Material Selection for Engineering Product, Prototyping Prototype, Functionalisation using Electronics and Instrumentation, Role of Robotics and Automation in Prototyping, Usability and Beta Testing, Product Deployment: Production planning and control Material handling In-house Budgeting and Outsourcing Quality Assurance Protocols Principles of Lean: Lean Manufacturing and Management Regulations and Standards: ISO Intellectual Property and Trademarks Building Markets and Creating Demand for New products services, Simulated test marketing, and Launching of new products, Product Lifecycle Management: Organisation for Product Management Marketing Manager-Product Manager-Brand Manager Concept Approaches and Organisational role Product Manager-Functions and Tasks-Tools and Techniques The Product in Corporate Life, Corporate and Product Objective Product Strategy and Policy Optimum Product Pattern/Line Range Challenge Of Change-Opportunity and Risk-Product Innovation, Modification, Addition and Elimination Product

		Proposals-Sources, Generation, Processing and Selection Contemporary Challenges and opportunities in product Management, Product Sales and Marketing: Brand Awareness, Consumer Brand Knowledge Product-line Decisions (extension, reduction), Product Category expansion Pricing Model and Strategy Product Costing Segmentation | Target | Positioning Sales Forecasting Distribution Channels Lead Generation-Role of Contacts and social media Customer Acquisition Customer retention, Commercialisation and Start-up: Introduction to Business Model Canvas Funding Requirement and Avenues Bootstrapping Team Building and Collaborations Customers and End Users Market Competition and Creating Barriers to Entry Deployment and Distribution Strategy Launching of Start-up: Rules and Steps Social media, Websites, and Digital Marketing Scale-up model and Sustainable growth plan
10	**Contents for lab**	No

1	**Program**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS020
5	**Title of the subject**	Operational Intelligence
6	**Any prerequisite**	None
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Describe the importance of data-driven operations along supply chains. Assess unbiased estimates of demand forecasting as well as optimization using various statistical methods. Employ mathematical models to capture and analyze data on supply chain carbon footprint.
9	**Brief Contents**	Problem-driven to Data-driven operations along supply chains, Big data in supply chain, Analytics in demand planning: Capturing demand data from different sources, Demand prediction models, Price optimization, Analytics in sourcing and procurement: In-house or outsource, Logistics and transportation, Supply chain contracts, Analytics in sales and operations planning: Differentiated service level to different products and customers, Location of plants, Product line mix at plants, Production planning and scheduling, Analytics in distribution: Location of distribution centre, Transportation and distribution planning, Inventory policies/order fulfilment at locations, Vehicle routing for deliveries, Analytics in reverse logistics in traditional and e-commerce firms: Location of return centres, Reverse distribution plan, Vehicle routing for returns collection, Analytics in supply chain carbon footprint
10	**Contents for lab**	Proficiency in using various software like SAS Business Analytics (SAS BA), Excel, Tableau, Microsoft Power BI etc.

List of electives from the specialization basket of Human Resource Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS021	Compensation Management	3-0-0	3	Odd
2	MS022	Change Management	3-0-0	3	Even
3	MS023	Corporate Social Responsibility	3-0-0	3	Odd
4	MS024	Competency Management	3-0-0	3	Even
5	MS025	Human Resource Information System	3-0-0	3	Odd
6	MS026	Emerging Areas in Human Resource	3-0-0	3	Even
7	MS027	Organization Theory and Development	3-0-0	3	Odd
8	MS028	Leadership and Talent Management	3-0-0	3	Even
9	MS029	Training and Development	3-0-0	3	Odd
10	MS030	Management of Employee Relations	3-0-0	3	Even

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS021
5	**Title of the subject**	Compensation Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The aim of this subject is to develop students' understanding of the concepts of compensation and rewards in the organization. In particular the subject is designed to develop the underpinning knowledge and skills required to understand the one of the complex management functions i.e. compensating employees and its importance. This subject introduces the student to the basics compensation structure and differentials. It familiarizes the students with the practice of various management techniques and its expected results like job evaluation etc. The learner is apprised about the latest issues in management related to compensation in order to make the students abreast about the recent trends in the area.
9	**Brief Contents**	Introduction to compensation and rewards, Objective of compensation and rewards, Introduction to framework of compensation policy, Labor market characteristics and pay relatives, Wage determination: Introduction to compensation, rewards, wage levels and wage structures, Introduction to wage determination process and wage administration rules; Introduction to factors influencing wage and salary structure and principles of wage and salaries administration, Introduction to the theory of wages: Introduction to minimum, fair and living wage, Introduction to nature and objectives of job evaluation; Introduction to principles and procedure of job evaluation programs, Introduction to basic job evaluation methods; Introduction to Implementation of evaluated job, Introduction to

determinants of incentives, Introduction to classification of Rewards, Incentive payments and its objectives, Introduction to wage incentives in India; Introduction to types of wage incentive plans, Introduction to prevalent systems & guidelines for effectives incentive plans; Introduction to non- monetary incentives, Introduction to cafeteria style of compensation, Introduction to problems of equity and bonus, Profit sharing & stock options, Introduction to features of fringe benefits, Introduction to history and growth factors, Coverage of benefits, Introduction to employee services & fringe benefits in India

| 10 | **Contents for lab** | No |

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS022
5	**Title of the subject**	Change Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Effective management within organizations requires an understanding of various behaviour and processes. Managers need to know why people behave as they do in relation to their jobs, their work groups and their organizations. This knowledge of individuals' perceptions, motivational attitudes and behaviour will enable managers to not only understand themselves better, but also to adopt appropriate managerial policies and leadership styles to increase their effectiveness. The major objective of this course is to provide students with a better understanding of behavioural processes and thereby enable them to function more effectively in their present or future roles as managers of human resources.
9	**Brief Contents**	Definition of Organization Development (OD), OD and planned change from other forms of organization change, Describe the historical development of OD, Describe and compare three major perspectives on changing organizations, Introduce a General model of planned change, Describe how planned change can be adopted to fit different kinds of conditions, Understand the essential character of OD practitioners, Understand the necessary competencies required of an effective OD practitioner, Understand the roles and ethical conflicts that face OD practitioners, Reinforce the definition of an OD practitioner as anyone who is helping a system to make planned change, Describe the steps associated with starting a planned change process, Equip students with a general framework of diagnostic tools from a systematic perspective, Define diagnosis and to explain how the diagnostic process provides a practical understanding of problems at the organizational level of analysis, Discuss

		criteria for effective interventions, Discuss issues, considerations, constraints, ingredients, and processes associated with intervention design, Give an overview of the various interventions, Understand the issues associated with evaluating OD interventions, Understand the process of institutionalizing OD interventions and the factors that contribute to it, Understand the importance of data feedback in the OD process, Describe the desired characteristics of feedback content, and Describe the desired characteristics of the feedback process.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS023
5	**Title of the subject**	Corporate Social Responsibility
6	**Any prerequisite**	None
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon course completion, students will be able to: Develop skills in recognizing and analysing ethical issues. Define cross cultural variations and similarities in organizational practices in corporate social responsibility and business ethics. Understand sources of organizational ethical culture and to design ethical programs designed to accomplish specific objectives in organizations. Develop ethical leadership skills and practices
9	**Brief Contents**	Business ethics- an overview, Concepts and theories of business ethics, Emerging business ethics issues, Ethical decision making in business, Creating an ethical organization globalization and business ethics, Stakeholders and business ethics, Social responsibility and ethics, Issues in social responsibility, Implementing stakeholders' perspective, Stakeholder and issue management approaches, Managing corporate responsibility with external stakeholders, Corporate governance and ethical leadership, Kohlberg's six stages of moral development, Levels of ethical analysis, Concept of corporate integrity, Issues in corporate governance, good corporate governance - obligations towards society and stake holders, Ethics in consumer protection, Role of government agencies, SEBI, judiciary in ensuring ethical practices, Ethics and Indian business, Marketing ethics, Ethics in human resource management, financial management, banking and insurance.
10	**Contents for lab**	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS024
5	Title of the subject	Competency Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The aim is to give students a better idea of how to work with their employees to make today's competency-based performance reviews more effective and a more positive experience. Begin to think of it differently: as a partnership or a collaborative effort.
9	Brief Contents	Introduction to competency: definition and history of competency, Basic components of competency (Knowledge(K), Skill(S), Attitude(A)), Performance Vs competency, Difference between competence and competency, Type of competency generic vs key competency, Functional and technical competency, Leadership and managerial competency, Need for competency framework, Limitation and learning from competency framework, Myth about competency, Competency development & its models: Need and importance of competency development, Stages in developing competency model, Types of competency Model – core/generic, Job specific, Managerial / leadership, Custom, development of personnel competency framework, competency mapping: procedures / steps-determining objectives and scope, Clarifying implementation goals and standards, create an action plan, Define competency-based performance effectiveness (key result area (KRA) & key performance indicators (KPI)), Tools for data collection, Data analysis, Validating competency model, Mapping future jobs, and single incumbent jobs, Using competency profile in HR decisions, Mapping competency for recruitment and selection, Training and development, Performance and compensation, Competency driven career and culture: Role of competency in career progression, Transactional competency, Tradition competency and transformational competency, Evaluation of career through KSA (Knowledge, Skill, and Attitude) Competency-based succession and career planning, corporate competency driven culture.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS025
5	Title of the subject	Human Resource Information System

6	Any prerequisite	Human Resource Management
7	**L-T-P**	3-0-1
8	**Learning Objectives of the subject**	To review and understand the basic concepts and principles of human resource information system and to apply the same to the real world. To explore strategic value of HRIS and its contribution to organizational success. To review the leading HRIS software. To explore the ways of identifying best HRIS based on industry specificity and ROI.
9	**Brief Contents**	Introduction to HRIS, Acquisition and HRIS costs, Needs Assessment; HR metrics, Database concepts and applications in HRIS, Change management and data validation, HRIS design and implementation considerations, HR administration and HRIS, Job analysis, Security and privacy issues, Emerging trends in HRIS.
10	**Contents for lab**	Case study exercises Class projects and exercises

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS026
5	**Title of the subject**	Emerging Areas in Human Resource
6	**Any prerequisite**	Human Resource Management
7	**L-T-P**	3-0-1
8	**Learning Objectives of the subject**	To recap the major concepts and theories of HRM. To explore the emerging areas of HRM. To understand practical applications of theory relevant to today's workplace. To explore contemporary topics in Human Resource Management. To build strong foundation and relevant skill set required in today's workplace.
9	**Brief Contents**	Setting the hybrid work model for collaboration, Human leadership, Working in the metaverse, Managing international human resources, Managing human resources in small and medium enterprises, Strategic human resource management, Change management, People analytics, The transition from employee well-being to healthy organization, Diversity, equity and inclusion
10	**Contents for lab**	Case study exercises Class projects and exercises Role playing

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS027

5	**Title of the subject**	Organization Theory & Development
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Describe how the need to increase organizational efficiency and effectiveness has guided the evolution of management theory. Explain the principle of job specialization and division of labor, and tell why the study of person-task relationships is central to the pursuit of increased efficiency. Identify the principles of administration and organization that underlie effective organizations.
	Brief Contents	Explain what is meant by the term organization, Classify the three levels of managers and identify the primary responsibility of each group, Describe the difference between managers and operative employees. Explain the skills and roles manager, Describe the value of studying organization. Identify the relevance of popular humanities and social science courses to management practices, Trace the change in theories about how managers should behave to motivate and control employees, Explain the contributions of management science to the efficient use of organizational resources, Explain why the study of the external environment and its impact on an organization has become a central issue in management thought, Describe forces that act as stimulants to change, Summarize the sources of individual and organizational resistance to change, Summarize Lewin's three-step change model. Explain the values underlying most OD efforts, Contrast process reengineering and continuous improvement processes, Identify properties of innovative organizations, List characteristics of a learning organization, Describe potential sources of stress, Organizational Development Techniques, Explain individual difference variables that moderate the stress–outcome relationship
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS028
5	**Title of the subject**	Leadership & Talent Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Leadership and Talent Management primarily focus on managerial leadership as opposed to parliamentary leadership or emergent leadership in informal groups. The objective of this module is to present the theory and research on leadership and talent management in formal group.
9	**Brief Contents**	Define leader and explain the difference between managers and leaders, Summarize the conclusions of trait theories of leadership, Describe the Fiedler contingency model, Summarize

		the path goal model of leadership, Explain situational leadership, Identify the qualities that characterize charismatic leaders and authentic leaders, Meaning of talent, Talent or human capital of an organization, Why talent/human capital management? Functions of talent management.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS029
5	**Title of the subject**	Training & Development
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To develop an understanding from the point of view of the individual employee. Improve the individual's level of awareness. Increase an individual's skill in one or more areas of expertise. Increase an individual's motivation to perform their job well.
9	**Brief Contents**	Overview of training, Trends in training, Career opportunities in training important concepts and meanings, Why conduct a training needs analysis, When to conduct a TNA, The TNA model, The framework for conducting a TNA, Output of TNA, Approaches to TNA, Introduction to the design of training organizational constraints developing objectives, Why use training objectives, Overview of the training design ,Matching methods with outcomes , Lectures and demonstrations , Games and simulations, On-the-job & off the job training, Development of training, implementation, transfer of training. Evaluation of training, Rationale for evaluation, Resistance to training evaluation
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS030
5	**Title of the subject**	Management of Employee Relations
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To develop an understanding of the interaction pattern among labour, management and the State. To build awareness of certain important and critical issues in Industrial relations. To impart basic knowledge of the Indian Industrial relations system and its distinctive features.

9	Brief Contents	The evolution of Industrial relations, understand the scope and objectives of Industrial relations, Essential of Industrial relations, participants of Industrial relations and dynamics of their participation, perspective and approach, The system of industrial relation in India, the historical perspective of Industrial relations, Describe the trends in Industrial relations management, The changing characteristics of Industry and workforce in India, Describe the demand for labour, The challenges to industrial relations, Labour laws pertaining to Industrial relations viz Trade Union act, Industrial dispute act, Factories act, A paradigm shift from Industrial relations to Employee relations, Understand the Employee relations management. Describe the differences in perspective of employee relations and industrial relations.
10	Contents for lab	No

List of electives from the specialization basket of Finance

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS031	Corporate Restructuring	3-0-0	3	Odd
2	MS032	Corporate Tax Planning	3-0-0	3	Even
3	MS033	Economic and Financial Modeling	3-0-0	3	Odd
4	MS034	Entrepreneurial Finance	3-0-0	3	Even
5	MS035	Management of Financial Services	3-0-0	3	Odd
6	MS036	Financial Risk management	3-0-0	3	Even
7	MS037	Personal Wealth Management	3-0-0	3	Odd
8	MS038	International Finance	3-0-0	3	Even
9	MS039	Project Appraisal and Finance	3-0-0	3	Odd
10	MS040	Security Analysis and Portfolio Management	3-0-0	3	Even

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS031
5	Title of the subject	Corporate Restructuring
6	Any prerequisite	Financial Reporting and Control Financial Engineering and Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The objective of this course is to sensitize the students about the need for corporate restructuring for achieving fast growth and maximize shareholders' value in the context of ever-increasing competition thrown up by liberalization and globalization of Indian economy. The focus of this course, however, will be to analyse the decisions in a financial perspective emphasizing valuation.

9	Brief Contents	Opening of the economy, Global view, Indian scenario, Economic liberalization, Corporate restructuring- mergers, acquisitions, and demergers, Mergers and amalgamations, Search for a merger partner, Negotiations, steps, and formalities, Demergers-divestitures, Spin off, Equity carved out, Split off, Split up, Reconstruction, Modes of demerger, Tax aspects, Advantages, and procedure of reverse merger- Requirements, Takeover by reverse bid, Techniques of and procedure for organizing takeover bids, Search for acquisition of target company, Procedure for takeovers and acquisitions, Valuation and exchange ratio-valuation of listed and unlisted companies, Modes of valuation, Fixing price for acquisition, Determination of share exchange ratio on merger, Feasibility analysis for cash acquisition, Valuation practices in India, Funding of merges and acquisitions-financing alternatives, Management buyouts, Leveraged buyouts, Post-merger management- accomplishment of objectives, Performance after merger, Mergers and accusations overseas by Indian corporates
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS032
5	Title of the subject	Corporate Tax Planning
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After the completion of this course, students will be able to understand and apply corporate tax provisions to real life business problems efficiently using appropriate concepts of taxation laws for corporate tax planning.
9	Brief Contents	Concept of tax planning, Tax management, Tax evasion, Tax avoidance, Corporate tax in India, Types of companies, Residential status of companies and tax incidences, Tax liability and minimum alternative tax, Tax on distributed profits of companies, Tax planning with reference to setting up a new business, locational aspect, Nature of business, Form of business, Tax planning with reference to financial management decision-capital structure, Dividend including deemed dividend and bonus shares, Tax planning with reference to specific management decisions - Make or buy, Own or lease, Repair or replace, Tax planning with reference to employee remuneration, Tax Planning with reference to business restructuring- Amalgamation, Demerger, Slump sale, Transfer between holding and subsidiary companies, Tax deducted at source, Advance Tax, Double taxation relief, Goods and service tax planning, Transfer pricing and taxation.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS033
5	Title of the subject	Economic and Financial Modeling
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The students will be able to: Learn the skills for framing finance and economy modeling. Develop problem solving abilities in the context of both macroeconomics and microeconomics. Analyze the company / industry performance on relevant financial parameters using historical information on companies
9	Brief Contents	Economic Modelling: Classical model of national income; distribution of national income to the households; fiscal policy and the allocation of resources between consumption, investment and government purchases; modelling economic growth, Modelling inflation; net exports; capital flows and exchange rates in the long run; Mundell Fleming model of business cycle; Edgeworth-Bowley box and the production possibility curve, Financial Modelling: Introduction to financial modeling; basic excel for financial modeling (formatting of excel sheets; use of formula functions; data filter and sort; charts and graphs; table formula and scenario building; vlookup; pivot tables), Introduction to financial statement analysis; financial reporting mechanics; income statement; balance sheet; cash flow statement; financial analysis techniques; inventories; long lived assets; non-current liabilities; financial statement application, Financial ratio analysis for financial statement interpretation; time value of money; long term financing; cash flow waterfall & resolve circular reference problem in interest during construction.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS034
5	Title of the subject	Entrepreneurial Finance
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Students will be able to Understand the importance of financial management and managing a new venture. Learn analyzing the various sources of investment and also know the support provided by the state and central government for

		entrepreneurship. Determine the various financial supp ort schemes provided different institutions to the entrepreneurs.
9	**Brief Contents**	Financing and managing new venture: Importance of financial management as an integral part of entrepreneurship; conducting a feasibility analysis; what lenders and investors look for in a business plan, Sources of Finance: Various sources of investment; basics of venture capital and angel investment; start-up culture; various measures of encouragement and support being provided by the state and central government for strengthening the entrepreneurial culture, Institutional Financial Support: Schemes and functions of rate of Industries; District Industries Centres (DICs); Industrial development corporation (IDC); State financial corporation (SFCs); Small scale industries development corporations (SSIDCs); Khadi and village industries commission (KVIC); Technical consultancy organisation (TCO); Small industries service institute (SISI); National small industries corporation (NSIC); Small industries development bank of India (SIDBI). Evaluating new venture: Project evaluation; Real options and risk assessment, Financial assessment of new venture: Measuring and evaluating financial performance; financial strategy and capital structure
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS035
5	**Title of the subject**	Management of Financial Services
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Students will be able to Enable participants, understand the financial services industry, regulatory environment, financial analysis, and risk management. Learn investment management, banking operations, financial planning, and financial technology, and ethics and professionalism. Determine the financial markets, financial intermediation and different financial services.
9	**Brief Contents**	Introduction to Financial Services: Financial services; Financial services sector in India: overview of financial services in India; nature scope and types of financial services: fund based and non-fund based financial services; venture capital: concept and types; regulatory framework; private equity; strategic secrets of private equity, investment strategies, hedge funds; new venture financing; risk & return in venture capital, Mutual Funds and Pensions Funds: Mutual funds and pensions funds; insurance services; bank assurances; reinsurances; securitization; Indian banking and financial crisis; asset reconstruction companies; depositaries; credit

cards; micro/macro finance; financial inclusion, Plastic Money - Concept and different forms of plastic money - credit and debit cards, pros and cons. Credit process followed by credit card organizations. Factors affecting utilization of plastic money in India, Financial Depository: Depository – introduction, concept, depository participants; functioning of depository systems; process of switching over to depository systems; benefits; depository system in India; dematerialization and rematerialization role; objectives and functions of SEBI and its guidelines relating to depository system, Credit Rating & Merchant Banking: Credit Rating: the concept and objective of credit rating, various credit rating agencies in India, credit rating agencies – importance, issue, difference in credit rating, rating methodology and benchmarks, are Indian credit rating credible? International credit rating agencies – crisis of confidence?, Merchant Banking: origin and development of merchant banking in India scope, organizational aspects and importance of merchant bankers. latest guidelines of SEBI w.r.t. merchant bankers. Debt Securitization & Risk Management in Banks: Debt Securitization: meaning, features, scope and process of securitization. factoring: development of factoring types & importance, procedural aspects in factoring, financial aspects, prospects of factoring in India, Risk Management in Banks: credit risk management, operational risk management, market risk management, corporate treasury management, liquidity risk management, governance risk and compliance.

| 10 | Contents for lab | No |

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS036
5	Title of the subject	Financial Risk Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Understand the concept of financial risk and a comprehensive understanding of the various types of financial risks that organizations face. Developing the skills to identify and measure financial risk using various quantitative and qualitative techniques. Understanding to develop and implement the strategies to manage financial risk. Understanding the regulatory environment surrounding financial risk.
9	Brief Contents	Overview of financial risks, Risk, expectations, and asset prices, Volatility behavior and forecasting, Market risk measurement, Value-at-Risk and its implementation, Credit and counterparty risk, Leverage and leverage risk, Liquidity risk, Extreme events and market risk measurement, Assessing the

		accuracy of Value-at-Risk, Incorporating extreme events into risk measurement, Credit risk measurement, Portfolio credit risk measurement, Structured credit risk, Financial crises, Overview of regulatory policy, Regulatory capital and liquidity standards, Financial stability regulation
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS037
5	**Title of the subject**	Personal Wealth Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	After completion of the course, students will be able to understand personal financial planning as an approach for investment, insurance, taxation, and retirement and can identified the best combination of different financial products in view of different time horizons and propositions of risk return trade-off.
9	**Brief Contents**	Introduction and importance of personal wealth management, Concept of personal financial planning, Objective of personal financial planning, Steps involve in personal financial planning process, Emergence of personal financial planning in India, Financial institutions and products, Concept of risk, Types of risk, Measuring risk, Understanding return, Concept of compounding, Real and nominal rate of return, Tax adjusted return, Risk adjusted returns, Asset classes, Portfolio construction, Practical asset allocation and rebalancing strategies, Portfolio monitoring and re-balancing, Need for insurance, Requirement of an insurable risk, Role of insurance in personal finance, Steps involve in insurance planning, Insurance products, Products and functions of life and non-life insurance business, Need of life insurance, Retirement planning process, Estimation of retirement corpus, Determination of retirement corpus, Retirement products, Understand income tax principles, Tax aspects of investment products, Personal tax planning, Estate planning.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS038
5	**Title of the subject**	International Finance
6	**Any prerequisite**	Financial Engineering and Management
7	**L-T-P**	3-0-0

8	**Learning Objectives of the subject**	Students will be able to understand the significance of financial management in the global context particularly for MNCs, importance of foreign exchange market and international financial institutions, and applications of financial instruments of the international financial markets for the working capital and financing decisions.
9	**Brief Contents**	Concept and comparison of international trade, International business, International finance, International trade theories, Balance of payments and capital account convertibility, Development of international monetary system, Nominal, real and effective exchange rates, Determination of exchange rates, Factors influencing exchange rates, Theories of exchange rate behaviour; International financial institutions, Major participants in foreign exchange market, Spot market and forward market, Markets for currency futures and options, Foreign exchange rates, Techniques of exchange rate forecasting, Nature and Measurement of Foreign Exchange Exposure, Management of Foreign Exchange Exposure, Theories of Foreign direct investment, International capital budgeting- Evaluation criteria, Computation of cash flows, Cost of capital, Adjusted present value approach, Evaluation and management of political risk, International Portfolio Investment-concept of optimal portfolio, modes of international portfolio investment, An overview of international financial markets, Channels for international flow of funds, Multilateral development banks, International banking, International financial instruments, Financial swaps, Management of interest rate risk, Working capital policy, Management of current assets, Financing current assets, Foreign trade documentation, Modes of payments in international trade, Methods of trade financing.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS039
5	**Title of the subject**	Project Appraisal and Finance
6	**Any prerequisite**	Elementary Financial Management
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The course aims at providing an understanding of project identification, feasibility study of the project and project report preparations. It facilitates the knowledge about different sources of financing and financial appraisal technique. It provides an acquaintance about social cost benefit analysis with understanding for different types of project risk and also post assessment of the project.
9	**Brief Contents**	An introduction to project appraisal, Project appraisal and evaluation , Project life cycle, Project cycle management , Cost

benefit analysis of Private and public sector projects; Identification of investment opportunities – industry analysis review of project profiles, – feasibility study , Project identification and formulation , Generation of project ideas, Basic principles of project analysis entrepreneurship concept, Theory and perspective, Market feasibility analysis of a project, Need for market analysis, Demand and supply analysis, Collection analysis, primary /secondary data, Forecasting of market growth; Market forecasting techniques, Technical appraisal of a project, Technology tie ups and diffusion; Management of technology and business, Financial feasibility analysis: Estimation of cost of project & means of financing, Arrangement of funds, Traditional sources of financing: Equity shares, preference shares, Debentures / bonds, loan from financial institutions, Alternative sources of financing: FDI & FII, private equity, securitization, venture capital, Different business/project support government schemes, Government funding for projects, Startup schemes of government, Projected cash flows of project, Appraisal criteria, NPV,IRR, PI, PBP, ARR, Economic analysis of a project : Social cost benefit analysis – rationale of SCBA, direct and indirect cost and benefits, shadow price efficiency and equity in project appraisal, UNIDO approach, Little Mirrlees approach, Environment impact assessment of a project and social impact assessment of a project, Risk and sensitivity Analysis, taxonomy of risks, break even analysis, Sensitivity analysis, Risk analysis using simulation models and decision trees, Monitoring and evaluation of a project – PERT / CPM, Monitoring mechanism, valuation and lessons, project audit, Preparation of project report, Case analysis.

| 10 | **Contents for lab** | No |

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS040
5	**Title of the subject**	Security Analysis and Portfolio Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	The objective of this course is to help students gain an understanding of the evolving domestic and international investment landscape in general, and the Indian capital market with special emphasis on the availability of different financial products and stock exchange operations. It aims to provide a thorough understanding of portfolio management theory and practice. With the goal of assisting the participants in making wise investment choices in the context of portfolio investment, significant theories, techniques, laws, and advancements in investment theory will be covered.
9	**Brief Contents**	Investment Alternatives and Objectives, Organization and Mechanics of Securities Markets, Types of Security Markets and

		their Functions, Stock Exchanges, Depository, Stock Indices, Role of Regulatory Authorities, and various participants in markets, Market Microstructure, Risk and Return dynamics, Utility Theory, Portfolio Theory, CAPM Capital Asset Pricing Model (CAPM), Arbitrage Pricing Model (APT), Multi-factor Models, Sharpe's Single Index Model, Lagrange Multiplier Theory, Basics of futures and options, Fundamental Analysis: Macroeconomic activities and security markets, The Cyclical indicator approach, Monetary variables, Business cycles and industry sectors, Evaluating Industry life cycle, Analysis of industry competition and industry rate of returns, Company analysis, Analysis of Financial statement and Stock valuation, Technical analysis: Assumption, Advantages, Challenges, Types of Charts, Technical Trading Rules, and Indicators, Introduction to Efficient Market Hypothesis, Random Walk Model, Forms of EMH, Empirical Evidence, Bond Fundaments, Valuation and Bond Yield, Term structure, Bond Theorems, Bond Portfolio Management Strategies, Passive and Active Management, Portfolio Management, Portfolio Objectives, Evaluation of Portfolio Performances, Application of Portfolio performance measures
10	**Contents for lab**	No

List of electives from the specialization basket of Marketing Management

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS041	Consumer Behavior	3-0-0	3	Odd
2	MS042	Advertisement and Sales Promotion Management	3-0-0	3	Even
3	MS043	Product and Brand Management	3-0-0	3	Odd
4	MS044	E-marketing	3-0-0	3	Even
5	MS045	Retail Management	3-0-0	3	Odd
6	MS046	International Marketing	3-0-0	3	Even
7	MS047	Sales and Distribution	3-0-0	3	Odd
8	MS048	Marketing Research	3-0-0	3	Even
9	MS049	Service Marketing	3-0-0	3	Odd
10	MS050	Strategic Marketing	3-0-0	3	Even

1	Program	MBA/IPG MBA
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS041
5	Title of the subject	Consumer Behavior
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Explaining the basic concepts of Consumer Behavior and its linkages to marketing. Examine how markets are segmented, and brands are positioned. Analyse the phenomenon of consumer learning about a brand and forming perceptions about it. Compare how the theoretical aspects of Consumer Behaviour are practiced in real scenarios by marketers and brands.
9	Brief Contents	Consumers, Marketers, and Technology, Consumer Behavior and Technology, Market Segmentation and Real-Time Bidding, The Consumer as an Individual, Consumer Motivation and Personality, Consumer Perception and Positioning, Consumer Learning, Consumer Attitude Formation and Change, Communication and Consumer Behavior, Persuading Consumers, From Print and Broadcast to Social Media and Mobile Advertising, Reference Groups and Communities, Opinion Leaders, and Word-of-Mouth, Social and Cultural Settings, The Family and Its Social Standing, Cultural Values and Consumer Behavior, Cross-Cultural Consumer Behavior: An International Perspective, Consumer Decision-Making, Marketing Ethics, and Consumer Research, Consumer Decision-Making and Diffusion of Innovations, Marketers' Ethics and Social Responsibility, Consumer Research.
10	Contents for lab	Case study exercises

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS042
5	Title of the subject	Advertisement and Sales Promotion Management
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the key concepts of advertising and sales promotion. To explore an organisation's numerous copy and media decisions. To understand the link between advertising and sales promotion for enhancing brand equity

9	Brief Contents	Role of integrated marketing communication, Role of IMC in marketing process, Marketing and promotions process, Organizing for advertising and promotion: the role of Ad agencies and other marketing communication organizations, Perspectives on consumer behavior, The communication process, Source, message and channel factors, Establishing objectives and budgeting for the promotional program, Creative strategy: planning and development, Media planning and strategy, Media decisions, Evaluation of broadcast media, The internet and interactive media, International advertising and promotion, Advertisement effectiveness, Sales promotion, Linkage between advertising and sales promotion, Brand equity, Regulation of advertising and promotion, Evaluating the social, ethical, & economic aspects of advertising & promotion.
10	Contents for lab	Case study exercises Class projects and exercises Field projects and company visits

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS043
5	Title of the subject	Product and Brand Management
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	After completion of this course students will be able to understand the concept of product and brand management, branding as marketing strategy; brand equity and its measurement, and operational aspects of brand management.
9	Brief Contents	Introduction and concept of product management, Management of new product development process, Understanding and managing product life cycle, Introduction to brand management, Brand management process, Brand choice decisions and models, Brand identity, Brand communication, Brand positioning, Brand image and personality, Brand valuation, Brand tracking and monitoring, Building brands in Indian market, Launching a new brand, Revitalizing brands, Brand extension strategies, Brand portfolio management, Managing brands across geographical borders, Managing brand experience, Digital branding, Employment branding, Co-branding.
10	Contents for lab	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS044
5	**Title of the subject**	E-Marketing
6	**Any prerequisite**	Marketing Management
7	**L-T-P**	3-0-1
8	**Learning Objectives of the subject**	To explore frameworks for the successful planning and execution of e-campaign strategies. To understand ROI enhancement, customer lifetime value and firm profitability aligned with business goals through e-marketing. To plan and implement search engine and social media campaigns in simulated environments. To understand leveraging digital marketing funnel for better customer engagement. To understand reach, engagement and conversions with paid and unpaid e-campaigns. To measure and optimize the e-campaigns through different matrices. Strategic application of digital marketing best practice.
9	**Brief Contents**	Marketing in the digital world, Exploring customer behaviour and customer journey in digital world, Crafting and executing digital strategy, Aligning business strategy, Reaching and engaging the customer, Strategies for paid and unpaid e-campaigns, Display, social media and e-mail campaigns, User experience and transformation, True personalization, Customer service, Content strategy, Matrices for strategy evaluation, Digital analytics, Emerging technologies
10	**Contents for lab**	Case study exercises Class projects and exercises Field projects and company visits

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS045
5	**Title of the subject**	Retail Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, students should be able to: Demonstrate an understanding of how retailers develop a retail mix to build a sustainable competitive advantage. Explain how retailers use marketing communications to build a brand image and customer loyalty. Understand the integration of merchandise management and supply chain strategies leading to excellent customer service. Understand the financial implication

		of strategic retail decisions. Demonstrate an understanding of decisions retailers make to satisfy customer needs in a rapidly changing and competitive environment.
9	**Brief Contents**	Introduction to the world of Retailing : A. History of retail, B. Retail overview and present scenario C. Concept and Functions performed by retailers D. Emerging Trends and career opportunities in retailing, Types of Retailers: A. Retailer characteristics B. Retail Formats - Store based, Non-store based, Web based C. Various format within store based retailing e.g. specialty store, hyper market, supermarket, buying decision process : A. The buying process - need recognition, information search, evaluation of alternatives. B. Social factors influencing the buying process family, reference groups and culture retail market strategy: A. Definition of retail and market strategy B. Target market C. Building a sustainable competitive advantage like - customer's loyalty, location, human resource management, distribution and information system, vendor relations. D. Growth strategies - Market penetration, market expansion, retail format development diversification, integration, E. Global retail strategies F. Strategic retail planning process, Choosing retail location: A. Types of locations - Unplanned locations free standing sites B. Evaluation of area for location C. Evaluating specific area for locations, HRM In Retailing : A. Human resource planning, Recruitment and selection, training and development of retail employees. B. Motivation of retail employees, C. team building in retailing D. Employee Rewards and Incentives, Store Planning: Design & Layout, Retail Image Mix, effective retail space management, floor space management, Retail Supply Chain Management: A. Introduction to supply chain management B. The distribution across centres 24 C. Collaboration between retailer and vendor in SCM D. Inventory Management E. Warehousing F. Transportation G. Use of IT in SCM 8. Customer Relationship Management - The CRM process 9. Retail Information System Instructrual Strate, Merchandise Pricing: Concept of Merchandise Pricing, Pricing Objectives, External factors affecting a retail price strategy, Pricing Strategies, Types of Pricing.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS046
5	**Title of the subject**	International Marketing
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0

8	Learning Objectives of the subject	The course aims at providing knowledge to students to the global business activities, marketing in international business and global forces transforming the international business today. Participants will learn to plan effectively for the marketing of consumer and business needs and wants on an international level. Special emphasis will be placed on cultural and environmental aspects of international trade, and integration of culture and marketing functions.
9	Brief Contents	An Overview of International Marketing: The Scope and Challenge of International Marketing, The Dynamic Environment of International Trade, The Cultural Environment of Global Markets: History and Geography: The Foundations of Culture, Cultural dynamics in assessing Global markets, Culture, Management style, and Business systems, The Political environment: A Critical concern, The International legal environment: Playing by the rules , Assessing Global Market Opportunities: Developing a Global Vision through Marketing Research, Economic Development and the Americas, Europe, Africa, and the Middle East, The Asia Pacific Region, Developing Global Marketing Strategies: Global marketing management: Planning and Organization, Products and services for consumers, Products and services for businesses, International marketing channels, Integrated marketing communications and International advertising, Personal selling and Sales management, Pricing for international markets, Implementing Global Marketing Strategies: Inventive Negotiations with International Customers, Partners, and Regulators
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS047
5	Title of the subject	Sales and Distribution
6	Any prerequisite	Marketing Management
7	L-T-P	3-0-1
8	Learning Objectives of the subject	To understand the key concepts of sales and distribution. To explore an organisation's numerous distribution and sales channels. To broadly look at the role of sales and distribution as a key element within marketing strategy. To equip with basic skills required in sales and distribution management.

9	**Brief Contents**	Sales management and the business enterprise, Sales management, personal selling, and salesmanship, Setting personal-selling objectives, Determining sales-related marketing policies, Formulating personal- selling strategy, The effective sales executive, The sales organization, Sales department relations, Sales personnel management, Recruitment and selection, Sales training, motivation and compensation, Evaluation and supervision, Sales budget, Territories, control and cost analysis, Marketing channels, Managing channel partners, Channel information system, Logistics and supply chain management, International sales and channel management
10	**Contents for lab**	Case study exercises Class projects and exercises Field projects and company visits

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS048
5	**Title of the subject**	Marketing Research
6	**Any prerequisite**	Basic knowledge of statistics and research methodology
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To understand the formulation of marketing problem into a feasible research question. To design and execute a basic survey research project. To understand the research tools and techniques for executing a marketing project and decision making.
9	**Brief Contents**	Introduction to Marketing Research: Marketing research an introduction, marketing research process design, Research design formulation: Measurement and scaling, questionnaire designing, sampling and sampling distributions, Sources and collection of data: Secondary data sources, Data collection: survey and observation, experimentation, fieldwork and data preparation, Descriptive statistics and data analysis: Measures of central tendency, measures of dispersion, hypothesis testing for single population and two populations, ANOVA and Experimental designs, hypothesis testing for categorical data (chi-square test), correlation and simple linear regression analysis, Multivariate analyses (multiple regression analysis, discriminant analysis, conjoint analysis, factor analysis, cluster analysis, multidimensional scaling and correspondence analysis, Result presentation: Presentation of results, report writing, Applications of marketing research: Marketing mix research: Product, price, place and promotion research
10	**Contents for lab**	Descriptive statistics and data analysis: Measures of central tendency, measures of dispersion, hypothesis testing for single population and two populations, ANOVA and Experimental

		designs, hypothesis testing for categorical data (chi-square test), Correlation and simple linear regression analysis, Multivariate analyses (multiple regression analysis, Discriminant analysis, conjoint analysis, factor analysis, Cluster analysis, Multidimensional scaling and correspondence analysis

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS049
5	Title of the subject	Service Marketing
6	Any prerequisite	Basic knowledge of Marketing Management
7	L-T-P	3-0-0
8	Learning Objectives of the subject	To provide an in-depth appreciation and understanding of the unique challenges inherent in managing and delivering quality services. To develop an understanding of the 'state of the art' of service management thinking. To understand the marketing concepts in the perspectives of services.
9	Brief Contents	Service Marketing Introduction : Meaning and nature of services, classifications of services, Introduction to service marketing, Evolution of service marketing, Service marketing mix and Gaps model: 7Ps of service marketing, service gaps framework, perceived service quality, model of service marketing, Service design and service delivery: Introduction to service design and service delivery, service delivery process, service encounters and moments of truth, employee role in service delivery, role of service provider, intermediaries involved in service process and delivery, managing demand and supply of service, STP strategy for Services: Need for segmentation of services, bases of service segmentation, segmentation strategies in service marketing, need for targeting and positioning strategies for services, Consumer behaviour in service marketing: Customer expectations in services, Service costs experienced by consumer, the role of consumer in service delivery, customer responses in services, customer delight, service failure and recovery, Emerging issues in Service marketing: Strategic approach in service marketing, Service marketing in e-commerce and e- marketing, Telemarketing services
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS050
5	Title of the subject	Strategic Marketing
6	Any prerequisite	No

7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	On completion of this course, the student will be able to: Understand and critically discuss the marketing activities that impinge on our daily lives as business managers and citizens. Critically evaluate key marketing theory, concepts, research and current practice. Discuss critically decision-making processes and frameworks for selecting marketing objectives, target markets and marketing mixes. Discuss critically how marketing practice is influenced by contemporary challenges in the operating environment. Apply theoretical frameworks to real-world marketing innovation challenges: identifying their key features and implications, setting appropriate marketing objectives and evaluating alternative marketing strategies.
9	**Brief Contents**	Fundamentals of Marketing Strategies, Marketing management for a turbulent era, The marketing fit with corporate and business strategies, Capturing key Marketing environmental insights, Customer insights and customer connections , Capturing marketing insights for demand measurement, Market segmentation and target marketing, Conducting Marketing audits, Branding and positioning, Marketing strategies for competitive and market scenarios, The integrated marketing mix, Marketing Metrics and Analytics, Organising, planning, delivering and measuring market performance, Innovation and Marketing Strategy, Marketing Channels and Pricing, Marketing Communications, Digital and Social media marketing, Marketing strategy to the bottom of the pyramid, Frugal & Grass root marketing
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	
5	**Title of the subject**	Customer Relationship Management
6	**Any prerequisite**	Marketing Management
7	**L-T-P**	3-0-1
8	**Learning Objectives of the subject**	To understand the meaning and application of CRM. To explore the benefits of CRM to companies and consumers. To explore CRM best practices implementation in organizations. To understand the importance of bonding and building loyalty with customers. To explore the ways of building long-term customer relationships.

9	**Brief Contents**	Introduction to CRM, Market segments, buyer personas, and voice, Understanding and building customer relationships, Managing the customer journey, Strategic CRM, Operational CRM, Analytical CRM, Economies of CRM, CRM applications, CRM in business markets, Building effective internal structure, and choosing the right CRM solution, CRM Implementation, Streamlining processes, automating where possible, and employing analytics, Futuristic developments
10	**Contents for lab**	Case study exercises Class projects and exercises Field projects and company visits

List of electives from the specialization basket of Management of Social Sector

S. No	Course Code	Title of the Course	L-T-P	Credits	Semester
1	MS051	Public Policy and Processes	3-0-0	3	Odd
2	MS052	Public Private Partnerships	3-0-0	3	Even
3	MS053	Sustainable Development	3-0-0	3	Odd
4	MS054	Management of Rural and Social Sector	3-0-0	3	Even
5	MS055	Information Technology Enabled Services	3-0-0	3	Odd
6	MS056	Management of Non-Formal Organization	3-0-0	3	Even
7	MS057	Healthcare System Management	3-0-0	3	Odd
8	MS058	Emerging Areas in Management of Social Sector	3-0-0	3	Even
9	MS059	Infrastructure Management	3-0-0	3	Even

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS051
5	**Title of the subject**	Public Policy and Processes
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Describe formulation and implementation of policies. Employ role of various institutions and interest groups in policy formulation and implementation process. Assess role of various stakeholders in influencing policy processes and associated outcomes.
9	**Brief Contents**	Concepts and Theories of Public Policy and Processes: Understanding public policy, Policy types, Approaches to policy making- various models of policy making and their relevance, Institutions and its role in Public Policy: Policy making institutions in India: Judiciary, executive and legislature, How policy making is accomplished in India, Constitutional/statutory bodies and its role in policy process, Political institutions,

Changing role of institutions: new public management, New governance model, Role of networks in shaping public policy, Policy Process: Formulation of policies: Principal phases of policy process: issue identification/agenda setting, Stakeholder consultation and review, Transparency in policy formulation, Identifying the main actors/stakeholders in the policy process, Idea of political power and influence, Regional versus national interest, Policy Process: implementation of policies: policy implementation, Identifying implementation gaps, Feedback on policies, Policy implementation as a political process: political economy, Service Delivery, Accountability and people's participation: role of decentralization and local governance, Policy Change: Identifying role of domestic and international actors in determining policy choices, Endowments and Constraints on their power to determine policy choices civil Society/pressure groups/networks and its role in influencing policy decisions, Market (private sector/business) as an agent in influencing policy decisions, Media and its role in public policy

| 10 | **Contents for lab** | No |

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS052
5	**Title of the subject**	Public Private Partnerships
6	**Any prerequisite**	
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Upon successful completion of the course, student should be able to: Understand the role of cooperation between public and private sectors in delivering public services; to develop understanding of PPP models and their contextual suitability; and employ various types of partnerships and assess their consequences.
9	**Brief Contents**	PPP Concept, Benefits and Limitations- Public service delivery and roles of government, recent trend of reforms on public service delivery, basic theories of pubic private partnership (PPP) PPPs Models- Concept and practices of outsourcing, Competition between private and public sectors, such as competitive sourcing and market testing, concept and practices of various types of private finance initiative (PFI), recent issues in PFI practices, theories and practices of deregulation, involvement of citizens, non-profit organization (NPOs) and social enterprises in public service delivery, Basic theories and practices of executive agencies and public corporations, theories and practices of privatization, recent practices to bring outsourced public services back in-house Government Role for Creating an Enabling PPP Environment- Conventional and innovative approaches for improving government procurement, practical models of shared services in public sector, advantages and disadvantages of PPP, strategies, steps, monitoring, evaluation of PPP, skills and resources required for managing PPP

		Risk Identification and Allocation- Risk assessment, value for money (VfM) and commercial feasibility exercises, risk identification, political risks, market risks, challenges for public service delivery and possible (desirable) future directions PPP Structure and Financing- Financing options, profitability assessment, funding cost, project attractiveness.
10	**Contents for lab**	N/A

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS053
5	**Title of the subject**	Sustainable Development
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	To enhance students understanding of the SDGs to create a better- informed citizenry, which will lead to a more sustainable action by all and for all. To understand the basic concept of Sustainable Development (SD), the environmental, social and economic dimensions. To know the history of the SD idea. To Be able to discuss the conflicts which are involved in the SD concept on the national as well as on the global scale. To be familiar with potential strategic options for SD (efficiency, sufficiency). To be able to discuss the (dis-advantages) of instruments for SD. To understand the SD challenge for companies, their responsibility and their potentials for action.
9	**Brief Contents**	Sustainability, sustainable development, and the sustainable development goals; SDGs overview, goals, and targets, Instruments for sustainable development, SDG Goal part-1 : Poverty, Hunger, Good health and Well-being, SDG Goal part-2 : Gender equality, Reduced inequalities, SDG Goal part-3 : Clean water and sanitation, Affordable and clean energy, SDG Goal part-4: Quality education, Decent work and Economic growth, SDG Goal part-5 Industry, Innovation, and Infrastructure; SDG goal part- 6: Sustainable cities and communities, Responsible Consumption and Production, SDG Goal part-7 Climate action, Life below water, Life on land; SDG Goal part-8 Peace, Justice, and Strong institutions, #17 Partnerships for goals, Implementing the SDGs, Monitoring, Evaluation, Reporting, Beyond sustainability to radical transformation, Company perspectives
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Even
3	**Type of course**	Elective
4	**Code of the subject**	MS054

5	**Title of the subject**	Management of Rural and Social Sector
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Course is designed to inculcate students with realistic understanding of rural segment and society for the application of managerial and technological learning.
9	**Brief Contents**	Indian rural and social sectors, Rural and sector economic development, Different rural and social sector reform programmes of Asia; Local, National and International focuses and policies for economic reforms of rural and social sectors.
10	**Contents for lab**	No

1	**Programme**	MBA/IMG
2	**Semester**	Odd
3	**Type of course**	Elective
4	**Code of the subject**	MS055
5	**Title of the subject**	Information Technology Enabled Services
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Understand the business strategy and business implications for strategic IT planning. Equip students to understanding the concepts of IT infrastructure library and services
9	**Brief Contents**	Business Strategy: Challenges- opportunities, Interconnection establish principles before practice, IT strategy, Application strategy, Technology strategy for IT, IT management strategy, Developing IT strategy for competitive advantage, Stages of IT strategy development and implementation, Challenges of IT and business strategy alignment, Inhibitors of business and IT strategy alignment, Three-D framework for Business and IT strategy alignment, Business implications for IT strategy and planning, Strategic IT planning, Motivations, SITP Process: Prevalent planning approaches difficulties, Best practices for achieving good SITP, SITP approaches: Prevalent researches, Defining EITA, Contents of a typical enterprise IT architecture, Standard for enterprise IT architecture, Technology Management strategy framework, Information Technology Infrastructure Library (ITIL), ITIL overview- ITIL Service-support processes, Incident management, Problem management, Service delivery, Service level management- Financial management, Capacity management, IT Service continuity management (ITSCM), Availability management, Imperatives for outsourcing, IT management layers- Variants of outsourcing, Business process outsourcing, Insourcing.
10	**Contents for lab**	No

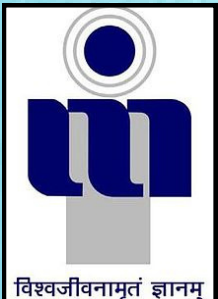| 1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS056
5	Title of the subject	Management of Non-Formal Organization
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	The Non-Informal sector is the backbone of the Indian Economy. The understanding of the issues related to the informal sector is necessary to have a better understanding of the Indian economy. This course would try to educate the researcher on different issues related to the informal sector in India and across the developing countries. This paper would enable the management student and potential researcher to conduct some in-depth research work in the unorganized sector.
9	Brief Contents	Introduction: Why the Informal Economy Matters to Management, Concept, Features and Types of Non formal sector, Difference between formal and informal organisation, Function of Non formal sector ,Formalizing informal sector, Challenges of the informal economy for the field of Management, Theoretical Foundations: A General Equilibrium approach, Communication, Visibility, and the Informal Economy, Technology in Non formal sector – Application and challenges, Management of The ICT in Non informal sector, Small Business in the informal Economy, Informal Financial Services: A Proposed Research Agenda, The hidden enterprise culture: Entrepreneurship in the Non informal sector, Organization and Contract in the Informal Economy, Comparative Economic Organization Revisited: Hybrid Governance in the Informal Economy, Factors Influencing the Registration Decision in the Informal Economy, Informal Firms in India What Do We Know and Where Does the Research Go, Healthcare in the Informal economy, Subsistence Entrepreneurs and Formal Institutions: Semi-formal Governance among Indian Entrepreneurs, Learning From India's Aadhaar Project, Lesson form Akshyapatra',Lesson from 'Arvind Eye care'
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Odd
3	Type of course	Elective
4	Code of the subject	MS057
5	Title of the subject	Healthcare System Management
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Delve into the components and functions of health care provider organizations and assess the unique challenges involved

in managing complex health care organizations. Appraise the motivations and interests of key internal and external stakeholders and managing expectations and communicating with these stakeholders. Weigh common problems and decisions faced by health care managers, and explore the implications of various alternative strategic solutions

| 9 | Brief Contents | Issues in health management: leadership, management and motivation, Organizational behavior and management thinking, Strategic planning, Information systems, Complexity and purpose of health care organizations, For profit and non-profit organizations, Management responsibilities and health care operations, Management code of ethics and ethical decision-making, Care and cure processes, Operations management, Impact of the pandemic on providers and caregivers, Physician practice management, The post-pandemic health care system, Strategic planning, Industry consolidation |
| 10 | Contents for lab | No |

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS058
5	Title of the subject	Emerging Areas in Management of Social Sector
6	Any prerequisite	No
7	L-T-P	3-0-0
8	Learning Objectives of the subject	Upon successful completion of the course, student should be able to: Apply social work skills, values and ethical responsibilities to leadership, management and supervision practices. Describe and critique selected theories, research and practice approaches relevant to effective and socially just leadership and management in human service organizations. Create a plan for strategic change using concepts, processes and skills related to leadership, management, and organization development.
9	Brief Contents	Corporate governance, Project management, Social entrepreneurship for sustainable development, Strategic planning for social sector organizations, Essentials of managing a social organization, Understanding financial statements, Measuring project results, Systems and tools for impact measurement, Social impact marketing and sales management, Scaling a social enterprise, Attracting & raising capital, Market regulation and compliance.
10	Contents for lab	No

1	Programme	MBA/IMG
2	Semester	Even
3	Type of course	Elective
4	Code of the subject	MS059

5	**Title of the subject**	Infrastructure Management
6	**Any prerequisite**	No
7	**L-T-P**	3-0-0
8	**Learning Objectives of the subject**	Understanding the importance of infrastructure in supporting economic development, quality of life, and public safety. Understanding the roles and responsibilities of different stakeholders involved in infrastructure management, including government agencies, private sector organizations, and community groups. Developing skills in infrastructure asset management, including maintenance, repair, and replacement of infrastructure assets. Understanding the principles of sustainable infrastructure development and management, including considerations of environmental and social impact. Developing an understanding of risk management, including identifying, assessing, and mitigating risks associated with infrastructure systems. Understanding the legal and regulatory frameworks governing infrastructure development and management. Developing an understanding of the financing and funding mechanisms for infrastructure projects, including public-private partnerships and other innovative financing approaches.
9	**Brief Contents**	Introduction to Infrastructure Management: Definition and scope of infrastructure, Importance of infrastructure management, Historical development of infrastructure management, Types of Infrastructure: Transport, Water and wastewater infrastructure, Energy infrastructure management, Telecommunication management, Asset Management: Asset inventory and condition assessment, life cycle costing, risk management, Funding and Financing of Infrastructure: Public sector funding, private sector funding, public -private partnership, Project Management: Project identification and selection, project planning and design, project procurement and contracting, construction management and supervision. Infrastructure Policy and Regulation: Government policy on infrastructure, regulatory framework for infrastructure management, environment regulations and considerations, Emerging trends in Infrastructure management: New technologies for infrastructure management, Sustainability and resilience considerations, Future challenges and opportunities in infrastructure management
10	**Contents for lab**	No